U.S. CORPS OF TOPOGRAPHICAL ENGINEERS

A HISTORY OF SURVEYING

By
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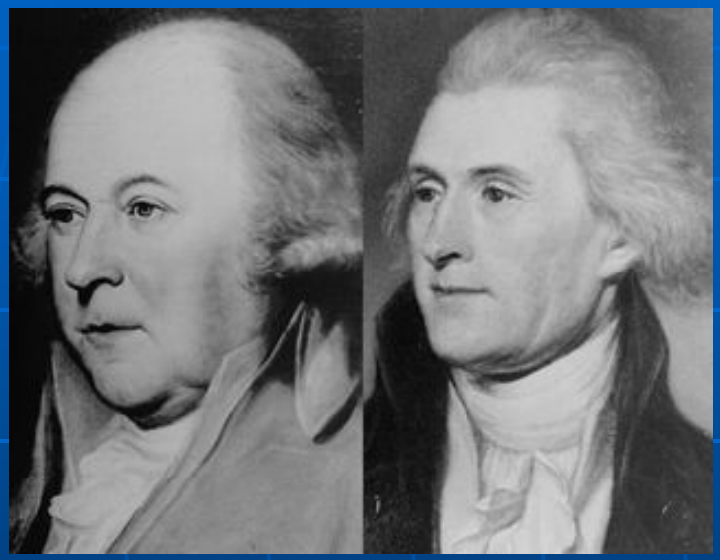
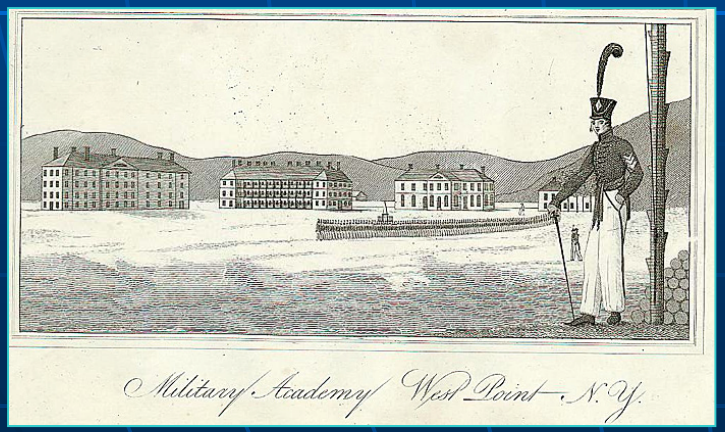
Paul Walsh, CPRP

1800 – A NEW MILLENIUM
A NEW COUNTRY
AND
THE NEED FOR ENGINEERS

U.S. MILITARY ACADEMY (WEST POINT)

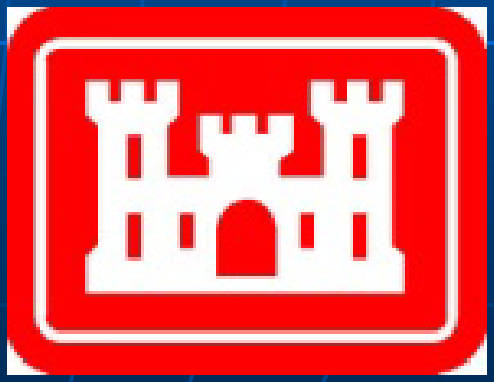




- Washington, Knox, Hamilton and John Adams urged the creation of an institution devoted to the arts and sciences of warfare.
- President Thomas Jefferson established the United States Military Academy in 1802.

THE NEED FOR ENGINEERS

- **March 16, 1802 the U.S. Army established the Corps of Engineers**
  - **The Corps of Engineers were responsible for founding and operating the U.S. Military Academy at West Point**
- **Politicians wanted the Corps to contribute to both military construction and works "of a civil nature."**

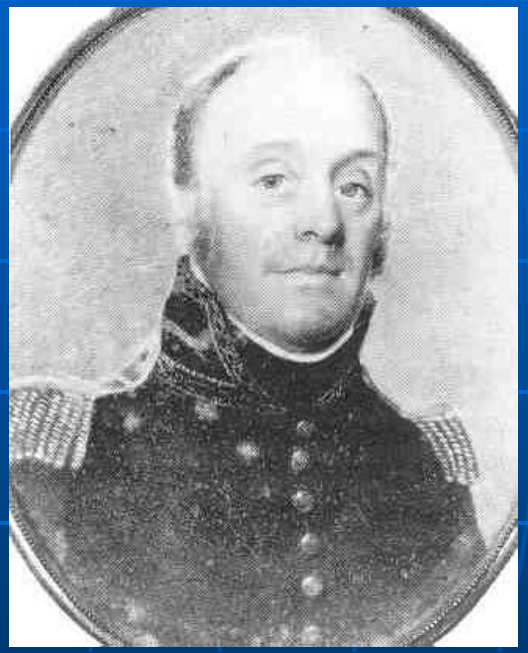


U.S. MILITARY ACADEMY (WEST POINT)

- Colonel Sylvanus Thayer, the "father of the Military Academy," served as Superintendent from l8l7-l833.
- **CIVIL ENGINEERING** made the foundation of the Academy's curriculum.
- For the first half century, USMA graduates were largely responsible for the construction of the bulk of our nation's infrastructure

U.S. Corps of Topographical Engineers

- Authorized for War Department duty in 1813, to conduct engineering surveys for military purposes and to explore routes for the passage of troops.
- The **Topographical Bureau** was established in August 1818



Maj. Isaac Roberdeau

U.S. Corps of Topographical Engineers Website

U.S. Corps of Topographical Engineers

- In 1838, the separate Corps of Topographical Engineers and placed under the supervision of Chief of the Topographical Bureau.
- As surveyors, explorers, cartographers, and construction managers, the Corps of Topographical Engineers helped open the nation's interior to commercial development and settlement.

U.S. Corps of Topographical Engineers Website

U.S. Corps of Topographical Engineers

- **John James Abert graduated from West Point in 1811, and after several assignments was appointed to the army in 1814 as topographical engineer, with the rank of major. In 1829, he became Chief of the Topographical Bureau at Washington, and in 1838 became colonel in command of the newly created Corps of Topographical Engineers.**
- **At its pre-war height the Corps consisted of:**
  - **1 Colonel**
  - **1 Lieutenant Colonel**
  - **1 Major**
  - **10 Captains**
  - **20 Lieutenants**

U.S. MILITARY ACADEMY GRADUATES

- **Graduates of the U.S.M.A were given their first choice of assignments based upon their academic rank at the Academy:**
  - **Corps of Engineers or Corps of Topographical Engineers got first placement**
  - **Artillery**
  - **Infantry**
  - **Cavalry**

U.S. Corps of Topographical Engineers Website

U.S. Corps of Topographical Engineers

- **Assignment to the Topographical Engineers was greatly sought:**
  - **Latest Scientific Equipment**

U.S. Corps of Topographical Engineers Website

U.S. Corps of Topographical Engineers

- **Assignment to the Topographical Engineers was greatly sought:**
  - **Frontier Assignments in the West**
  - **Opportunity for Advancement**

U.S. Corps of Topographical Engineers

U.S. Corps of Topographical Engineers

- **"After breakfast the topographical engineers, Lieutenants Abert, Emory, and Peck, started for the prairies. They had some eight or ten *voyageurs* as servants, several pack mules, a baggage wagon, and a handsome spring car, with four mules harnessed to it, to 'tote' their instruments."**

Lt. Richard Smith Elliott, Laclede Rangers, Fort Leavenworth, 27 June 1846

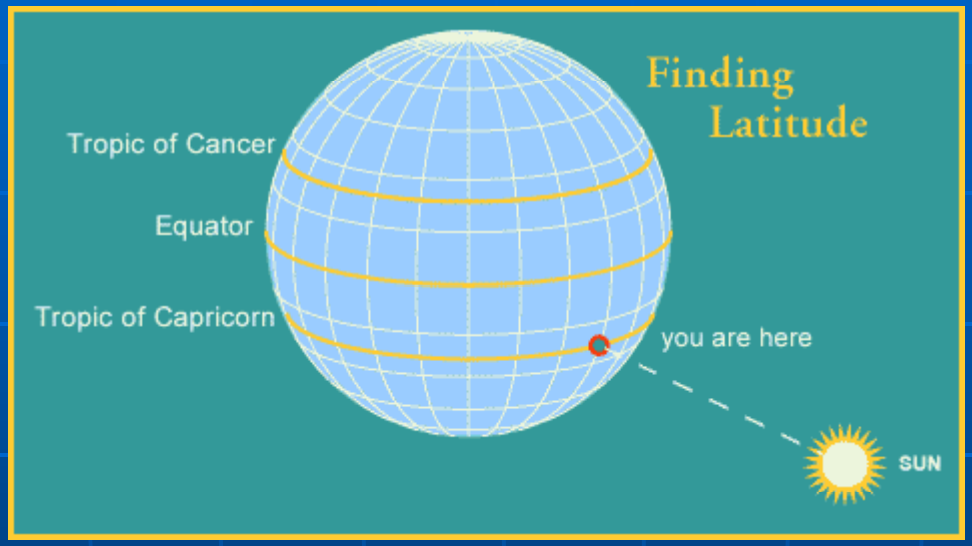
1846

U.S. Corps of Topographical Engineers Website

1890

NOAA – NGS Website

U.S. Corps of Topographical Engineers - Position by Sextant



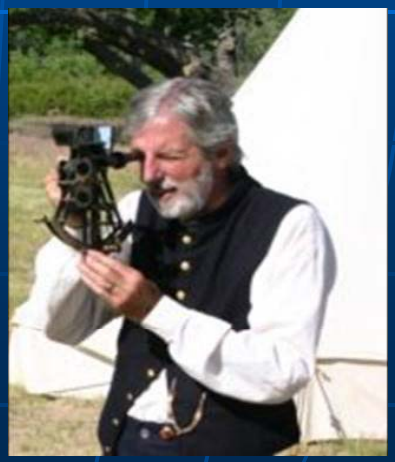
Celestial Navigation - Position by Sextant

