NC STATE UNIVERSITY

FOR 353: Air Photo Interpretation and Photogrammetry

Introduction/Syllabus

Center for Earth Observation

General Information

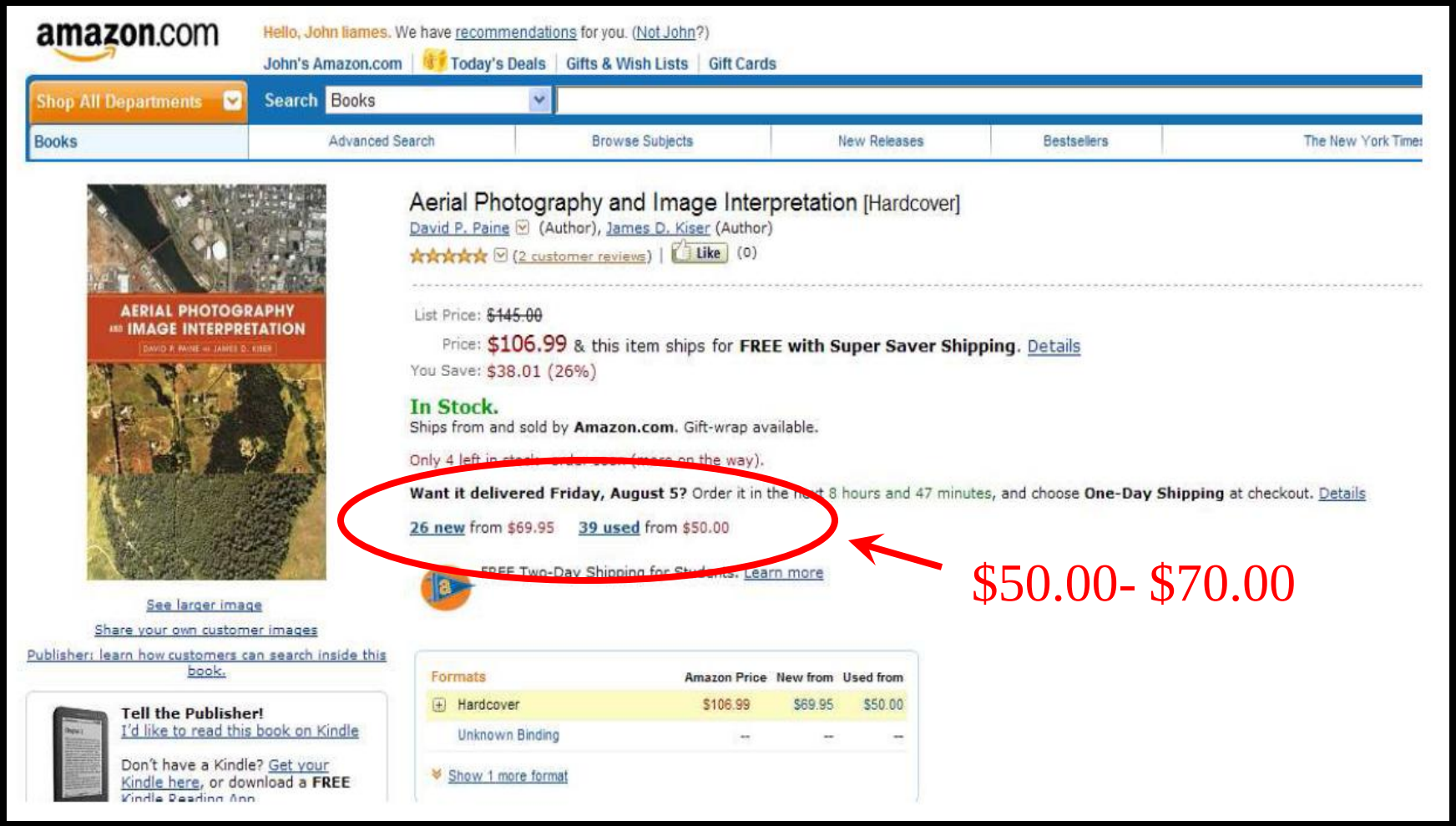
Instructor:	Dr. John S. Iiames (jsiiames@ncsu.edu), 919-541-3039
Lecture Hours:	Mon 4:35 pm – 6:25 pm
	Rm 3214 Jordan II
Lab TA's:	Joshua Verkerke (jlverker@ncsu.edu) Rm 5118
Lab Hours	Monday (1:30-4:15) Rm 2230 – Jordan II
	Tuesday (1:30-4:15) Rm 2230 – Jordan II

General Information

Text: Aerial Photography and Image Interpretation , second edition, by D.P. Paine and James D. Kiser, John Wiley and Sons, 2003.

Course Packets (Required): Available at the NCSU Bookstore (1) handouts, homework, lab exercises, and dot grid and (2) lab packet with 11 photographs, grease pencil, eraser, acetate sheets and engineer scale

General Information



General Information

Basis of Grades:	Lecture Midterm Exam	25%
	2 Lab Midterms (10% each)	20%
	Homework	10%
	Lab work	20%
	Final Exam (Comprehensive)	25%
	Total	100%

General Information

Grading scale:

Grade	Percentage
A+	97 - 100%
A	93 - 96.9%
A-	90 - 92.9%
B+	87 - 89.9%
B	83 - 86.9%
B-	80 - 82.9%
C+	77 - 79.9%
C	73 - 76.9%
C-	70 - 72.9%

Grade	Percentage
D+	67 - 69.9%
D	63 - 66.9%
D-	60 - 62.9%
F	0 – 59.9%

Course Syllabus

Lecture	Date	Day	Week	TOPIC	LAB
1	26-Aug-2013	Mon	1	Role/Syllabus-Expectations/"Why take this course?"/Photogrammetry: History and Photointerpretation	Stereoscopy (attendance grade)
2	26-Aug-2013	Mon	1	CameraDynamics_ElectromagneticTheory	
HOLIDAY	2-Sep-2013	Mon	2	NO CLASS	NO LAB
3	9-Sep-2013	Mon	3	Scale/Azimuth (EMR Homework #1 DUE)	Scale (PDF)
4	9-Sep-2013	Mon	3	Geometry of a Vertical Aerial Photograph	
5	16-Sep-2013	Mon	4	Height Measurements (Parallax/Displacement/Shadow)	Ht/Area/Azimuth (PDF)
6	16-Sep-2013	Mon	4	Area Measurements (Scale Homework #2 DUE)	
7	23-Sep-2013	Mon	5	Introduction to GIS (Heights Homework #3 DUE)	GIS & RS Demo/App
8	23-Sep-2013	Mon	5	Acquiring Existing Photography	
9	30-Sep-2013	Mon	6	Photo Mission Planning	DOQQ Analysis of Ht/Area/Azimuth
10	30-Sep-2013	Mon	6	Photo Mission Planning (Area/Azimuth Homework #4 DUE)	
	7-Oct-2013	Mon	7	**LECTURE MIDTERM**	Flight Line Planning
	7-Oct-2013	Mon	7		
11	14-Oct-2013	Mon	8	Map Projection and Coordinate Systems	TopoFlight (Flight Line Planning software)
12	14-Oct-2013	Mon	8	Locating True Positions/Radial Line Plotting (Photo Acquisition Homework #5 DUE)	
13	21-Oct-2013	Mon	9	Drainage Analysis	**LAB MIDTERM #1**
14	21-Oct-2013	Mon	9	Forest Type Mapping/Volume Estimation	
15	28-Oct-2013	Mon	10	RS Overview/Sensor Characteristics	Locating True Positions
16	28-Oct-2013	Mon	10	RS Process (I)	
17	4-Nov-2013	Mon	11	RS Process (II)	Forest Type Mapping
18	4-Nov-2013	Mon	11	Accuracy	
19	11-Nov-2013	Mon	12	Remote Sensing of Vegetation (Accuracy Homework #6 DUE)	Forest Volume Estimation
20	11-Nov-2013	Mon	12	Spectral Indices/LAI	
21	18-Nov-2013	Mon	13	UAV Applications	Landuse/Landcover
22	18-Nov-2013	Mon	13	Sensors/ Pods/ and other excellent stuff	
23	25-Nov-2013	Mon	14	Lidar and Radar Applications	LAI
24	25-Nov-2013	Mon	14	Object Oriented Image Classification	
	2-Dec-2013		15	*Review for LECTURE FINAL*	**LAB MIDTERM #2**
	2-Dec-2013		15		
	16-Dec-2013	Mon	16	**FINAL EXAM (1-4 pm)**	

