42nd Annual Meeting

A. O. Quinn, P.E.
Quinn and Associates
Horsham, PA 19044

Opening Address: Two Centuries of Service

I AM INDEED GREATLY HONORED to be asked to provide the Opening Address for this Annual Meeting of the American Congress on Surveying and Mapping and the American Society of Photogrammetry. I have concluded that your convention chairman, Jack Friedman, decided that in this bicentennial year, he'd pick a guy from the "place where it all started", Philadelphia, and that that person should be old enough to account in some way for nearly two centuries of surveying and mapping service. I suspect that my credentials place me somewhat close to this unenviable category. At any rate, I am pleased to provide you with my review of a few of the highlights during 200 years of service in our profession.

A. O. Quinn.

By attending this convention, you will see and hear the very latest in technology and professional development in surveying and photogrammetry. The program is resplendent with outstanding speakers who will describe surveying and photogrammetric activities throughout the world, including space. I recommend that you carefully review the schedule of papers so that you may hear and participate in those parts of our profession that warrant your attention. When you are weary of listening, you should see the outstanding exhibits which reflect an unbelievable degree of sophistication in the combination of optics, electronics, and mechanics in the instruments and techniques on display.

After accepting the invitation to give this address, I embarked upon a most enjoyable review of the history of our country to pinpoint a few of the events of our 200-year growth in which surveying and mapping played an important part.

Maps were the earliest form of communication between members of ancient civilizations. Cartography emerged slowly from obscure origins to define places and things onto a medium that could be used and preserved. Old map collections have provided valuable insights into the world's history. With the start of World War II in Europe, map collections throughout the world were dusted off and used to provide information about little known areas. Many obsolete and, regretfully, poorly prepared maps provided the only source for forgotten islands, plateaus, mountains, and jungle trails. In my own experience, I remember trying to fit recent aerial photographs to old Japanese maps of the Pacific islands. The result was pretty horrible and led to the production of new maps based upon the best available control.

The Pennsylvania Historical and Museum Commission published, in 1965, a book entitled "Indian Paths of Pennsylvania" which describes the old trails which, in many instances, are the routes of our present highways. The author, Paul Wallace, says, "It is possible to map the old paths with a fair approach to precision. There are many sources of information available. Among these are early maps, traveler's journals, land warrants, reminiscences of old timers and landmarks and crude diagrams recovered in archaeologists' findings."

Surveying and mapping were not new terms to our Founding Fathers. They had just finished a war that made them aware of the vast differences between the colonies which were united only in their desire to be free. The Virginia gentlemen fought side by side with New England farmers and mountaineers. Yet these men found their way through the forests of New York and Pennsylvania. The battle maps, and maps used to plan the military operations, while crude by present-day standards, proved to be adequate in meeting the needs of the Revolutionary War.

In the American colonies, there had been great concern with mapping of the land since earliest Europe settlements. In 1585, John White drew a map of the Cape Hatteras area during the ill-fated Roanoke expedition of Sir Walter Raleigh. In 1612, Captain John Smith explored the Chesapeake Bay and produced an important map of that locality. One of the most important maps in Colonial times was produced in 1670 by Augustine Hermann (a Bohemian) for Lord Calvert of his Maryland patents and a large region beyond. A map covering an even larger area from Virginia to the Great Lakes was made by Joshua Fry (under whom George Washington served in the French and Indian Wars) and Peter Jefferson (father of Thomas Jefferson) in 1751. The most ambitious map made in Colonial America was by John Mitchell in 1755. This map and all the others were printed outside the country, and while adding to geographical knowledge, they were essentially European in methodology and symbolism. After the Revolutionary War, American cartography developed along more independent lines. An immediate concern was the settlement of a vast public domain and a committee under Thomas Jefferson proposed a method for its subdivision.

Jefferson's committee's report led to the enactment by Congress of the Land Ordinance of 1785. The major elements of this legislation were—

(1) A survey was required prior to settlement.
(2) Orientation of survey lines was to be systemized.
(3) The township unit was established and,
(4) The section concept was required.