Celestial navigation using a sextant is a complex and involved process that involves a fair amount of calculating, correcting, referring to tables, knowledge of the heavens and the Earth, as well as a lot of common sense.

U.S. Corps of Topographical Engineers - Position by Sextant

Finding Latitude by Solar Observation

The first thing you need to do is measure the angle between the horizon and the sun when the sun is at its highest (Zenith) position, which is right at noontime on your chronometer. A quick look at your trusty tables tells you which line of latitude the sun should be above on that particular day.



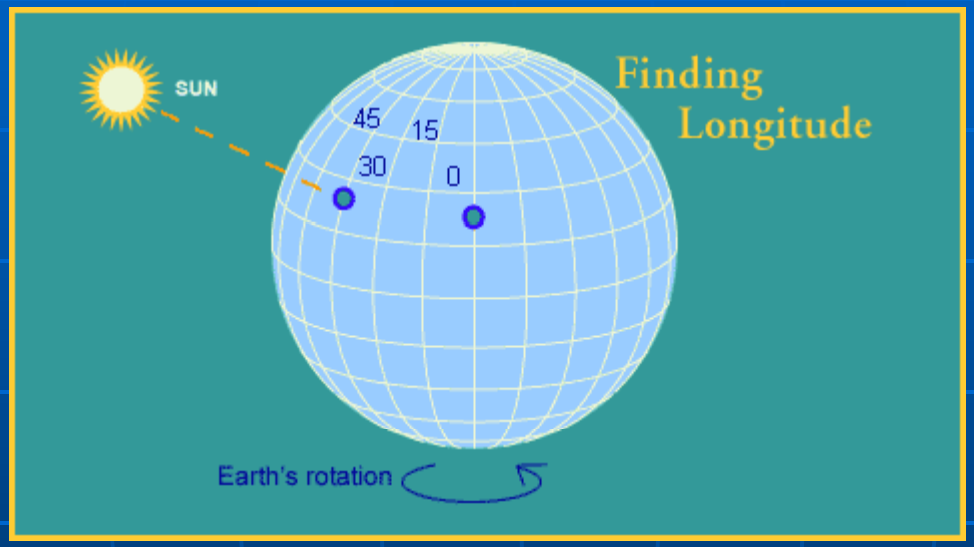
U.S. Corps of Topographical Engineers Website

U.S. Corps of Topographical Engineers - Position by Sextant

If you have a chronometer (this is just a fancy name meaning "extremely accurate clock"), you can find your longitude by observing the moment the sun at it's zenith – high noon.
At our Latitude 1 second of error will result in 100 feet of error.

U.S. Corps of Topographical Engineers Website

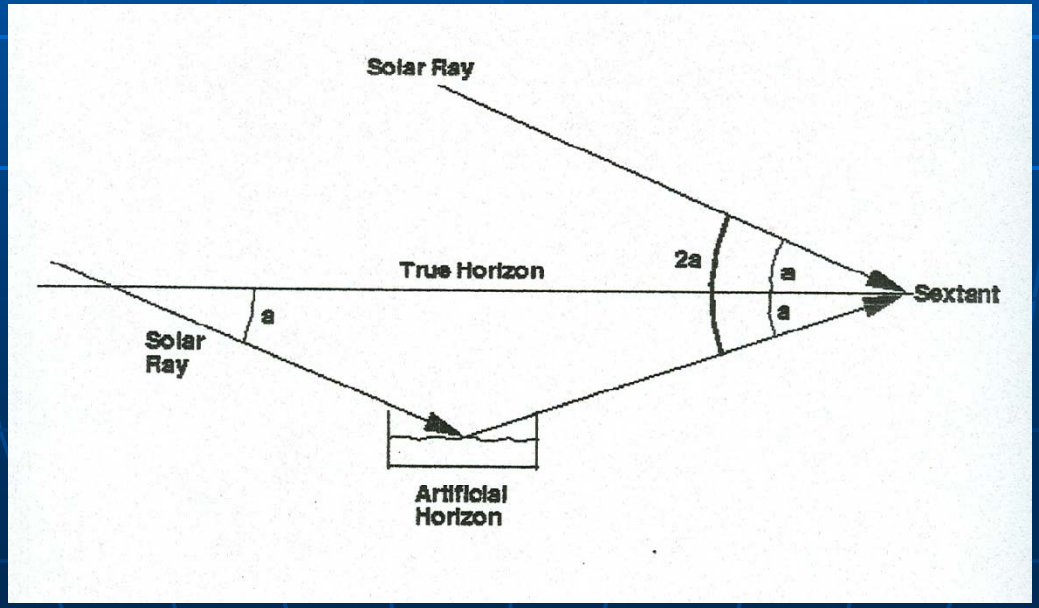
U.S. Corps of Topographical Engineers - Position by Sextant



The Earth spins around at such an even pace; Every hour it moves 15 degrees. This means that if the sun is above the longitude of 0 degrees at noon. One hour later it will be above 15 degrees West.

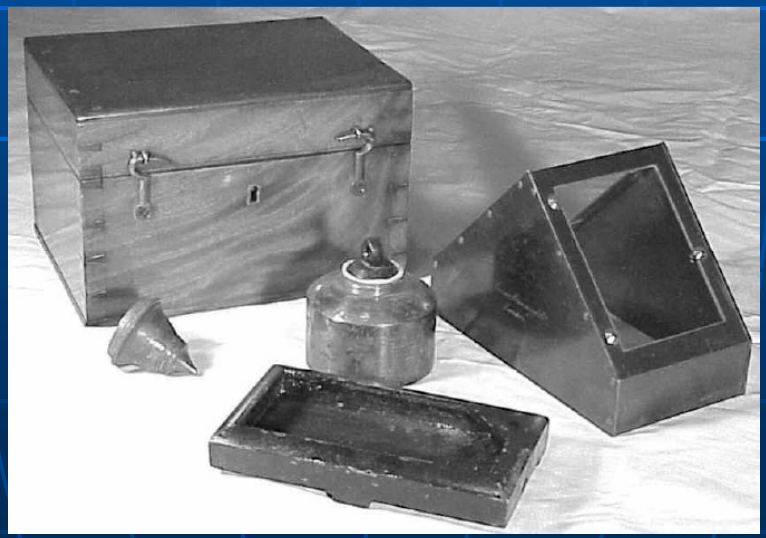
U.S. Corps of Topographical Engineers - Position by Sextant

- **The artificial horizon was used to enable observation of the altitude of objects when the true horizon was not visible. The most common form, dating from about 1790, consists of an oblong trough containing mercury, which provides a level reflecting surface, and two panes of glass set at right angles to the observer's line of sight and held in a protective frame.**



U.S. Corps of Topographical Engineers - Position by Sextant

- **The artificial horizon set shown in the slide consists of a cast iron tray, brass mercury bottle with screw on funnel and black oxidized brass triangular wind hood with a pair of right angle oriented optical windows.**



U.S. Corps of Topographical Engineers - Elevation

- Barometric Leveling is based on the fact that the air pressure changes about 1” of mercury per 1000 feet of elevation.
- If the pressure is measured on a known elevation and at another point simultaneously – the relative vertical distance can be determined.
- Jedediah Hotchkiss (Confederate Topographer was known to use an Aneroid Barometer in mapping the Shenandoah Valley in the early 1860’s.