My Background

B.S.	***Virginia Tech***	***Forest Resource Management***
M.S.	***NCSU***	***Remote Sensing/GIS (Forestry)***
PhD	***University of New Hampshire***	***RS/GIS (Forestry)***

Work Experience:

-International Paper (Inventory/Procurement Forester)

-Massachusetts Woodland Resources (Forester)

-Land Surveyor (Massachusetts, North Carolina)

-US Environmental Protection Agency (Research Biologist)

NC STATE UNIVERSITY

FOR 353: Air Photo Interpretation and Photogrammetry

Lecture 1a

Why take this course?

Center for Earth Observation

Why take this course?

Why take this course?

- A curriculum pre-requisite

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- A curriculum pre-requisite
- Added options for future employment

Why take this course?

- A curriculum pre-requisite
- Added options for future employment
- Salary structure for image analysts

2011 Salaries

- Average Image Scientist Salaries $78k/year (Senior scientists $125-150k/year)
- NC DOT (Technicians) $38k - $61k/year
- NC DOT (Project Managers) $70k/year
- Technical Lead – Fugro Earth - $76k - $81k/year

Why take this course?

- A curriculum pre-requisite
- Added options for future employment
- Salary structure for image analysts
- Understanding the underlying mathematics

Why take this course?

- A curriculum pre-requisite
- Added options for future employment
- Salary structure for image analysts
- Understanding the underlying mathematics
- Historical photointerpretation (change analysis, etc.)

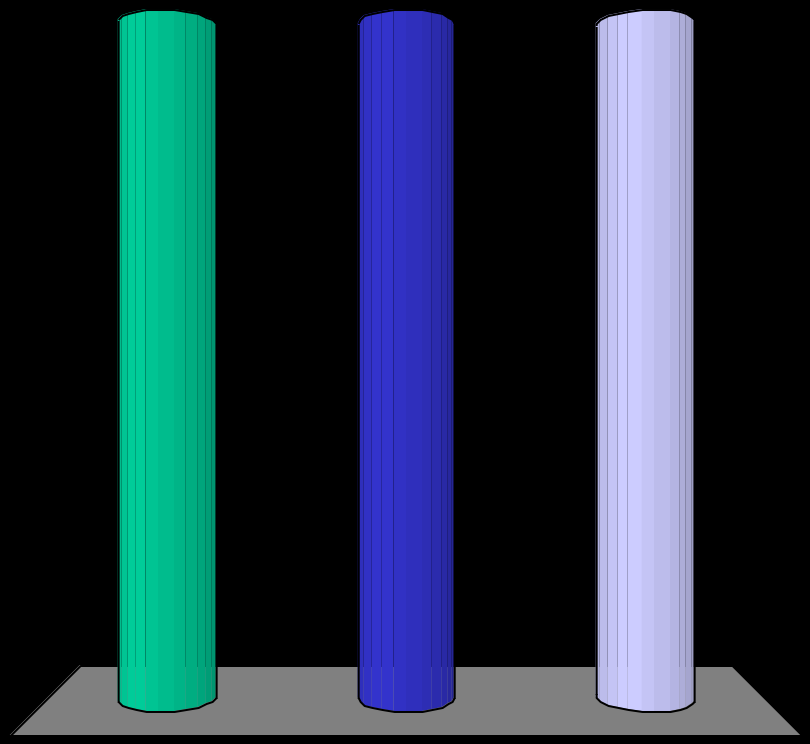
Do you expect to use geospatial information in your field of work?

:30

A. Yes

B. No

C. Maybe



Remote Sensing and GIS in the Remediation of Chemical Weapons Contamination in an Urban Landscape