To implement this systematic cadastral survey, Thomas Hutchins of New Jersey, who had served under Washington as a surveyor, was appointed Geographer of the United States—or first officer in charge of government surveys. Using a magnetic compass and chain, the U. S. Public Land Survey was begun in eastern Ohio. The section surveys resulted in a network of fundamental survey lines oriented predominantly in cardinal directions, which stand in sharp contrast to the metes and bounds surveys along the eastern seaboard.

The pace of cadastral surveys was slow but later, as settlers clamored for land, it increased in speed. By the time of the Civil War (1861-65) a large part of the eastern United States had been subdivided. During the war, many of the surveyors enlisted and were employed in a variety of military mapping activities. Upon the restoration of peace, cadastral surveying occupied the attention of many workers, and a remarkable number of published and unpublished, official and unofficial cadastral maps were available.

Fire and underwriters' maps of urban areas were developed in the period 1850-1900 and used extensively to show the location and the fire-resistive character of buildings and other types of data.

Surveys for the transfer of properties and the development of the cities and villages was accomplished first by apprentices from European countries and later by surveyors trained in the colonies and by graduates of the early American colleges. Two of our early Presidents—Washington and Jefferson—worked as Surveyors.

Surveying instruments and techniques were imported. However, as the need for surveys increased, "Yankee ingenuity" rose to meet the demand for "homemade" equipment and new methods were developed to cope with conditions in the new country.

The first set of 83 road maps produced in the United States were made in 1789 by Christopher Colles who came to Philadelphia from Ireland in 1739. The maps covered routes and alternates from Albany, New York, to Yorktown, Virginia.

The earliest use of contour lines to show elevation changes in a large area on topographic maps is attributed to a French engineer, J. L. DuPain Triel. The date of his work was 1791. The application of DuPain Triel methods to American cartography was by two West Pointers, Lt. George Whistler (who was the father of James Whistler the famous American painter) and Lt. William G. McNiell in 1822.

Our expanding country required the development of roads, canals, and (later) railroads. The exploration and stakeout of routes demanded an ever increasing number of surveyors. The Erie Canal across New York State was completed in 1825; the Chesapeake and

Delaware Canal in 1829; and numerous canal systems in New Jersey and Pennsylvania were designed and built to meet the needs of growing transportation in the East.

Scientific mapping of the nation by triangulation and astronomical observation began after the acquisition of the territory west of the Mississippi River. The Louisiana Purchase in 1803, costing 15 million dollars, increased the national domain by 140 per cent and provided the land for all or part of 13 states. As early as 1796, Thomas Jefferson pointed out to his colleagues in the American Philosophical Society the importance of the territory west of the Mississippi River and the necessity of exploring it in the interests of national defense and the future welfare of the nation. Thus, when the time came to take possession of the territory of Louisiana, Jefferson negotiated, in 1803, a confidential grant of money by Congress for the purpose of exploring the new purchase. Meriwether Lewis, Jefferson's private secretary, and Captain William Clark of the United States Army were sent by President Jefferson to explore the new territory and survey a route to the Pacific Ocean. The success of the expedition opened vast new territories to American knowledge and led the way for the settlement of the West. From 1810 until 1880, rarely a year went by without at least one military reconnaissance party being in the field or about to embark on an expedition into the wilds of the interior. Yet the country was so vast and, according to the best reports, so much of it was uninhabitable that few, if any, seriously considered an intensive topographic survey of the whole.

The principal difficulty of making an intensive topographic study of the United States before 1800 had been caused by the fact that there was so much to be done in a hurry, without precedent and before the central government was properly organized. The boundaries of the country were poorly defined and much of the interior was a dark mystery filled with unknown perils.

President Jefferson proposed a survey of the Atlantic coast to aid navigators and provide scientific data for future mapping activities. Congress authorized the "Survey of the Coast" on February 10, 1807, placed it under the jurisdiction of the Treasury Department and appointed a Swiss scientist, Professor Ferdinand Rudolph Hassler as superintendent. After many delays including the procurement of surveying instruments and equipment from England, geodetic surveying began in 1816 with two baselines, each about four miles long. One ran in New Jersey just west of Englewood; the other west from Gravesend, Long Island. The first maps were published in 1834 and involved the New York City and Long Island.