U.S. Corps of Topographical Engineers

Mercury Barometer – 1840’s

Pocket Aneroid Barometer – 1860’s

U.S. Corps of Topographical Engineers – Direction or Azimuth

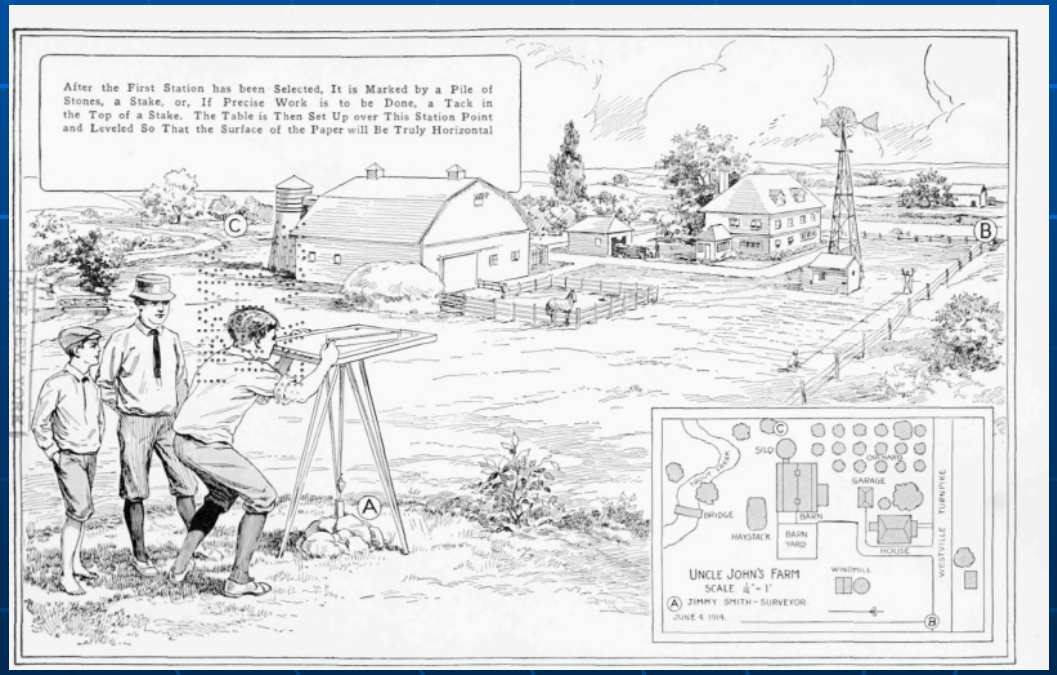
- **Once the position (Latitude, Longitude and Elevation) of a point was known, true north or an azimuth would generally be determined by an Astronomic Observation.**

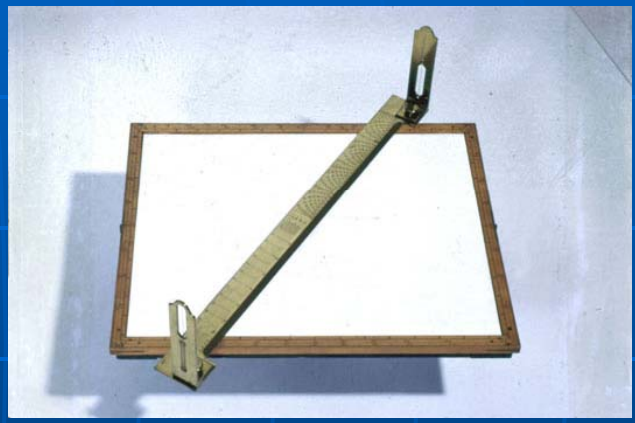
Polaris Observation

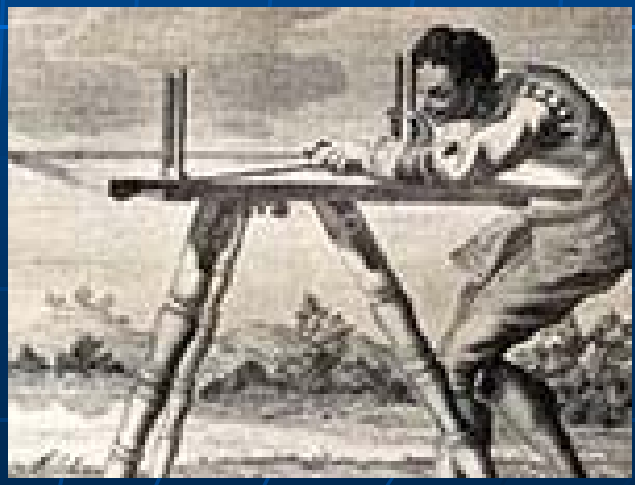
U.S. Corps of Topographical Engineers

U.S. Corps of Topographical Engineers - Mapping

- **Plane Table Mapping – Determining Position by Triangulation with an Open Site Alidade - Planimetric.**