E. Terrence Slonecker (US EPA)

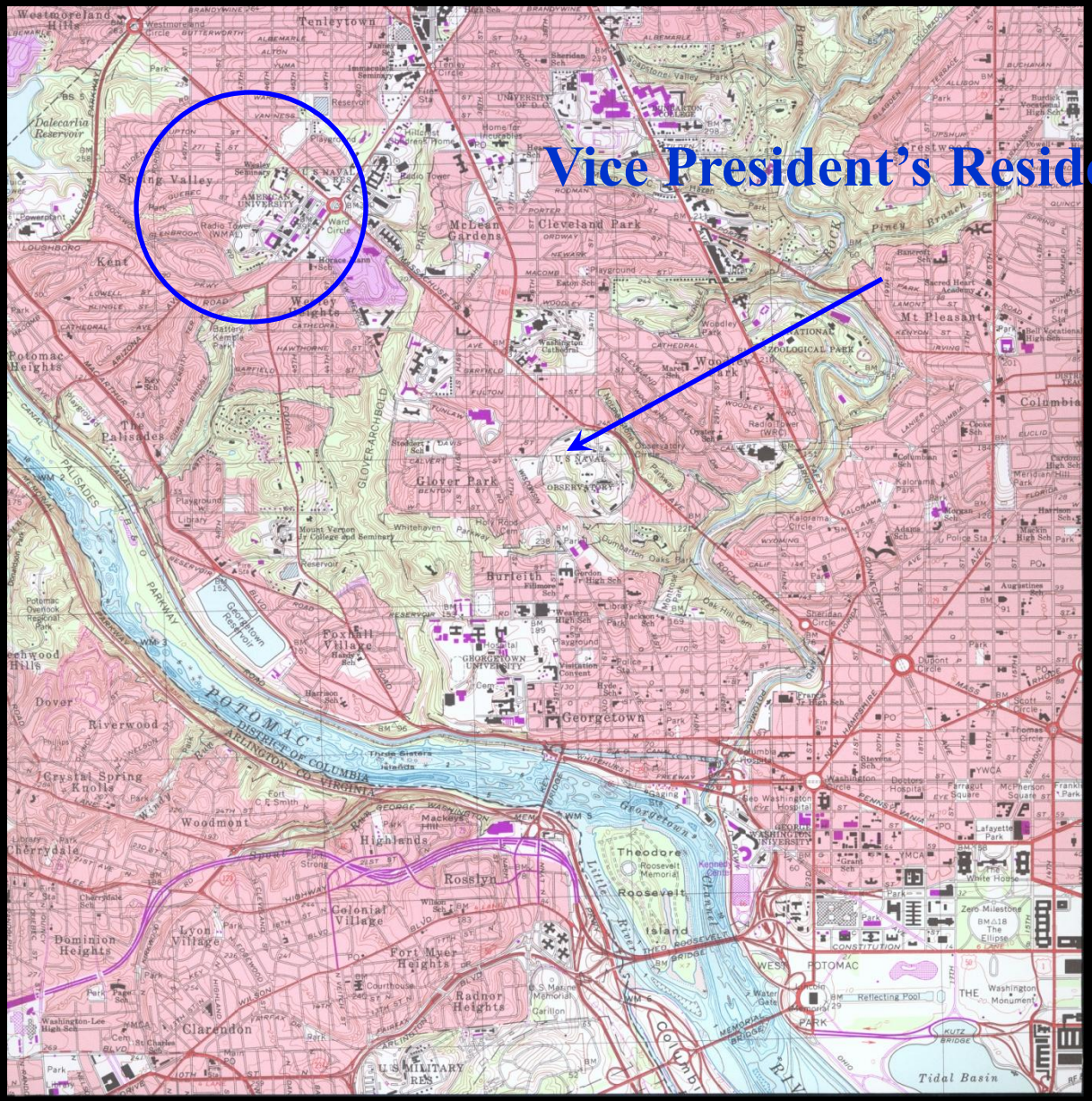
Use of Chemical Warfare during WWI

Gas Casualties from WWI

Casualties From Gas - The Numbers

Country	Total Casualties	Deaths
Austria-Hungary	100,000	3,000
British Empire	188,706	8,109
France	190,000	8,000
Germany	200,000	9,000
Italy	60,000	4,627
Russia	419,340	56,000
USA	72,807	1,462
Others	10,000	1,000

Spring Valley/ American University



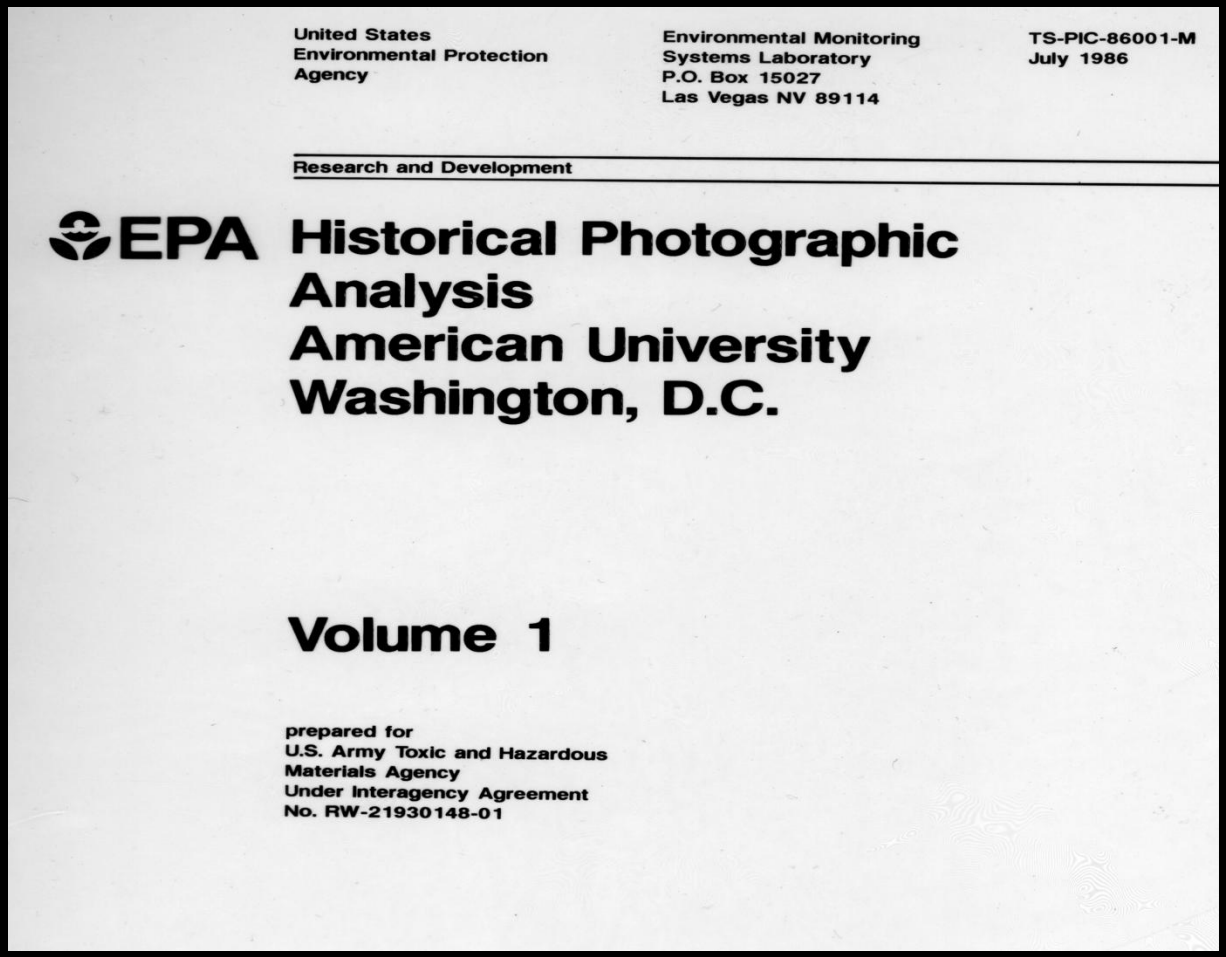
Chemical Weapons

- Mustard Gas
- Lewisite
- Arsenicals
- Phosgene
- Ricin
- 200+ Toxic Agents

Types of CW Testing

- Ordnance & Delivery
- Persistency
- Toxicity (Animal and Human)
- Countermeasure Effectiveness

USEPA Environmental Photographic Interpretation Center (EPIC)



United States
Environmental Protection
Agency

Environmental Monitoring
Systems Laboratory
P.O. Box 15027
Las Vegas NV 89114

TS-PIC-86001-M
July 1986

Research and Development

EPA

Historical Photographic Analysis American University Washington, D.C.

