Oliver Scott Reading

Memorial Address*

Oliver Scott Reading**
1894-1984

PART I. BY GEORGE P. READING†

SCOTT READING was born on August 2, 1894 on a farm near Westfalls, New York, about thirty miles south of Buffalo. His father was Charles Richard Reading. The Readings had immigrated to western New York from England about 1825.

His mother was Olive Scott Reading and he was named Oliver but never called anything but Scott. The Scotts were of Scotch-Irish descent and had come to North Carolina before the American Revolution and moved later to northern Kentucky. Scott had an older brother, Richard.

A story is told about Scott as a youngster. He was slow to talk. He had not learned to speak and had said nothing at about the age of three when one day a particularly nasty rooster was strutting about the yard in which Scott was playing. He is said to have uttered his first words, "Don't let that chicken get me."

His father moved many times and Scott grew up in Waukegan and Chicago, Illinois. He was a very slight, thin individual and his coaches at his high school thought that he ought to play some sport. They recommended tennis. Scott is said to have learned to play tennis by reading a book. He was always reading and learning new things by his reading.

At that time, the Lane Technical High School was brand new. It was said to be the very finest and latest in technical secondary education. A story is told that two of his classmates went to an employment agency and were asked what they could do and they said, "We can do anything; we graduated from Lane Technical High School." Although these classmates were hired as floorwalkers in a department store, the adage, "I can do anything; I graduated from Lane Technical High School," was something Scott believed the rest of his life.

Following his high school education, there was no money available to send Scott to college. He determined to earn money for his college education, and one of his projects was farming tomatoes in Florida. He had a large crop which he felt would be worth several thousand dollars, enough to finance his college education, but a late frost killed the tomatoes.

At that time he worked for the Coast and Geodetic Survey which had a surveying party in Florida. He decided to become a commissioned officer in that service.

While waiting for his appointment as a deck officer in the Coast Survey, he worked at the Bureau of Standards in Washington, D.C. He had a boring job weighing cement samples. To make the job more interesting, he determined he would perform it in the most efficient way, and set about planning this. He related this in later years, noting that one way to make any job interesting was to try to figure out the best and most efficient manner of doing it. At this time a new laboratory building was to be built on the grounds of the Bureau of Standards and his

* Presented at the Annual Convention of the American Society of Photogrammetry, Washington, D.C., 12 March 1985.

† Eulogy delivered by Dr. George Reading on 14 April 1984 at his father's memorial service in Bellport, New York.

** All the illustrations in this paper were gratiously furnished by Mr. John T. Smith.

chief was unhappy with the design. Scott took the plans home and redesigned the building. This building was constructed according to his plans. During the time when we lived in Washington, we often drove by the Bureau of Standards and could see this building that our father had designed about 1915.

He became a deck officer and joined the Commissioned Service of the Coast and Geodetic Survey. He served on a number of ships. He was assigned to the Philippines during World War I.

His brother, who was a rice farmer in Eagle Lake, Texas, died in the flu epidemic in 1919. Scott took a leave of absence from the Coast Survey to operate the rice farm there. He was successful as far as having a bumper rice crop, but everyone else had a bumper crop too. The price fell to about one-fifth of the previous year's price of rice. This was financial disaster and Scott sold out and rejoined the Coast Survey.

Scott had a cousin (his mother's niece) named Nell Garrett. She lived in Covington, Kentucky, and Scott visited her on occasion. One day he noticed in her house a picture of a particularly lovely young lady. He asked that he be introduced to this girl. This was a picture of Nell Garrett's very good friend, Martha Gothard, with whom she had gone to high school. Scott and Martha corresponded, after an introduction by letter previous to the time they met.

Scott had always been interested in machines and gadgets and kept this interest for his entire life. About this time, he decided that he would either buy an airplane or get married. We are all very pleased that he decided to get married.

Scott and Martha were married on November 10, 1923. Martha's sister, Elsie Gothard, was maid of honor and she is here today, with her daughter Ann Edmiston and her son Albert Hawes.

Scott and Martha had three children. Richard Scott Reading, born in 1924, Martha Jane Reading, born in 1927, and George Paul Reading, born in 1929.