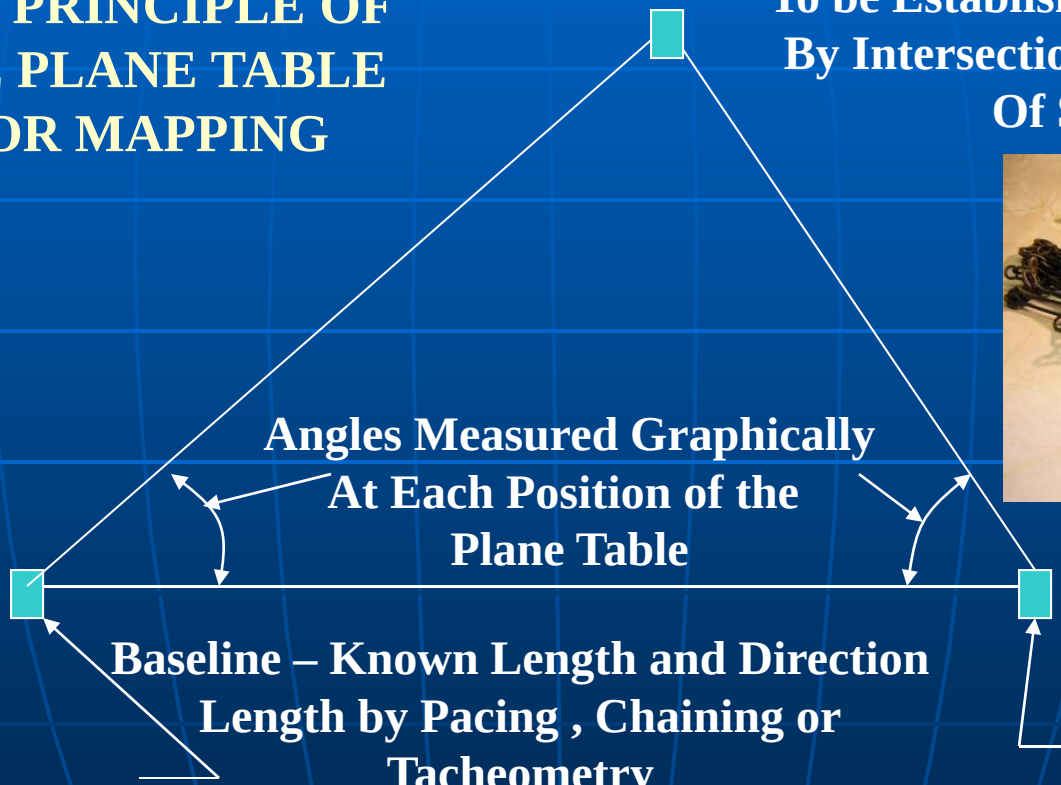






U.S. Corps of Topographical Engineers – Triangulation

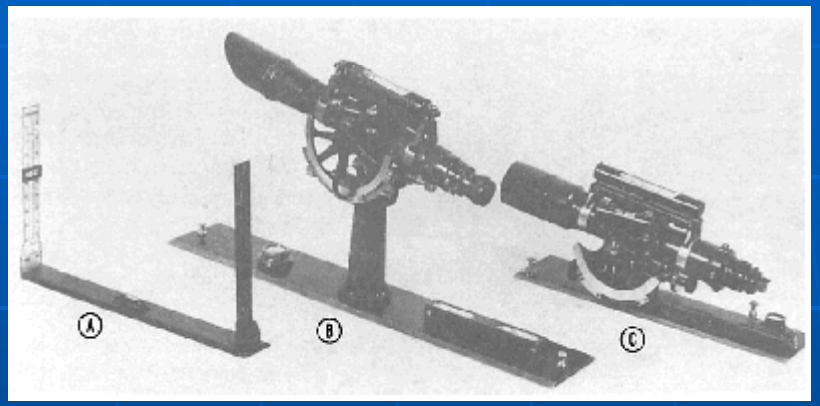
GRAPHICAL TRIANGULATION
THE PRINCIPLE OF
THE PLANE TABLE
FOR MAPPING



Gunter's Chain

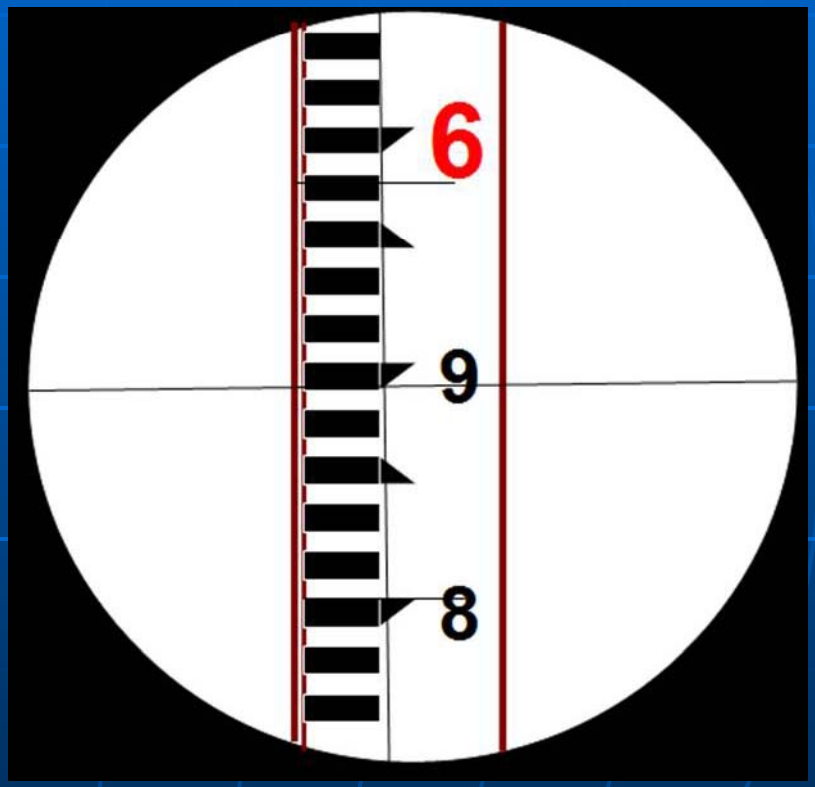
U.S. Corps of Topographical Engineers - Mapping

- **Tacheometry - This method of survey consists of using either a level, transit or specially constructed alidade to make cross hair intercept readings on a leveling staff. As the angle subtended by the crosshairs is known, the distance can be calculated.**



U.S. Corps of Topographical Engineers - Mapping

- **The alidade is oriented to the baseline and the scope is directed at the level rod and the distance is measured by reading the top and bottom stadia hairs on the telescope view.**

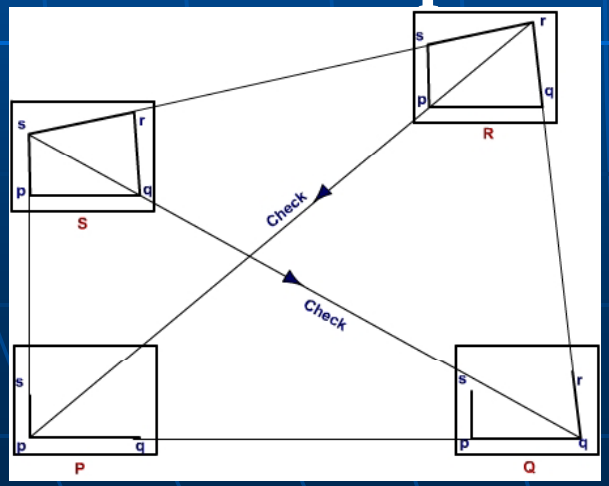


(Top Reading – Bottom Reading) x Stadia Constant

(5.98 – 5.80)x100 = 18’

U.S. Corps of Topographical Engineers - Mapping

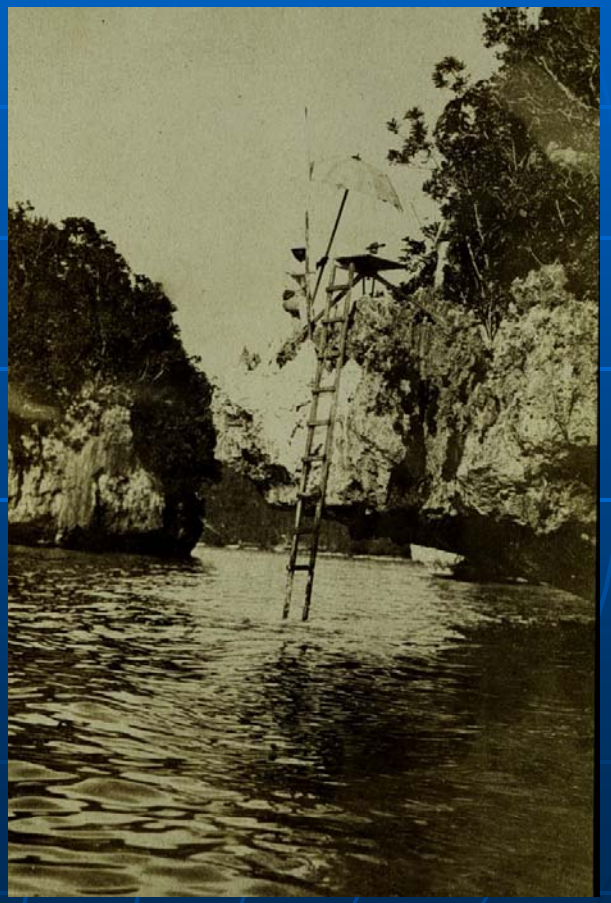
- Typically, many sightings are taken from different positions (points on traverse) and compiled to make a map.



U.S. Corps of Topographical Engineers - Mapping

Of course some points were less accessible than others

NOAA – NGS Website



U.S. Corps of Topographical Engineers – the Ohio Connection

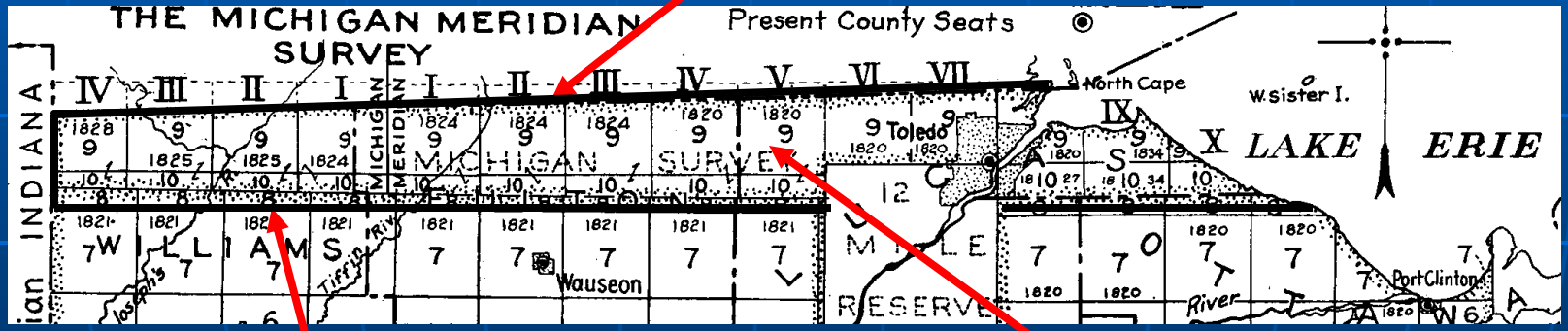
The Toledo War

- The most bizarre war in American history was the comic opera Toledo War of 1835 fought between Ohio and Michigan. It involved a poorly drawn boundary line, a 19 year old “boy” Governor, and armies that could not fight because they got lost in the swamps.

U.S. Corps of Topographical Engineers – the Ohio Connection

The Toledo War

Harris Line – Ohio Enabling Act



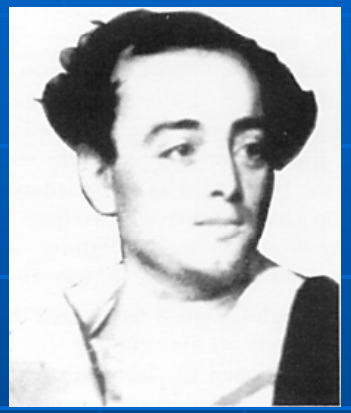
THE TOLEDO STRIP

Fulton Line – Northwest Ordinance of 1787

U.S. Corps of Topographical Engineers – the Ohio Connection

The Toledo War

- The young hotheaded territorial governor of Michigan, Stephens T. Mason, who was appointed as governor at the age of only 19 by President Andrew Jackson, angrily sent the Michigan militia south to claim the Toledo Strip. Ohio Governor Robert Lucas sent Ohio's militia northward in response.
- Fortunately bloodshed was avoided because the two armies got lost for a week in the swamps near Perrysburg, Ohio and were unable to find each other.