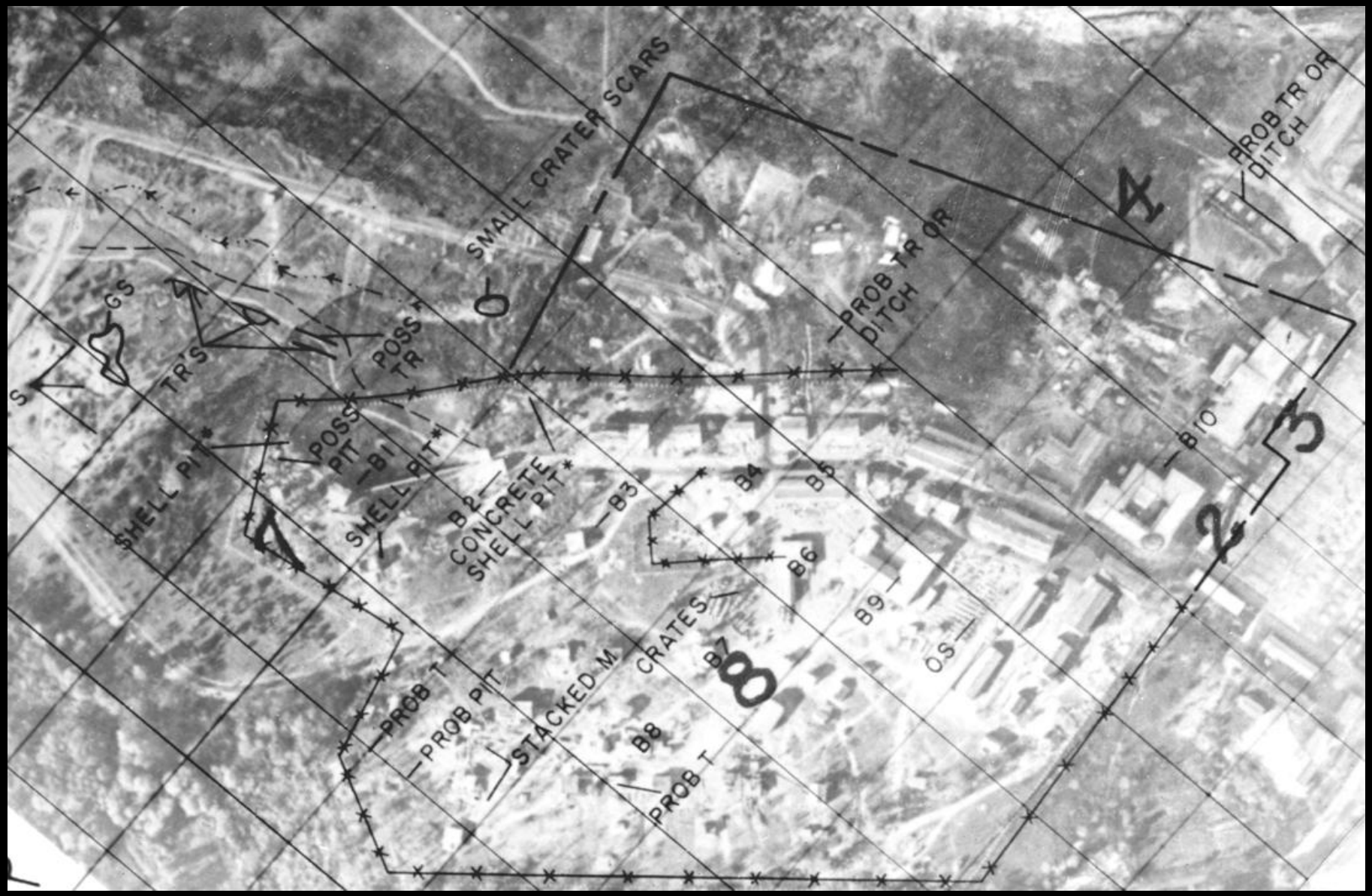
Volume 1

prepared for
U.S. Army Toxic and Hazardous
Materials Agency
Under Interagency Agreement
No. RW-21930148-01

Historical Air Photo Coverage Spring Valley Area

- **1918 AU**
- **1922 LOC/USAAC**
- **1927 NARA**
- **1927 USACOE**
- **1928 LOC/USAAC**
- **1931 NARA**
- **1936 NARA**
- **1937 NARA**
- **1940 NARA**
- **1945 NARA**

American University/Spring Valley Area
1918

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PROB
PROB
#2 Resize (Resize (Band 1:1991.tif):1991rr):1991x
Start
ArcVie...
IDL #...
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Availa...
#1 Sc...
#1 Zo...
#2 Sc...
#2 Zo...
#1 Re...
#2 ...
10:56 AM

NC STATE UNIVERSITY

FOR 353: Air Photo Interpretation and Photogrammetry

Lecture 1b

Photogrammetry: History and Photointerpretation

Center for Earth Observation

Definitions:

PHOTOGRAMMETRY

"the science, art, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting photographic images and patterns of recorded radiant electromagnetic energy, and other phenomena.."

PHOTO INTERPRETATION

"Deals principally in recognizing and identifying objects and judging their significance through careful and systematic analysis."