Richard was to die of the complications of strep throat in 1931.

The life of a Coast Survey officer was demanding, especially for those in the field. Scott and Martha moved and set up housekeeping 26 times in the first six years of their marriage.

One day, while surveying the coast of Alaska and jumping from rock to rock with some danger involved, Scott noticed an airplane flying overhead. He thought, "If we took photographs from airplanes, we could make these maps without jumping from rock to rock." He wrote a letter to the Washington headquarters of the Coast Survey. He was invited to come to Washington for a year or two to develop the idea, but he spent the next 25 years in this project with the new technology of photogrammetry, making maps from aerial photographs.

Scott gathered together others who were involved in photogrammetry and, in 1934, the American Society of Photogrammetry was organized around our dining room table in Washington, D.C. Scott was elected the third president of the American Society of Photogrammetry in 1937.

He was selected to head the American delegation to the Congress of the International Society for Photogrammetry in 1934 in Paris.

On that voyage he had an experience that influenced all his future thoughts on science and religion.

Scott designed a very complex camera to take photographs of large areas from the relatively low altitude that airplanes could fly in those days. The camera had nine lenses. I remember that, while working out the details, he spent long hours in the laboratory in the Commerce Building at night and on weekends. In 1938 Scott again headed the U.S. delegation to the International Society for Photogrammetry, this time in Rome. He remembered that, at the time of the Munich crisis, Mussolini came back to address the crowds from his balcony. He promised that there would be "Peace in our time."

During World War II, Scott was active in developing maps for the armed services.

After the war, the International Society for Photogrammetry met in 1948 in The Hague, The Netherlands. Scott was elected president. The Society held its next international meeting in 1952 in Washington.

In 1953 Scott retired from the Coast Survey. In the next year he moved to Bellport, New York. He worked as a surveyor for the Brookhaven National Laboratory for the placement of the electromagnets at the circular synchroton accelerator for nuclear physics experiments. The placement of these electromagnets had to be done precisely. He worked at this for the next eight years.

Scott was much impressed by the cooperation between the scientists at Brookhaven and between his International Photogrammetric friends in spite of their disparate backgrounds. He reasoned that all people should be able to solve their problems using well-known psychological facts and scientific principles.

Scott and Martha joined the Unitarian Fellowship at Bellport and were active in its affairs including the Fellowship house. Martha was a delegate to the conventions which united the Unitarians and Universalists.

Scott spent the last 20 years of his life writing, reading, arguing, and re-writing, trying to explain his concept of scientific knowledge and its application to cooperation in world peace. He spent many years trying to get others to accept these ideas and to move forward. He wrote and re-wrote his papers on this subject and in recent years several of them were published.

Certainly we all have been exposed to and influenced by these efforts. Scott suffered a stroke in July of 1983. He suffered a heart attack shortly after his return to the Bellport region. He died on April 10, 1984.

PART II. BY G. C. TEWINKEL*

We are fortunate to have the foregoing eulogy by Dr. George Reading, son of our celebrated Oliver Scott Reading. It would have been preferable that George himself present his talk here. But that was scarcely possible: he wrote that he had recently married and would be in New Zealand for the next five weeks. (Congratulations, George, and good luck!)

As you probably know, a similar memorial paper of mine was published in the July 1984 issue of *Photogrammetric Engineering and Remote Sensing.* Although George had not seen that item, his eulogy nevertheless closely parallels that of mine. A few added comments can perhaps be noted. Also, the September 1984 issue of that magazine included an article of mine on the nine-lens aerial camera. I shall repeat some of the pertinent material from both papers.

As George noted, Captain Reading was seriously interested in the International Society for Photogrammetry. Not only did he attend the quadriennial congresses in Paris and Rome in 1934 and 1938, but also the one in Helsinki in 1976, *and all the intervening ones.* He carefully studied all the contemporary photogrammetric systems (German, French, Italian, Swiss, etc.). At Rome he was amazed at the candid frankness of all the delegates in spite of the electrifying tenseness of the impending World War II. There seemed to be no secrecy at all, and all the delegates were unusually friendly. The attitudes were completely different in 1948 at the congress at The Hague after the War.