Mason

Lucas

U.S. Corps of Topographical Engineers – the Ohio Connection

The Toledo War

- **The United States Congress intervenes and a compromise is reached:**
  - **Ohio gets Toledo (Harris Line)**
  - **Michigan receives the Upper Peninsula**
- **The Corps of Topographical Engineers – Captain Andrew Talcott with two lieutenants perform a survey of the Ohio – Michigan Line.**

U.S. Corps of Topographical Engineers – the Ohio Connection

The Toledo War

Captain Andrew Talcott

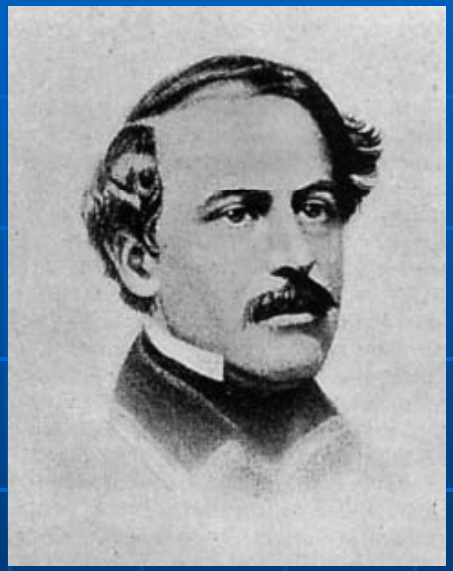
Andrew Talcott (1797-1883)
Graduated Second in class West Point, 1818; Engineers

Lieutenant Washington Hood

Washington Hood 1808 – 1840
Graduated 68 out of 100 West Point, 1827; Infantry

U.S. Corps of Topographical Engineers – the Ohio Connection

The Toledo War



Lieutenant Robert Edward Lee

Robert Edward Lee (1807-1870)
Graduated Second in class West Point, 1829;
Engineers

U.S. Corps of Topographical Engineers – the Ohio Connection

The Great Lakes Survey

- Perhaps the best-known work of the Topographical Engineers was the Great Lakes Survey.
- Work began in 1841.
- Captain George Gordon Meade headed the Lakes Survey from 1857 to 1861.

U.S. Corps of Topographical Engineers – the Ohio Connection

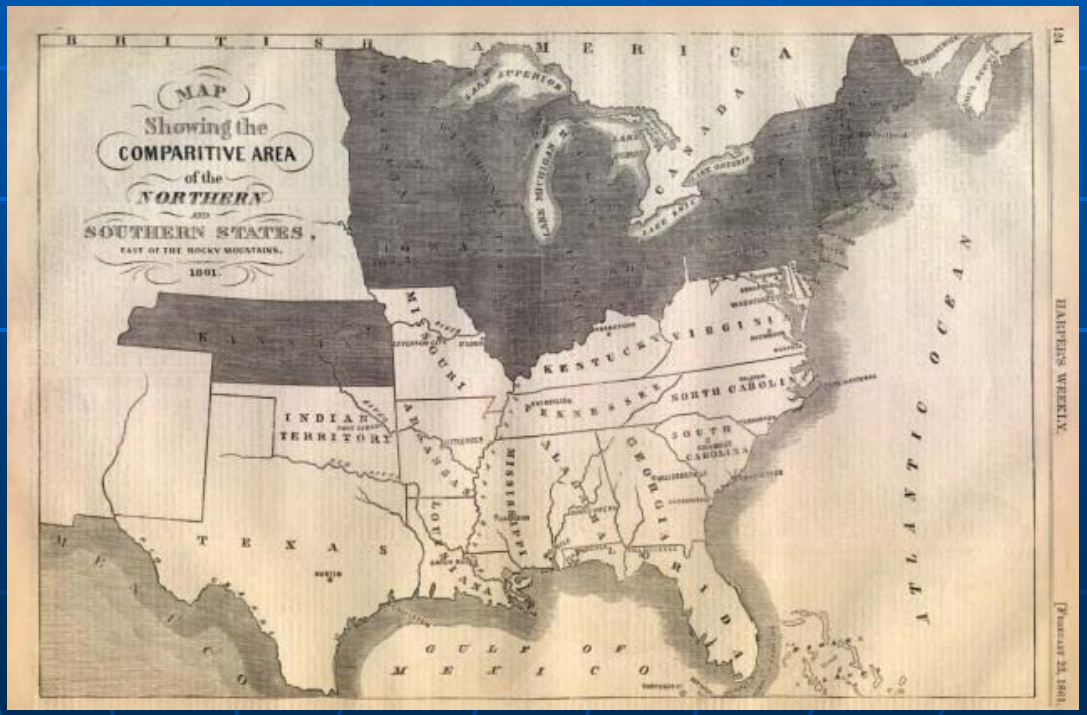
The Great Lakes Survey

George Gordon Meade (1815 –1872)
Graduated 19th in his class of 56, 1831 – Artillery
1841 – Assigned to Corps of Topographical Engineers

Captain George Gordon Meade

U.S. Corps of Topographical Engineers – The War Years

- **The War between the States caught the Army (less than 1000 officers and 17,000 regulars) Corps of Engineers and Corps of Topographical Engineers extremely understaffed.**

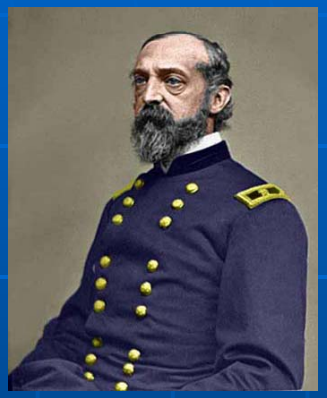


U.S. Corps of Topographical Engineers – The War Years

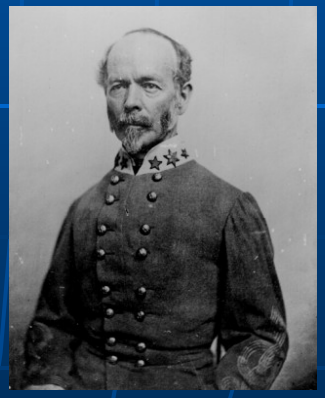
- **In 1861 Congress authorized an increase of the officers in the Corps of Topographical Engineers to 48, but, did not authorize formation of an enlisted company until after the beginning of hostilities.**

U.S. Corps of Topographical Engineers – The War Years

- **The Corps of Topographical Engineers actually hit a peak strength of 45 in 1861 but dropped off to 28 the following year. The decline was due to the assignment of TOPOGS to responsibilities outside the bureau.**

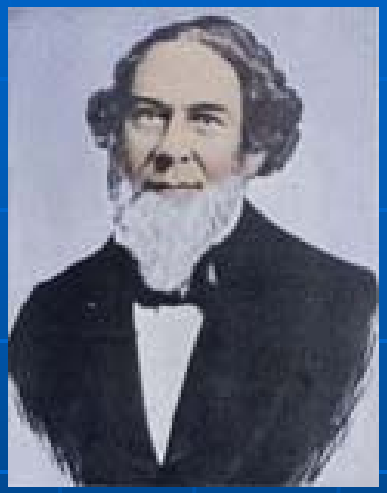


General George Gordon Meade USA



General Joseph E. Johnston CSA

The Coast Survey A Source for Topographical Engineers



Alexander Dallas Bache.

- 1843: Alexander Dallas Bache, a great grandson of Benjamin Franklin, is appointed second Superintendent of the Coast Survey

Civil War Service.

- 1861 - 1865: U.S. Coast Survey serves in all theaters of the Civil War and with all major commanders. Coast Surveyors serve as hydrographers, topographers, and scouts often in advance of front lines.
- At first Coast Surveyors served as consultants – but later given military rank to avoid being hanged as spies if captured.

NOAA – NGS Website

U.S. Corps of Topographical Engineers – The War Years

- **The Pre-War Mission:**
  - **Pre-War Activities included establishing boundaries, building roads, railroads, canals and lighthouses, mapping and exploration.**
- **The New Mission:**
  - **Move 70,000 to 100,000 troops and associated gear 20 miles a day with no or inadequate maps.**
  - **Provide military intelligence about enemy positions and entrenchments.**

U.S. Corps of Topographical Engineers – The War Years

- In addition to the lack of personnel, there was a lack of adequate maps of the interior of the United States for military purposes at the outbreak of hostilities.
- Many commercial maps such as the 1856 Franklin County Map were available, but lacked sufficient topographical detail or accuracy for movement of troops.