Short History of Photogrammetry/Remote Sensing

1826 Niepee takes first photo

1839 Louis Daguerre announced direct photographic process

1849 Laussedat – "Father of Photogrammetry" (topographic surveying)

1861 Three-color photographic process developed

1873 Vogel changes photo emulsions to allow infrared photography

1891 Roll film perfected

1903 First flight

1904 Carl Pulfrich of Germany, stereo pairs

1914-18 World War I photo reconnaissance

1939-45 World War II photo reconnaissance

1940s Radar invented

1942 Kodak patents false infrared film

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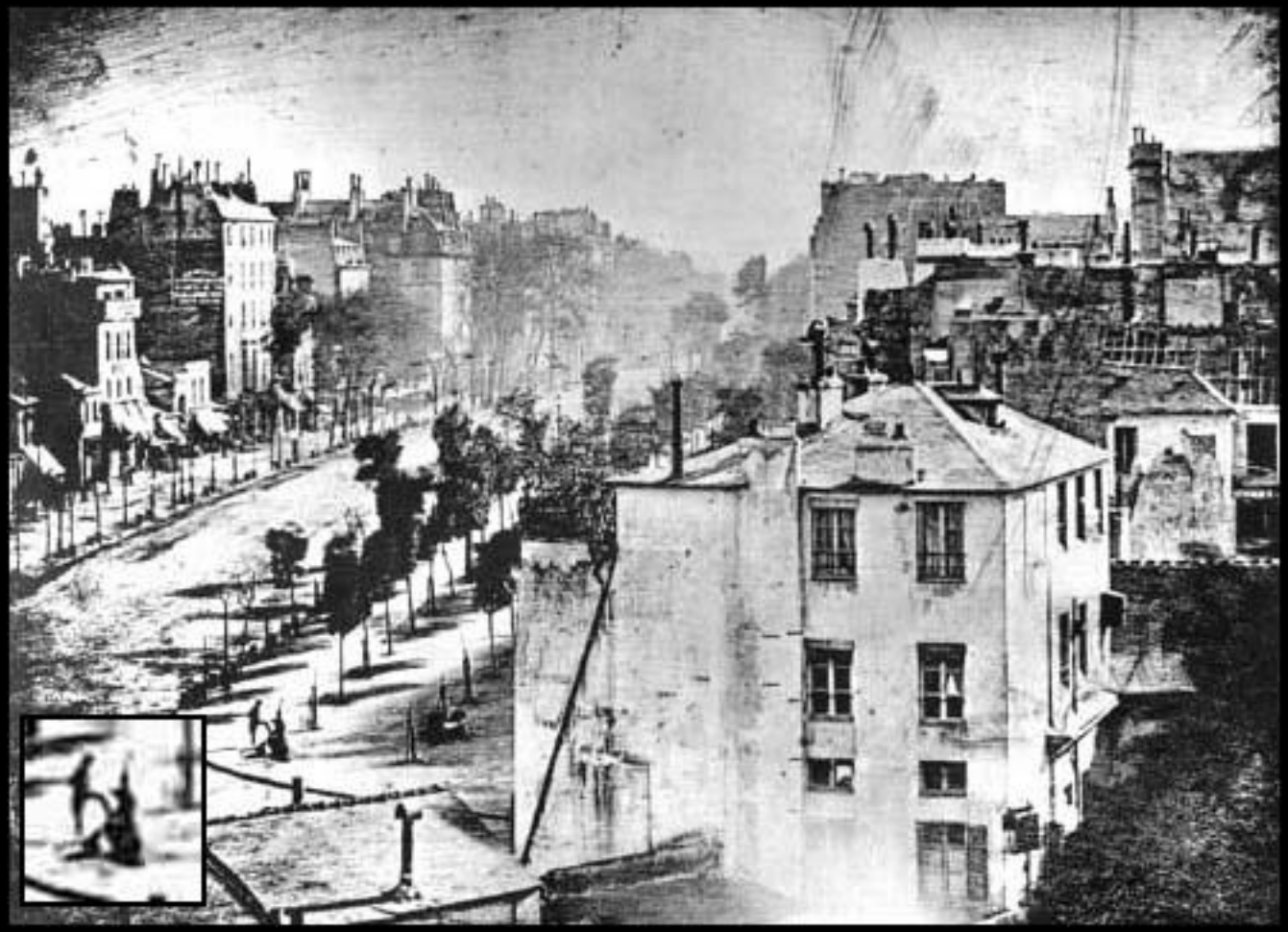
In 1827, Joseph Nicephoce Niepee (pronounced Nee-ps) reportedly took the first photograph.

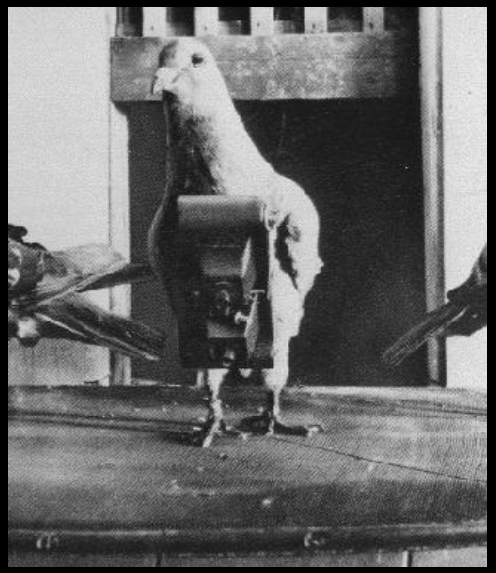


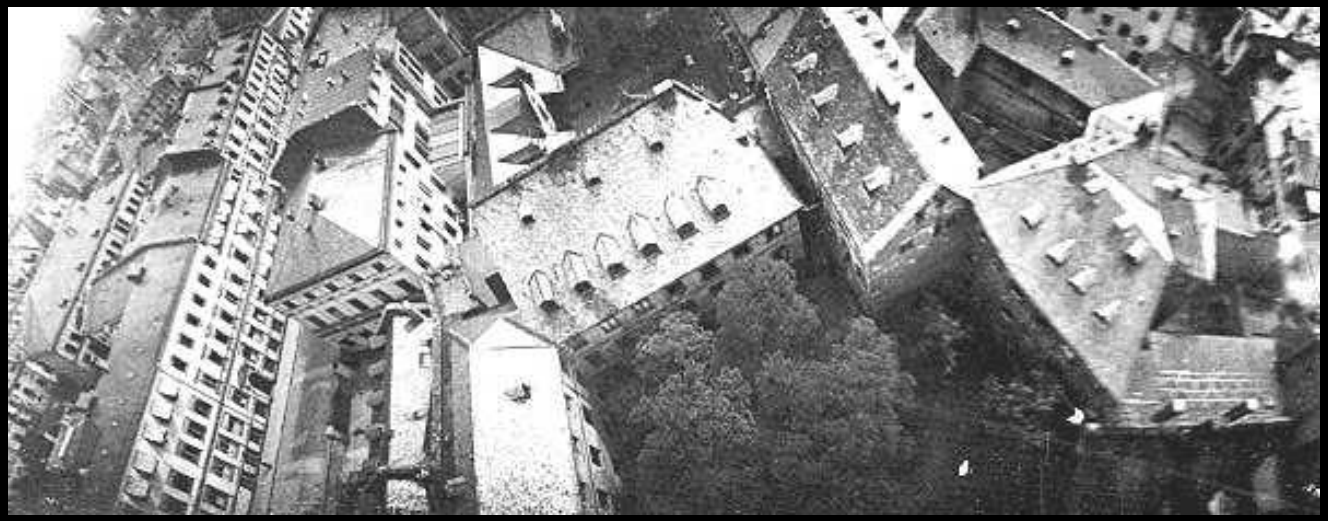
Taken in 1839, this photograph, taken from the roof of a tall building, might be considered the first oblique aerial photograph.

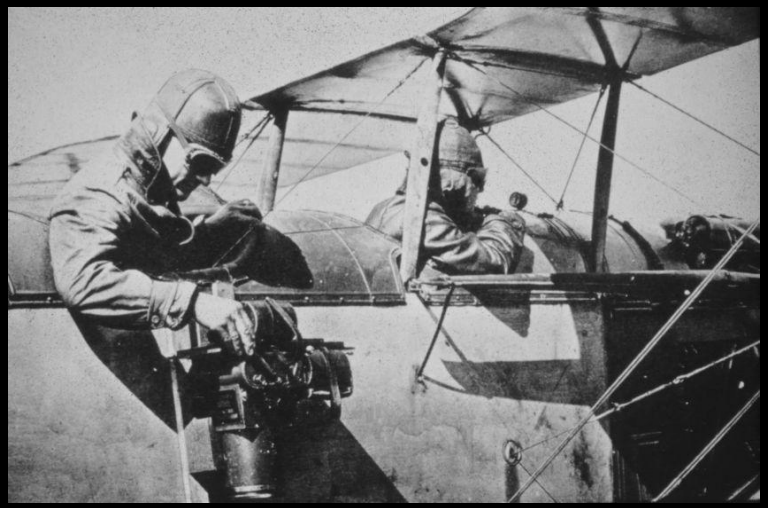
However, credit for the first aerial photograph goes to French author and artist Felix Tournachon who used the nom de plume Nadar. He captured the first aerial photo from a balloon tethered over the Bievre Valley in 1858.