At the 1952 Congress in Washington, Reading persuaded the U.S. Departments of Commerce and of State to invite 30 photogrammetrists from the war-torn countries of Europe to attend with all expenses paid, including a two-week tour of American photogrammetric operations as far west as Denver. It was a never-to-be-forgotten experience for the group.

Captain Reading was a genius at developing large implements of unusually high accuracy. Even before the nine-lens camera was in service, he had produced two other devices at the Coast & Geodetic Survey: a large copy camera and a projection ruling machine. Until recently the copy camera was still in operation in the basement of the Department of Commerce Building at 15th Street and Constitution Avenue, N.W., in Washington, D.C. The camera (about 20 feet long, 8 feet wide, and 8 feet high) was suspended from three points resting on piers set in the muddy earth beneath the building. The camera photographic area was 50 inches square and it was used in the preparation of printing-press plates for nautical and aeronautical charts produced by the Survey. The errors were sufficiently small that no inaccuracy could be attributed to the machine or the lens.

The projection ruling machine was a manually operated flat-bed plotting table about 7 feet square with which the curved parallels and converging meridians could be drawn in ink (or scribed) with an accuracy of about 0.1 millimeter.

The nine-lens camera (Figure 1) was the primary part of a very useful photogrammetric mapping system that also included (a) a transforming printer that removed the effect of the 38° tilt of the eight peripheral images, (b) a two-story rectifying printer for removing the effect of accidental tilt (about 3° or less) of the aerial camera, and (c) two stereoscopic plotting instruments for compiling contour lines and planimetric detail.

A chronological summary of the nine-lens camera development may help one appreciate Reading's interest in the project:

- 1919—The Coast & Geodetic Survey began using aerial photographs (principally multi-lens) for mapping ocean shoreline and for aeronautical charting.
- 1927—Three-lens camera was deemed not sufficiently applicable for the Survey.
- 1928—Lt. Reading was listed as an aerial photographer using a Fairchild T-2A four-lens camera.
- 1933—Design of the nine-lens camera began under the direction of Lt. Reading.
- 1934—Designs were submitted for bidding and a contract was concluded with the Fairchild firm.
- 1935/36—The camera was received.

FIG. 1. The nine-lens camera. Reynold E. Ask (C&GS) on left, Capt. Louis J. Rumaggi (USAF), Lt. B. B. Tally (USAF), Lt. O. S. Reading, (C&GS).

* Tewinkel worked under the general direction of Captain Reading from 1941 to 1953.

1936—Field tests were completed and the camera was placed in operation.
1943—An airplane crash badly damaged the camera.
1945—Fairchild rebuilt the camera and it was put back into service.
1949—Two stereoscopic (Reading) plotters were put into service (made by a different firm).
1963—The nine-lens camera system was retired from service and presented to the Smithsonian Institution.

In the design of the nine-lens camera, Reading had the unwavering support of his superior, Commander Kenneth T. Adams, who was a firm believer in the application of airphotos to the solution of the charting problem. In 1942 Adams organized the first photogrammetric division in the Survey and served as its first chief to be succeeded later by Reading. However, rather than put all his lenses in one basket, Adams insisted that the division also use commercial single-lens cameras, together with appropriate plotting devices (Fairchild, Wild, Bausch & Lomb, Kelsh, Zeiss, etc.).

The Great Depression in the financial world was a windfall for Reading and his camera. The U.S. Works Progress Administration provided funds that were used in the design and construction. The Brock & Weymouth photogrammetric firm of Philadelphia had developed and was using a mapping system which Reading liked. The firm became bankrupt and Reading was able to hire several of their employees.

Capt. Reading's design crew had disbanded before I reported to work for the Survey but a few of them remained. Mr. Thomas W. McKinley was the primary mechanical engineer and designer who had come from Brock & Weymouth. Mr. Reynold E. Ask specialized in the selection and testing of the lenses (at the Bureau of Standards).

Captain Reading was not a very good communicator in the sense that his sketches were scarcely legible, and he was a poor public speaker and a worse writer. But Tom McKinley could produce fine working drawings from the sketches and Adams was an excellent writer, editor, and grammarian.