U.S. Corps of Topographical Engineers – The War Years

EXAMPLE OF A COMMERCIAL MAP

U.S. Corps of Topographical Engineers – The War Years

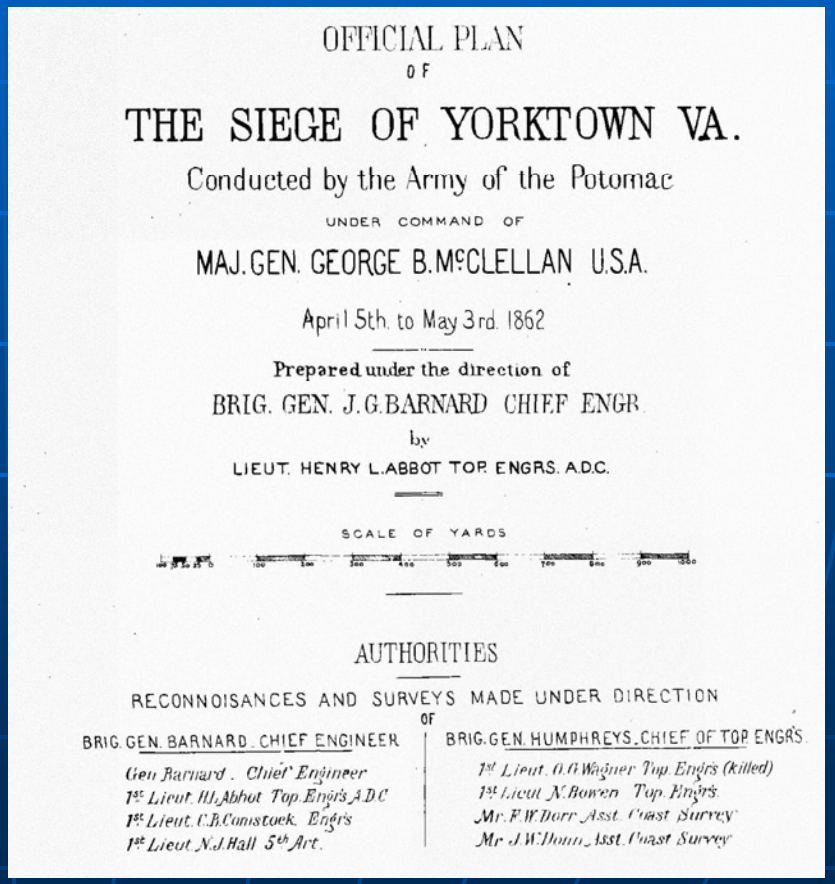
EXAMPLE OF A COMMERCIAL MAP

U.S. Corps of Topographical Engineers – The War Years

- As the Union or Confederate Army occupied an area, the topographers would "confiscate" available commercial maps.
- Usually these showed roads and land ownership – but – not topography.
- Using these maps as a base map, the topographer would perform the necessary reconnaissance to add the topography and "ground truth" the map.

U.S. Corps of Topographical Engineers – The War Years

TOPOGRAPHICAL MAP – PENINSULAR CAMPAIGN

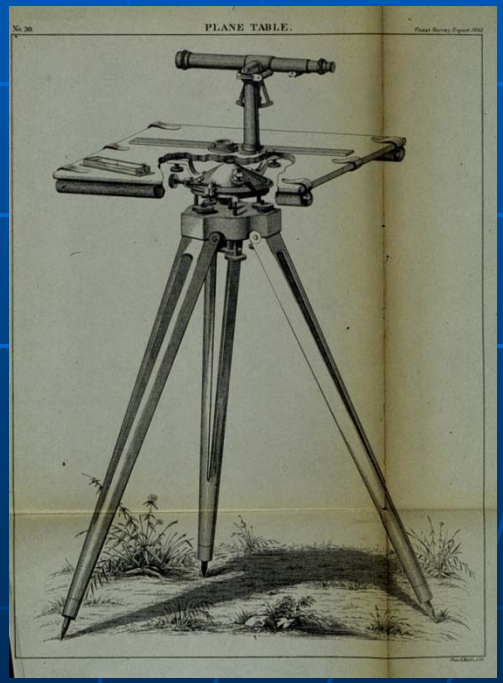

OFFICIAL PLAN
OF
THE SIEGE OF YORKTOWN VA.
Conducted by the Army of the Potomac
UNDER COMMAND OF
MAJ. GEN. GEORGE B. McCLELLAN U.S.A.
April 5th. to May 3rd. 1862
Prepared under the direction of
BRIG. GEN. J. G. BARNARD CHIEF ENGR.
by
LIEUT. HENRY L. ABBOT TOP. ENGRS. A.D.C.
SCALE OF YARDS
AUTHORITIES
RECONNOISANCES AND SURVEYS MADE UNDER DIRECTION
OF
BRIG. GEN. BARNARD. CHIEF ENGINEER
Gen Barnard . Chief Engineer
1st Lieut. H.L.Abbot Top.Engrs A.D.C
1st Lieut. C.B.Comstock. Engrs
1st Lieut N.J.Hall 5th Art.
BRIG. GEN. HUMPHREYS. CHIEF OF TOP ENGRS.
1st Lieut. O.G.Wagner Top. Engrs (killed)
1st Lieut. N.Bowen Top. Engrs.
Mr. F.W.Dorr Asst. Coast Survey
Mr J.W.Donn Asst. Coast Survey

U.S. Corps of Topographical Engineers – The War Years

TOPOGRAPHICAL MAP – PENINSULAR CAMPAIGN

U.S. Corps of Topographical Engineers – The War Years

PENINSULAR CAMPAIGN – FIRST FIELD USE OF THE PLANE TABLE UNDER WARTIME CONDITIONS



THE OUTCOME – NOT GOOD – LT. WAGNER KILLED

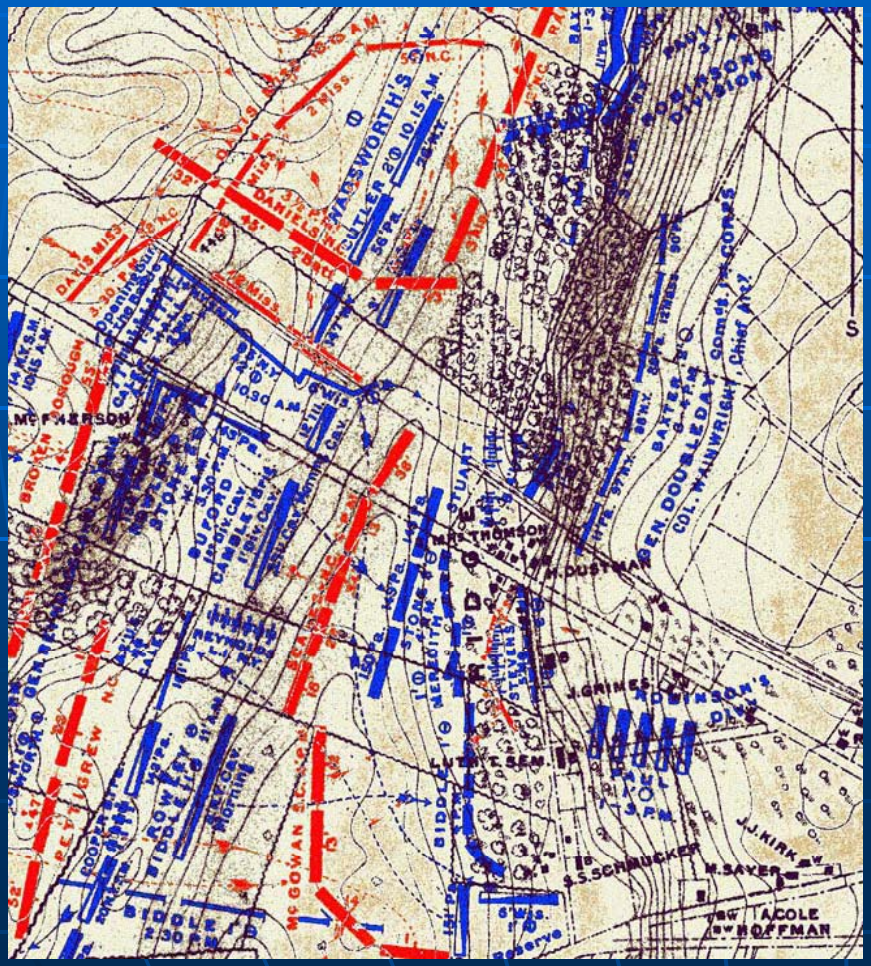
U.S. Corps of Topographical Engineers - Traversing

Quick and Sufficiently Accurate

- **Distance and Direction by Compass and by Odometer Wheel or Counting Horse Paces.**
- **Adjustments made at the end of the day – Position versus Traverse.**