The oldest extant aerial photograph is a view of Boston by James Wallace Black in 1860.

In 1903, Julius Neubranner, photography enthusiast, designed and patented a breast-mounted aerial camera for carrier pigeons

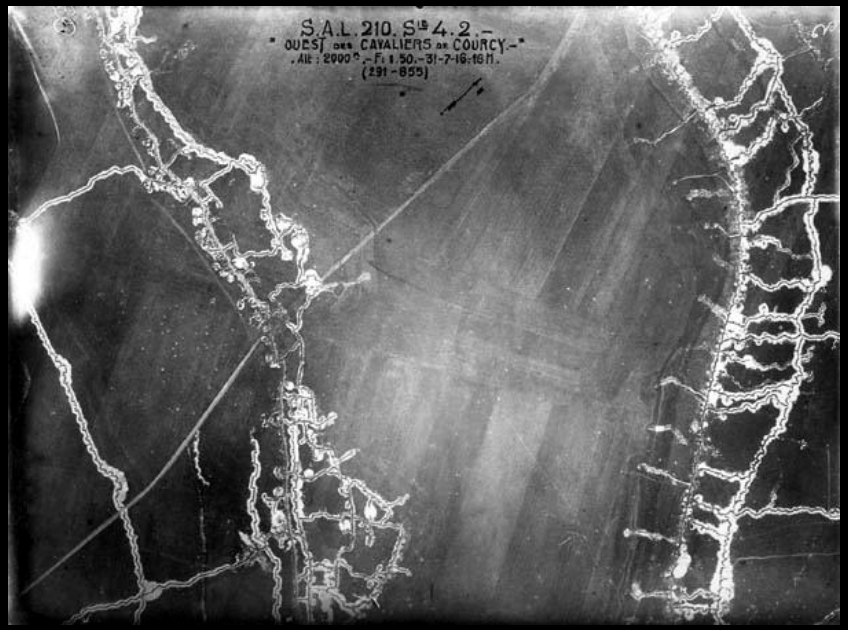


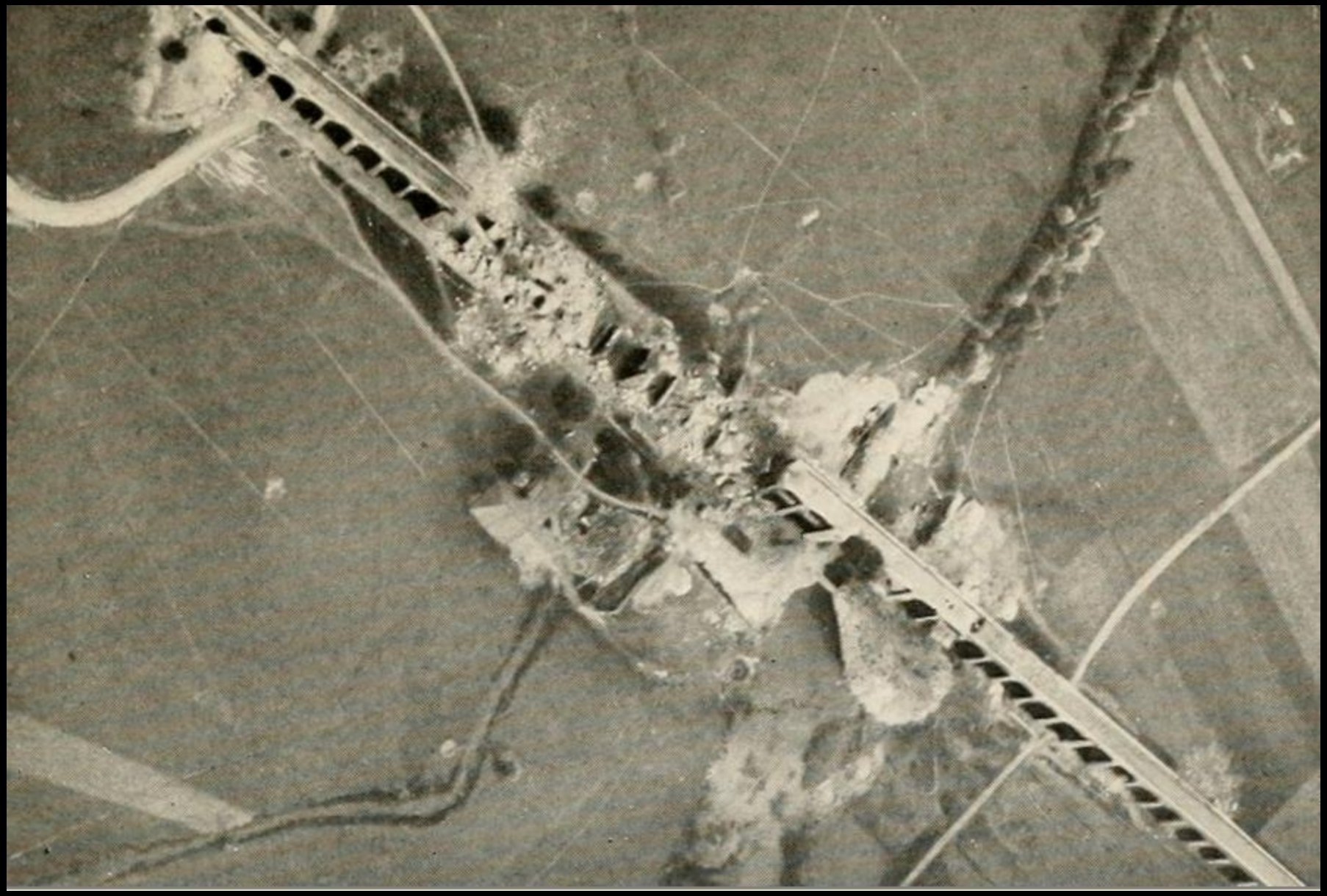




In 1879, Eastman Kodak discovered the formula for making a successful gelatin emulsion covered dry-plate. These developments led to the invention of rolled paper film. The resulting prints were sharp, clear and free from paper grain distortion

His work was shorty followed in 1903 by the Wright Brothers' first successful flight of a heavier-than-air aircraft. Another type of aerial platform was available.





World War I Aerial Photography

This is the first crude picture obtained from Explorer VI Earth satellite launched August 7, 1959

FIRST TELEVISION PICTURE FROM SPACE
TIROS I SATELLITE APRIL 1, 1960

This picture electrified the world when it was taken in 1966 by one of the Lunar Orbiter spacecraft.

Short History of Photogrammetry/Remote Sensing

1956-60 CIA U-2 Program

1957-58 First Russian and American Satellites

1960s Emphasis on photointerpretation; U-2 imagery shown to world; first digital processing and public unveiling of thermal infrared and radar.