Cost overruns occurred even in the '30s and '40s and Reading was the victim a time or two. One time, even though I was present, one of Reading's superiors accordingly administered an unmerciful tongue lashing.

One of my first assignments with Captain Reading was to develop a system for determining the tilt of nine-lens photographs and for making the settings on the rectifying camera. I was surprised to learn that the problem had not already been resolved—the camera was already being assembled! I spent a year or more on the study, testing all the known methods of tilt-determination, and constructed detailed graphs of the rectifier settings. The solution became ridiculously simple with the help of colleagues William D. Harris and Benjamin Lyon. The discarded radial-line templates served as rectification templets. They displayed the image displacements for each ray. Furthermore, numerous points at sea level were almost always available. I learned a lot about photogrammetry from the experience. Did Captain Reading know all along that it would turn out this way?

Perhaps the greatest fault of the nine-lens camera system was the effect of uneven film deformation on the errors at the junctions of the nine separate sections of the transformed photograph, particularly the kind of deformation that differs in the two directions of the film. It so happened that, due to the geometry of transformation, the error had to be a maximum summation of the deformation difference in the two directions.

Shortly before he retired from the Survey, Captain Reading worked with the Federal Aviation Administration and with the aircraft manufacturing industry in the development of a coordinate setting machine. This was a system of jigs, invar tapes, and theodolites which enabled the several component parts of a large aircraft to be constructed at different sites and then assembled easily and accurately (about 0.001 inch).

During his service at Brookhaven after retiring from the Survey, Captain Reading developed and helped install the pedestals and magnets on the circumference of a circle 1 kilometer in diameter with an accuracy of about 0.1 millimeter. For making thermal corrections to invar tapes, he suspended the tapes in paper tubes and applied electrical impedence to determine temperature.

Captain Reading had the uncanny ability to grasp very complicated ideas, which seemed very simple to him. One example was the laboratory calibration and adjustment system for the nine-lens camera. I hesitate to describe the system lest you think I am exaggerating, whereas I am actually attempting to simplify the story.

When I first came to the Survey, Reading took me to meet Mr. Ask. Rey was lying on his stomach on some planks up on a steel tower looking down into the body of the nine-lens camera. He was putting the final touches to the adjustment of the camera before it was to be flown to Alaska. Years later Reading personally taught the procedure to Bill Harris and me.

The calibration procedure involved three distinct steps, each having to be repeated several times at the beginning and the end of each photographic season. The steps were: (1) aligning six collimators with a T-3 theodolite, (2) observing the positions of the collimator crosses with respect to etched crosses on a master glass plate and correcting any discrepancies, and (3) flattening the camera mirrors using an optical flat and a monochromatic light source and then studying interference fringes. Each stage required a separate and distinct laboratory setup which necessitated that one upset completely the previous setup. It was necessary to repeat the stages in the fashion of successive approximations.

The camera was large and heavy. It used film 24 inches wide and the focal length was $8^{1/4}$ inches. Stripped down for calibration, the lens cone and mirror assembly weighed about 175 pounds. On the ground the camera rested on a cart, but in the airplane and in the calibration laboratory the camera was hoisted into position with a hand winch. The camera had 49 fiducial marks.

An annual calibration was necessary for two reasons. First, the mirrors eroded because they were situated during photography on the outside of the camera body in the slipstream of the airplane. Usually, each year from one to three mirrors needed to be removed, resurfaced, and then replaced into their precise locations. Secondly, mechanical vibrations and thermal changes sometimes caused minor maladjustments.

The calibration laboratory (Figure 2) looked like a Rube Goldberg nightmare. A steel frame 12 feet high included a hoist so that the camera could be raised over one's head to permit the operation of a T-3 set at the camera's perspective center for aligning the six collimators which sat on the floor.

The first step in the process was setting the collimators. A collimator consisted of an old theodolite of 1850 vintage with its eyepiece replaced with a flashlight lamp to illuminate the cross hairs. The telescopes of these old theodolites were two feet or more in length. The first time the laboratory was set up in a location, it was indeed a severe chore to get all the collimators positioned and aimed properly; afterwards it was simply a matter of "fine tuning."