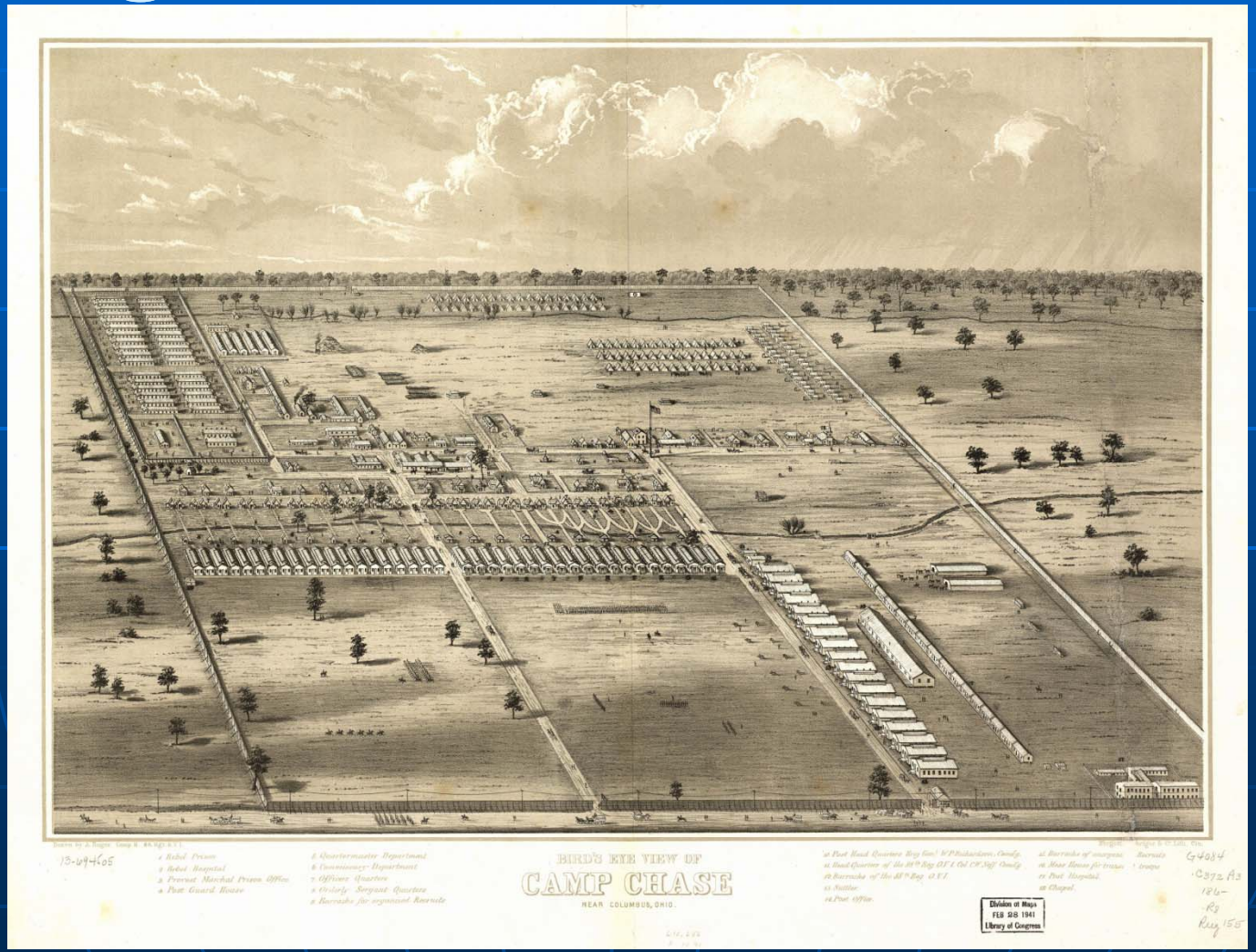
THE ODOMETER CARRIAGE.

U.S. Corps of Topographical Engineers – The War Years



TOPOGRAPHICAL MAP GETTYSBURG – FIRST DAY MAP COMPILED POST WAR (1871)

U.S. Corps of Topographical Engineers – The War Years



Coast Survey & U.S. Corps of Topographical Engineers

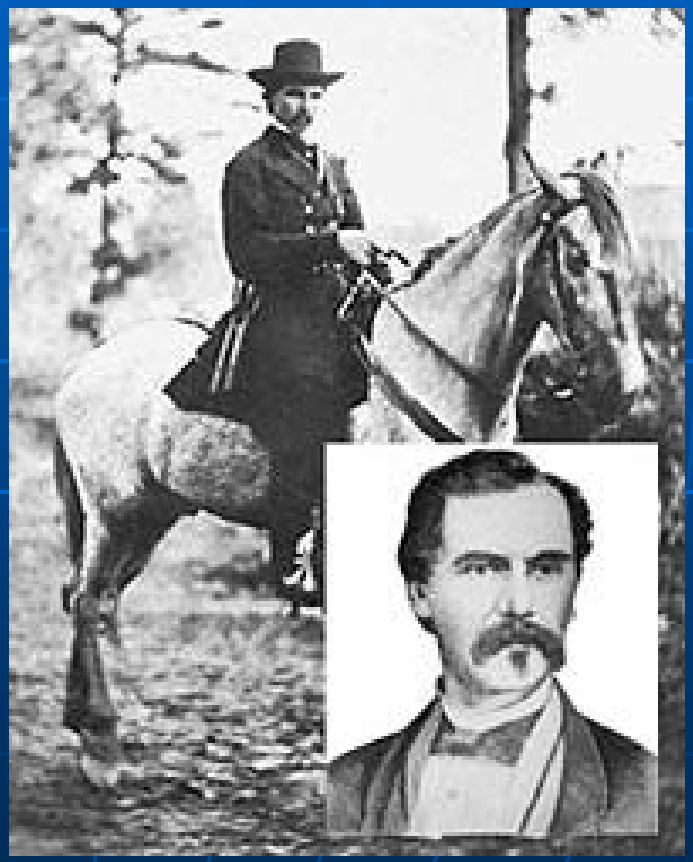
- **The Civil War saw the greatest increase in mapping the interior of the United States.**
  - **1861 – 20,000***
  - **1862 – 47,000***
  - **1864 – 80,000***

***Great Maps of the Civil War* by W. J. Miller**

NOAA – NGS Website

U.S. Corps of Topographical Engineers – Balloon Corps

- **Professor Thaddeus Lowe believed that balloons used for military purposes had to be better constructed than the common balloons used by civilian aeronauts.**



U.S. Corps of Topographical Engineers – Balloon Corps

Active	**October 1861 - August 1863**
Country	**United States**
Allegiance	**Union**
Branch	**Army**
Type	**Aviation**
Role	**Aerial reconnaissance**
Size	**8 aeronauts**
Part of	**Topographical Engineers (civilian contract)**
Garrison/HQ	**Fort Corcoran, Va.**
Equipment	**7 aerostats (Balloons) with hydrogen gas generators**
Engagements	**Bull Run Yorktown Fair Oaks Vicksburg**

U.S. Corps of Topographical Engineers – Balloon Corps

- **The Small Balloons:**
  - ***Eagle***
  - ***Constitution***
  - ***Washington***
- **The Large Balloons:**
  - ***Union***
  - ***Intrepid*** **(Lowe's favorite balloon)**
  - ***Excelsior***
  - ***United States***

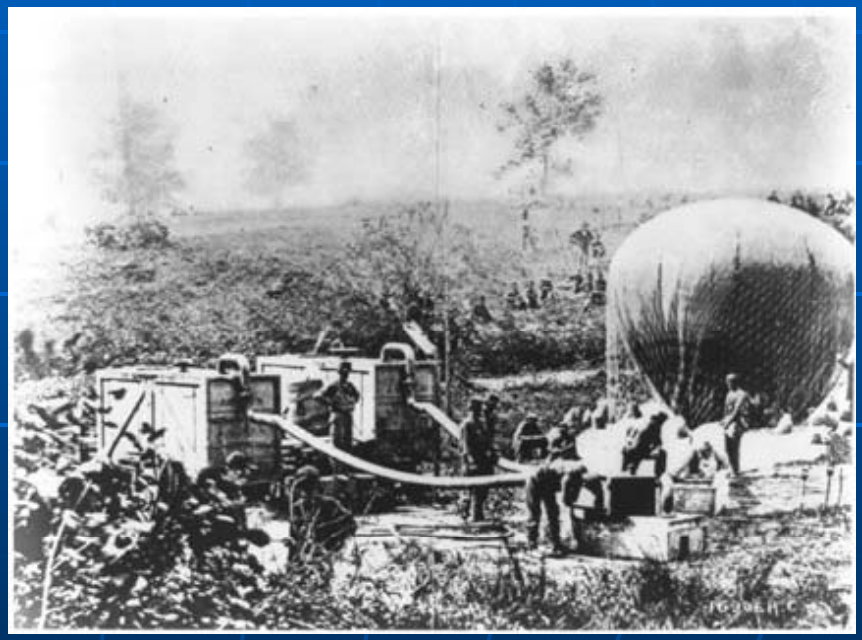
U.S. Corps of Topographical Engineers – Balloon Corps

Peninsular Campaign

Intrepid **(Lowe's favorite balloon)**

U.S. Corps of Topographical Engineers – Balloon Corps

- At first the balloons of the day were inflated at municipal coke gas supply stations and were towed inflated by ground crews to the field.
- Lowe recognized the need for the development of portable hydrogen gas generators.