1970s Specialization in R.S. available; R.S. first integrated with GIS

1973-79 Skylab

1972, 1975, 1978 Landsat 1, 2, 3

1981 Space Shuttle

1982-84 Landsat 4, 5

1986 SPOT Imaging

1990s Degrees in R.S. available; digital photogrammetry; LIDAR; Hyperspectral imagery; USGS takes over Landsat program

Short History of Photogrammetry/Remote Sensing

1993 Landsat 6 dives into Indian Ocean; SPOT 3

1998 SPOT 4

1999 Landsat 7 TM+; IKONOS

2000s Imagery readily available, often free

2001-2005 Quickbird, Google Earth

In 1972, from a distance of about 45,000 km (28,000 mi), the crew of Apollo 17 took one of the most famous photographs ever made of the Earth. This original Blue Marble inspired later images of the Earth compiled from satellite data.

History of aerial photos in Forestry?

- The first forester credited with pioneering aerial photography was German (1892)
- Vegetative mapping from aerial photos (British Empire - 1920's)
- Aerial timber volume estimation (1923) in Germany
- Aerial mapping of timber types (1929 – Canada; 1930's USA)
- Aerial photography for forest applications took off after WWII due to advancements in aerial recon/cameras/film (IR)

Photo Interpretation

Defined

"The act of examining photographic images for the purpose of identifying objects and judging their significance."

Objective

To be able to recognize landscape features on a aerial photograph and make inferences about the environment.

Requirements

Experience, ground visitations, background in earth and biological sciences

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

Relative size: the size of an unknown object in relation to the size of a known object.

Absolute size: the actual size of a landscape features, requires an understanding of the photo scale.

Size

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

Human manipulated land features have somewhat linear lines or angular shapes, (e.g., farm field) where natural features tend to have random or irregular shape

Shape

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

Give clues to the profile shape and relative sizes of landscape features.

Can obscure detail in other landscape features (i.e. cloud shadows)

Shadows

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

- tone / color differences make all other recognition elements possible

- Learn to interpret objects on different film types…

- understanding albedo / spectral signatures of objects

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

Tone depends on:

a) Light reflectivity of object
b) Light sensitivity of the film
c) Light scattering by haze
d) Light transmission by filter
e) Sun angle

Tone/Color

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

- The result of changes in tone, or the arrangement of tone
- on a landscape

- Textures: very fine, fine, medium, coarse, very coarse

Texture

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

- The spatial arrangement of objects on a landscape

- Human-made: well-defined geometric patterns made up of smooth lines and curves

- Natural: not as uniform

Pattern

Photo Interpretation

Principles of Photo Interpretation

- Size
- Shape
- Shadows
- Tone or Color
- Texture
- Pattern
- Association/Location

- A reasoning process to relate an object to its surroundings.
- Biological association is important in resource management.
- Requires knowledge of biological and geomorphic processes.
- Uses shape, size, textural, pattern, and tonal/color information.

Association

Which PI principle allows you to distinguish water quality between these two Wisconsin lakes?

A. Size

B. Shape

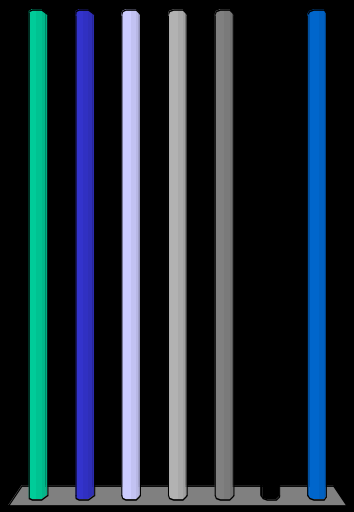
C. Shadows

D. Tone/Color

E. Texture

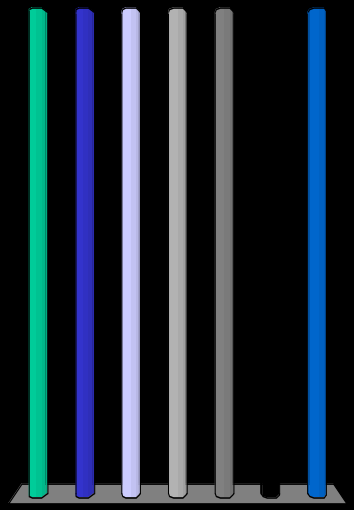
F. Pattern

G. Association/Location



Which PI principle points to the causes of poor water quality?

A. Size
B. Shape
C. Shadows
D. Tone/Color
E. Texture
F. Pattern
G. Association/Location



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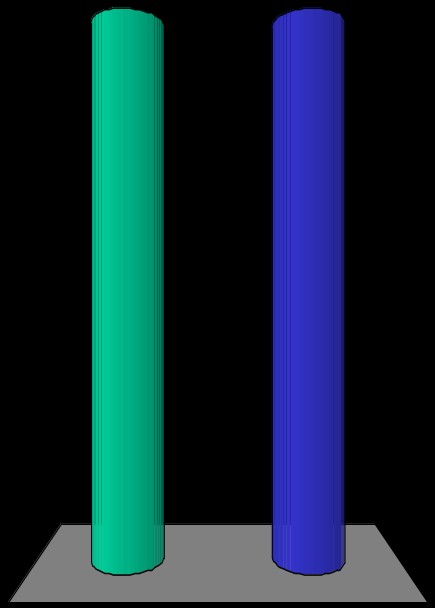
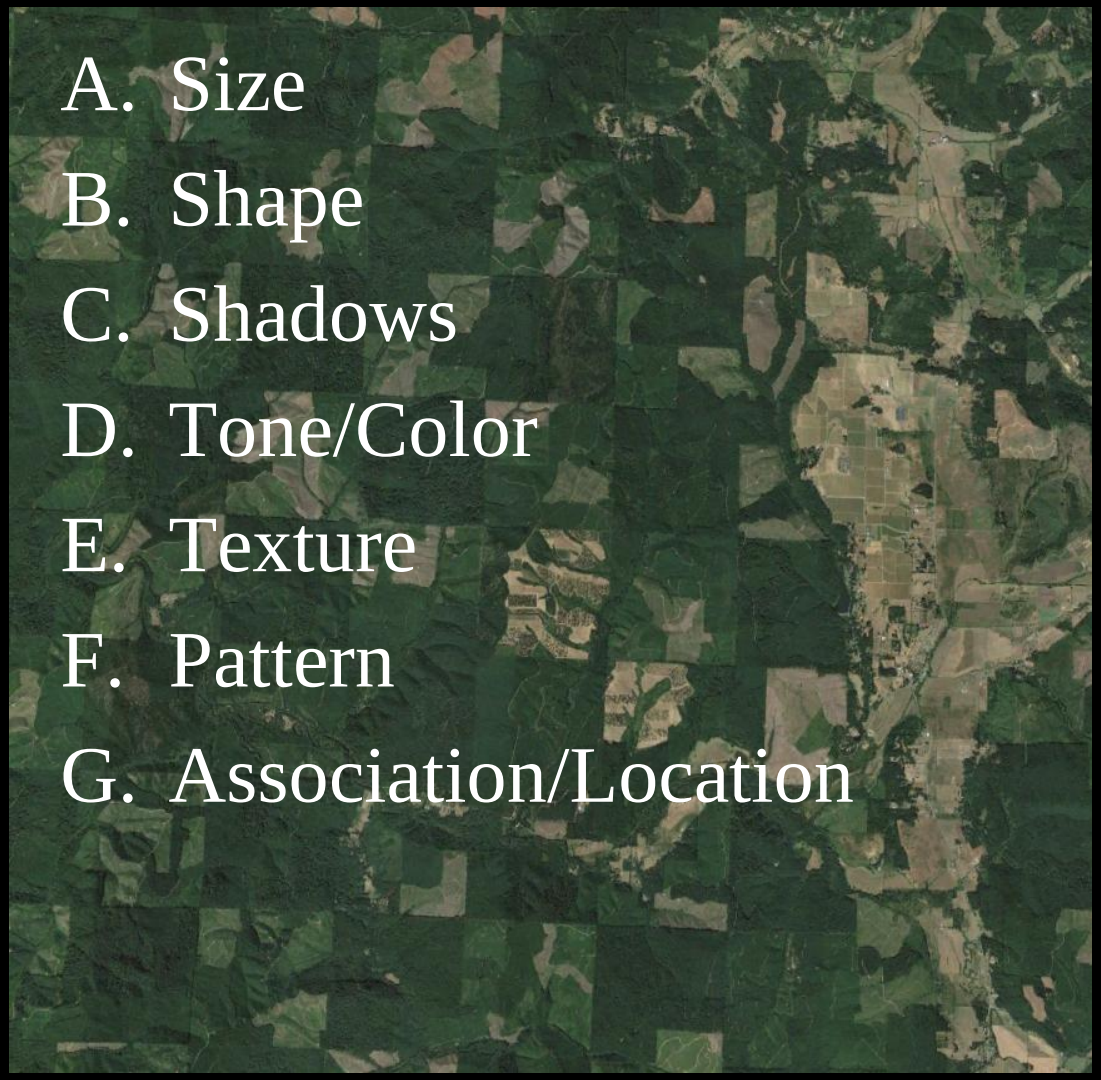
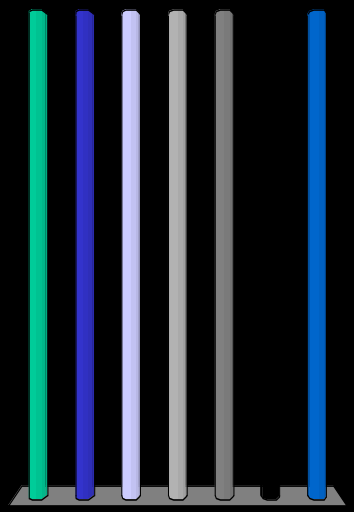
Is this an East or West coast image?