Additional troubles followed the initial delays. The Survey was transferred to the Navy Department; Congress now and then failed to provide the necessary funds to carry on the work; shipowners failed to receive the promised navigational charts from the Survey and demanded a congressional investigation. (Sounds like 1976, doesn't it?)

After 1843, the Survey was given a more stable organization and provided with funds which were more nearly adequate. The expansion of the country and the acquisition of island dependencies increased the duties of the Coast Survey, bringing under its surveillance more than 100,000 miles of coast line. In 1878, with still no national topographic survey in the offing, the duties of the Coast Survey were increased still further. Accurate maps of the wild West were urgently needed, and the only department of the Government that was properly organized and tooled to meet the emergency, to provide the necessary connecting triangles between the old territory and the new, was the Coast Survey. On June 20, 1878, Congress enlarged the scope of the Coast Survey to cover inland topography as well.

Almost as old as the Coast and Geodetic Survey is a second government mapping agency which evolved more or less from the expedition of Lewis and Clark. This was the Corps of Topographical Engineers, organized March 3, 1813. This body, later consolidated with the Corps of Engineers of the Army under the War Department, furnished a nucleus for organizing and executing an adequate topographic survey of the nation. The Corps was charged with military topographic reconnaissance, exploration and survey at a time when the population, both white men and red, was in dire need of military discipline. It was kept so busy exploring and policing the interior that it had neither the time nor the funds to do anything else. After 1863, its duties were broadened to include the "planning and construction of works for the improvement of rivers and harbors; the trigonometric, hydrographic and topographic survey of the northern lakes; the astronomical determination of boundaries and initial points; the topographic surveys and reconnaissances of the Interior and of the Western Territory, & c."

The Geological Survey was constituted March 3, 1879, under the Department of the Interior. Its function was to furnish closer

coordination between government agencies assigned the job of classifying the public lands and "the examination of the geological structure, mineral resources, and products of the national domain." It was to supersede all of the earlier geological and geographic surveys. Limited at first to the land west of the 100th meridian, the field of the Geological Survey was eventually extended over the entire country.

Multipurpose maps of the National Topographic Series now are produced and maintained by the Topographic Division of the Geological Survey, with some effort contributed by the Forest Service, the Tennessee Valley Authority, and the Mississippi River Commission. Military mapping is handled by the Defense Mapping Agency, the Army Map Service, and military units. National mapping requirements, as determined primarily by federal agency requests, are the basis for the National Topographic Program which includes several individual map series. Most of the program effort is dedicated to the production and maintenance of the 1:24,000 scale, 7½ minute topographic map series. The ortho-photo map recently has been added as a new edition of the 7½ minute series. The report of the Federal Mapping Task Force on Mapping, Charting, Geodesy and Surveying in July, 1973, indicated that general purpose map coverage at scales of 1:24,000 or 1:62,500 is now available for about 87 per cent of the total area of the United States. Alaska is about 80 per cent covered with maps at a scale of 1:63,360.

The activities of the federal mapping agencies in small-scale mapping were supplemented by various state organizations which, until relatively recently, conducted independent surveys and mapping to meet their own needs. One such survey was the work in the Adirondack Mountains of northern New York State by Verplanck Colvin. Colvin was born in Albany, New York, in 1847. He was educated as a lawyer with a strong taste for the sciences. Following a career in mining surveys and geology, he taught higher surveying, geodesy, and topographical engineering at Hamilton College. The Adirondack Mountain area was a virtual wilderness, used as a hunting ground by the Indians, which received little attention from the original settlers in the state. Military grants at the end of the Revolutionary War prompted surveys to establish boundaries. The going was difficult and there were no reliable maps, blazes, or stakes to make these surveys any better than educated guesses.