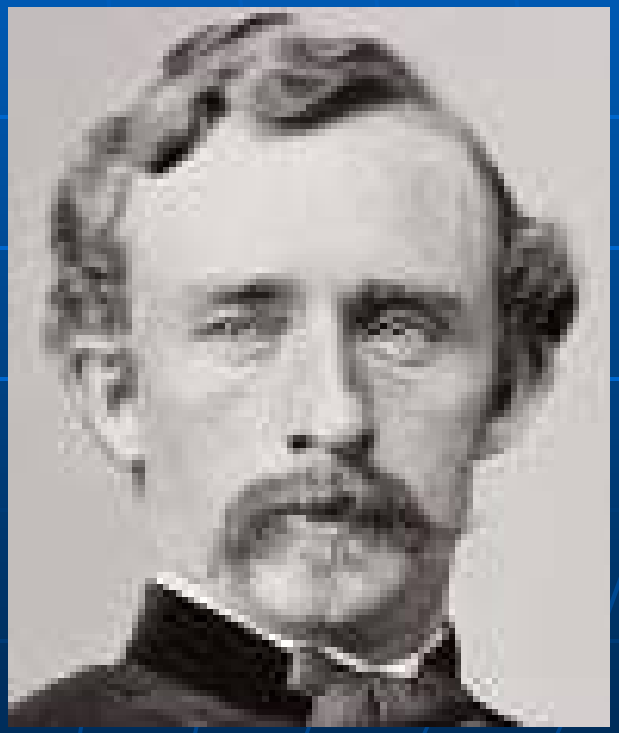
U.S. Corps of Topographical Engineers – Balloon Corps

- The generators were built at the Washington Navy Yard by master joiners who fashioned a contraption of copper plumbing and tanks which, when filled with sulfuric acid and iron filings, would yield hydrogen gas. The generators were Lowe's own design.

U.S. Corps of Topographical Engineers – Balloon Corps

The Ohio Connection – Custer Peninsular Campaign

- **"My confidence in balloons at that time was not sufficient, however, to justify such a course, so I remained in the bottom of the basket, with a firm hold in either side."**



U.S. Corps of Topographical Engineers – Balloon Corps

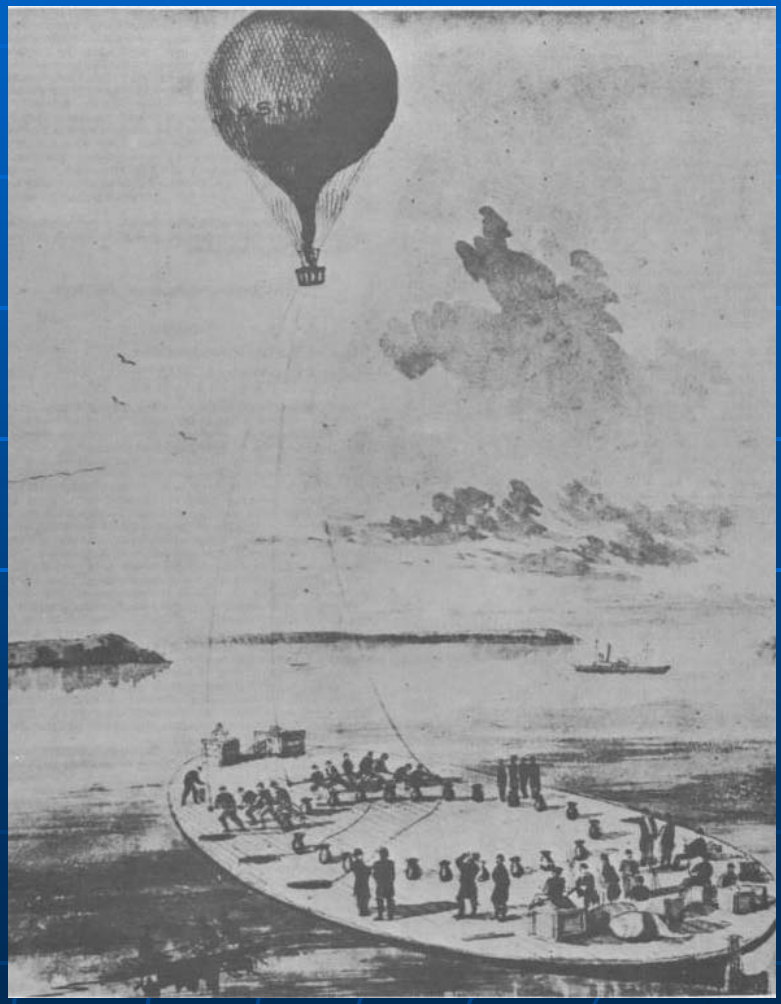
The Ohio Connection – Custer

Peninsular Campaign

- As a cavalryman I had a choice as to the character of the mount, but the proposed ride was far more elevated than I had ever desired or contemplated."
- The interstices (gaps in the wickerwork) in the sides and bottom seemed immense, and the further we receded from the earth the larger they seemed to become until I imagined that one might tumble through."

U.S. Corps of Topographical Engineers – Balloon Corps

- The George Washington Parke – Custis – Arguably the World's First Aircraft Carrier: Converted Coal Barge
- Thaddeus Lowe ordered the craft to be outfitted to accommodate his balloons and support equipment.



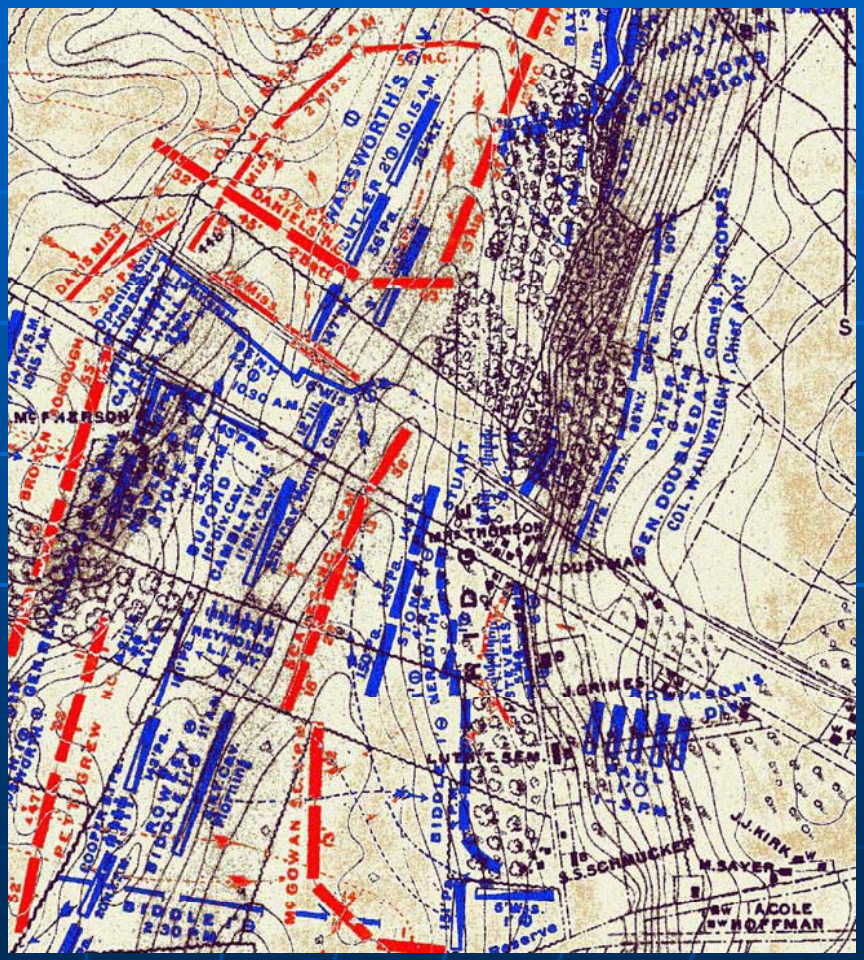
U.S. Corps of Topographical Engineers

- During the Civil War, the Topographical Bureau and the Corps of Topographical Engineers were abolished by an act of March 3, 1863, with functions transferred to the Office of Chief Engineer and Corps of Engineers, respectively.
- The Balloon Corps ultimately was transferred to the Signal Corps and disbanded after Lowe resigned.

Civil War Topographers, shown at Camp Winfield Scott, near Yorktown, Virginia, in May 1862.

POST WAR YEARS

- At War's End - General Grant orders the topographers back into the field to map the Civil War Battlefields.
- As President, Grant expands the scope of the **Coast Survey to the Coast and Geodetic Survey.** They assume many of the mapping duties performed by the Pre-War Corps of Topographical Engineers.



Coast and Geodetic Survey

Transcontinental Arc of Triangulation - 1871

NOAA – NGS Website