Which PI principle points to this being a west coast forestry operation?



A. Size
B. Shape
C. Shadows
D. Tone/Color
E. Texture
F. Pattern
G. Association/Location



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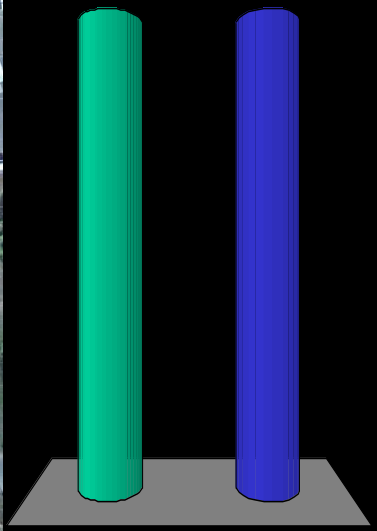
Is this a pulp/paper mill or sawmill?

A. Pulp/paper mill

B. Sawmill



Some Key Terms in Aerial Photography

Average Photo-base (PB): For adjacent air photos, the average of the distance between the PP and CPP on each photo

Camera-base (CB) (a.k.a. **Air-base**)**:** Ground distance between centres (PPs) of adjacent photos along a flight line

Conjugate Principal Point (CPP) (a.k.a. **Corresponding P.P.**): The location of a Principal Point from one photo on an adjacent photo along the flight line

Focal length: Distance from the optical centre of the lens to the focal plane, when the camera is focussed at infinity.

Control Point: A reference point precisely located on both the ground and the photo (ground control point) on both a map and the photo (map control point), or on two adjacent photos (photo control point)

Controlled Mosaic: A series of overlapping air photos that have been rectified and aligned with ground control points, to allow planimetrically-correct distance Measurements

Crab: Rotation of the camera (and aircraft) relative to the flightline

Drift: Lateral shift of the aircraft from the planned flightline

Eye-base (EB): Interpupillary distance, normally 6.4 (± 0.4) cm.

Fiducial Marks: Marks built into aerial cameras which appear on the sides or in the corners of the photo (or both), and which are used to determine the precise location of the principal point.

Forward Overlap: (a.k.a. **Endlap**): The amount of overlap between successive photos in a flight line to allow for stereo viewing (usually 60 – 70%)

High Oblique photo: An air photo which shows the horizon line (usually having high vertical tilt, of 60° or more)

Isocentre: The point on an air photo which lies halfway between the Principal Point and the Nadir (Tilt-displacement radiates from this)

Low Oblique Photo: An air photo tilted from the vertical, but not enough for the horizon to be visible (usually having vertical tilt of 3°- 60°)

Mosaic: A series of overlapping air photos

Nadir: That point on the ground vertically beneath the camera lens (or aircraft), or thepoint on the photo which corresponds to it. (Topographic Displacement radiates from this)

Orthophoto: A vertical air photo which has been rectified to remove parallax

Parallax: The apparent displacement of the position of an object, with respect to a reference point, caused by a shift in the point of observation.

Photo-base (PB): On a single air photo, the distance between the photo's principal point and the CPP of an adjacent photo (see Average PB)

Principal Point (PP): The geometric centre of an aerial photograph, located at the intersection of lines drawn between the fiducial marks (i.e., at the intersection of the x and y axes). (Lens distortion radiates from this)

Radial Line Triangulation (RLT): The production of planimetrically-correct (i.e. uniform scale) maps from two or more adjacent vertical air photos, using the techniques of resection and intersection.

Rectification: The process of converting a vertical air photo to remove displacements caused by tilt or topography (i.e., to remove parallax).

Sidelap (a.k.a. **Lateral overlap**): The amount of overlap between air photos in adjacent flight lines (usually 20 – 30%)

Stereogram: A stereopair or stereo-triplet mounted for proper stereovision (conjugate points 5.7±0.3 cm apart)

Tilt: Rotation of the camera away from the vertical, about the x- or y-axis

Tilt Displacement: Changes in position caused by scale variations related to the tilt of the camera, about either the x-or y-axis

Topographic Displacement (a.k.a. Relief Displacement, Radial Displacement, or Planimetric Shift due to Elevation): Changes in position caused by scale variations related to differences in elevation or height.

Uncontrolled Mosaic: A series of overlapping air photos which have not been aligned to ground control points

Vertical Air Photo: An air photo with less than 3° of vertical tilt

X-axis: For a single photo, the line through the photo showing direction of flight at the centre of the photo (i.e., nose-to-tail axis)

Y-axis: the line at right-angles to the x-axis (i.e., wingtip-to-wingtip axis)