Colvin was convinced that to remedy this situation, "A Survey with theodolite or transit, entirely independent of the magnetic compass, was required to provide by trigonometrical measurement of the relative angular position of the mountain summits and other landmarks, a map of the wilderness." His persistency earned him the job of superintendent for the New York State Land Survey, and for the next 15 years, starting in 1873, Colvin literally ran up and down the mountains carving sight lines, triangulating using personally devised solar reflectors, leveling and recording water depths and temperatures of hundreds of mountain lakes. In addition to his surveying capabilities, Colvin was a master at sketching terrain conditions and in the preparation of detailed narratives which he submitted to the legislature. He was a tyrant to work for and he had no idea of time. He ascended many mountains late in the day and was frequently forced to make dangerous descents through wilderness areas or to spend frigid nights fighting howling gales on the sides of the Adirondack peaks. His reports read like thrilling novels with frequent encounters with bears, wolves, and unbelievable weather conditions.

His surveys and resulting maps largely established the history of the Adirondacks and his persistent efforts led to the creation of the area as a state park in which millions of acres are dedicated to be "forever wild."

I am certain that surveyors present today would be interested in the following paragraph from Colvin's 1874 report:

"As during previous seasons, the use of alcoholic or fermented liquor of any kind was prohibited to anyone connected with the survey. Neither while engaged in the laborious climbing of the mountains nor while encountering bitterest storms or the severity of winter's snows was any stimulant used or carried. The result has been steady and persistent work, and men who have believed stimulants absolutely necessary have expressed a change of opinion." Can anyone doubt Verplanck Colvin's credibility?

The work of Colvin in accomplishing a most difficult survey has been duplicated a million fold in the survey work for our major engineering projects—the transcontinental railroads, our highways, canals, dams and the development of millions of acres into cities, farms, parks, and commercial centers.

Substantial progress in our private and national mapping programs has been made since the introduction of aerial photogrammetric mapping methods. In the 1850's, photographs were taken from kites and balloons in France and used experimentally for

the compilation of topographic maps. The art of photogrammetry was continually improved in France, Germany, and Austria during the latter part of the nineteenth century. In 1895, Captain E. Deville, Surveyor General of the Dominion of Canada invented a stereo-plotting instrument and published a book on photogrammetry.

In the United States the first known aerial photograph was taken by James Black and Samuel King from a balloon called "Queen of the Air." This photograph was made over Boston from an altitude of 630 meters. Oliver Wendell Holmes immortalized the photo by captioning it, "Boston .... as seen by the eagle and the wild goose." A print is on display in the Boston Museum of Science. Other photographs were taken from captive balloons by the Union Army in 1862 at Richmond, Virginia, and used for military intelligence purposes. A survey camera was used in conjunction with a plane table for mapping in Alaska in 1895 by the U. S. Coast and Geodetic Survey. The most successful of the kite photographers was G. R. Lawrence. He flew cameras weighing as much as 1,000 pounds and, with one of these large cameras hanging from seven kites, he took a picture in May 1906 of the earthquake-leveled San Francisco from an altitude of 600 meters.

The use of aerial photography for mapping progressed slowly in the United States, and it was not until after World War I that any significant developments occurred. The Arthur Brock, Jr. Tool and Die Works was formed in 1912 by Arthur Brock, a Philadelphian with an A. B. Degree from Harvard. After the start of World War I in 1914, Brock conceived the idea of taking photographs of battlefields from an airplane. Edward Cahill, his mechanical engineer, was responsible for the design of this camera which had a Wollonsak 12" lens, F:4.5 and which had a magazine carrying 4"-×-5" cut film. The camera was tested over Fort Sill, Oklahoma in the summer of 1915. A second camera was designed to accommodate roll film 4½" wide and 46 feet in length which would produce about 100 exposures. The camera was fully automatic and controlled by the pilot. It was sent to the Mexican border in 1916 and flown by the Ordinance Department of the U. S. Army to obtain aerial photographs for the military expedition.

France and Great Britain, as well as the United States, purchased a number of these cameras during 1917-1918, and they were used in World War I.

In 1921, Mr. Cahill devised a method of mapping from aerial photographs and designed the optical-mechanical instruments required. The aerial camera used 6½"-×-8½" glass plates instead of roll film. This became known as the Brock process which was a unique American solution to photogrammetric mapping. Prior to this development, photogrammetric instruments were of European design and manufacture.

In 1922, the first test area at Media, Pennsylvania, was mapped. Subsequent tests were performed in the United States as well as in France and Italy. The first commercial mapping contract was performed in 1924 in South Carolina for a hydro-electric project. Later projects included work for the Canadian railroads; the U. S. Corps of Engineers, Louisville District; and mapping at Hoover Dam for the Bureau of Reclamation.

Frank Weymouth, Chief Engineer of the Bureau of Reclamation, joined the group in the early 1920's to form the engineering firm of Brock and Weymouth which continued operations until 1931 when the worldwide financial situation brought all activities to an end. The equipment was acquired by Aero Service Corporation and used until 1950 on a wide variety of mapping assignments.

The accomplishments in photogrammetry using Swiss, German, and Italian instruments as well as the American designed and built Kelsh-type stereo plotters are well known. Many of these instruments are on display. The recent publications of the American Society of Photogrammetry, the American Congress on Surveying and Mapping, and Canadian and European organizations contain numerous papers concerning our current status in photogrammetry and surveying.

I'm told that it's difficult to bring a love story to an end. The stories about surveys for the major engineering projects in our country could go on forever. Take, for instance, the construction of our railroads and highways across the country; dams and irrigation projects; pipelines; transmission lines, etc., etc.

For me, my love for our profession of surveying and mapping will never end. I felt the same thrill of accomplishment when Neil Armstrong stepped on the surface of the moon as I do when I step on one of Verplanck Colvin's triangulation stations on the top of an Adirondack peak or when maps made by our company are used to design a major engineering project. Surveyors, photogrammetrists and map makers can take just pride in their accomplishments during the first 200 years of our country's life. My recent studies have shown me a most astounding and yet orderly development of our knowledge and technology. One cannot deny the feeling of a

Divine Hand in the guidance and expansion of our work. Is it, for example, sheer accident that the airplane was conceived after the automobile? And what would we have done with electronic measuring instruments before optical reading theodolites? Obviously, we never could have reached the moon without the computer.

Our technology is continuing to develop to meet the great challenges that lie before us. We must be certain that our own professional standards, ethical behavior, and technical capabilities will continue to grow to solve the problems that are before us. "What's past is prologue," and I am certain that your opening speaker in 2076 will point with pride to the accomplishments in surveying and mapping between now and that time.

I am deeply indebted to many reference books and magazines, some of which I've listed in a bibliography appended to this paper, and to many individuals who have suggested areas of interest for me to trace.

A most interesting description of Tennessee Valley Surveying 1745 to 1780 by E. D. Heppert, Jr., is contained in the December 1975 issue of "Surveying and Mapping." At the conclusion of the article, the author suggests, "Why not start a public affairs project for your own community researching records of surveying, Mapping and Civil Engineering projects of days gone by." Based upon by recent research, I can promise you a most fascinating experience. You will be pleasantly surprised at the wealth of survey and mapping lore to be found in your local library and courthouse. I hope that many papers similar to Mr. Heppert's will be published. This would be a most worthwhile project for the various chapters of our two societies.

Bibliography

Adirondack Life, Spring, 1970; Winter, 1970.
Brown, Lloyd, *The Story of Maps*—Boston 1949.
Colvin, Verplanck, *Report on the Topographic Survey of the Adirondack Wilderness* 1873; *Report of the Superintendent of the State Land Survey* 1897.
Jensen, Oliver, *Railroads in America* 1975.
New York State Conservationist—February-March 1954.
The Pennsylvania Magazine of History and Biography, October, 1960.
Skelton, R. A., *Maps*—Chicago 1947.
Synder, John P., *The Mapping of New Jersey* 1926.
Storms, C. E., *Aerial Mapping in the Delaware Valley* 1976.
Thrower, Norman J. W., *Maps and Man* 1972.
Tooley, R. V., *Maps and Map Makers* 1949.
Wallace, Paul A. W., *Indian Paths of Pennsylvania* 1965.