The second step was to remove the T-3 and to lower the camera into its "operating" position. The master glass plate had etched on it some 45 crosses indicating the correct locations of all the collimator crosses. The camera could be rotated (crabbed) a full circle so that each of the eight chambers could be studied in detail. One could view both the etched crosses and the collimator cross hairs at the same time—provided that he lay on his stomach on planks and sighted down at the proper angle through a microscope. The glass plate had arm holes so that one could reach into the camera to loosen and tighten adjusting screws. This step was executed the last thing before sending the camera back to the airplane in the spring, and then again in the fall at the end of a photographic season.

The third step was observing the interference fringes and lack of mirror flatness (Figure 3), and then to manipulate the stud bolts in order to create a large flat area in the center of a mirror by decreasing the number of fringes. It was possible to reduce the number of fringes to less than ten throughout the working area of a mirror. No mirror was sufficiently flat at the outset. The trick was to manipulate the nine push-pull screw studs, using a special dual wrench.

The callibration procedure was adversely sensitive to vibrations such as those caused by the operation of an elevator in a building, by trucks and street cars on the street, and even the human voice. The lab was removed from Ask's office on the ground floor to the attic over the seventh floor of the Commerce Building because building officials were unhappy with the full-time dedication of valuable office space to instrument calibration requiring

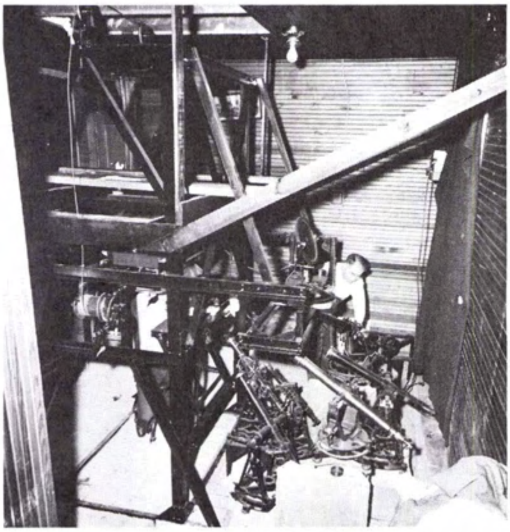


FIG. 2. Calibration laboratory for the nine-lens camera. Capt. Reading is in the background.

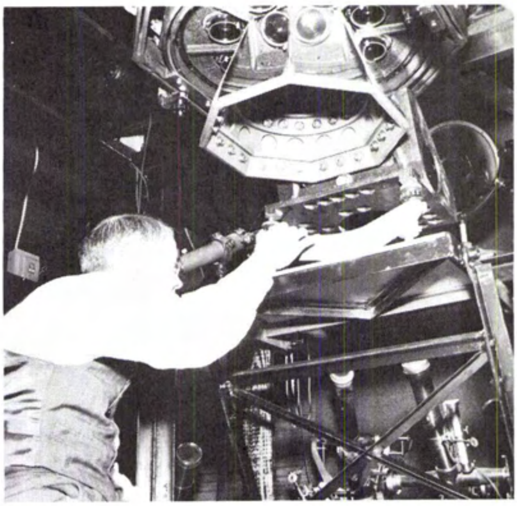


FIG. 3. Capt. Reading observing the interferometer fringes of a mirror of the nine-lens camera.

only two months a year. But the building vibrations were much worse in the attic than in Ask's office. Even working at night was of little help.

Finally the lab was moved to a vacant observatory on the astronomy grounds at the edge of Gaithersburg. During the first calibration at the new site, the city began to drill a new well about a half-mile from the lab. One could see the fringes jump each time the drill bit was dropped. Again night operations were essential. When daytime operations could be resumed, only minor interruptions were caused by the passing of a Baltimore & Ohio freight train, and by trucks on the highway. Once operations were postponed because of strong, gusty winds buffeting the building. Occasionally afterwards we chose night operation for final flattening. Those fringes were beautiful, sharp, and completely stationary. Captain Reading's knowledge, wisdom, vision, understanding, and persistence paid off.

Captain Reading always wore a shy smile. He didn't cuss and I never heard him berate anyone. I found him easy to get to know, and then you couldn't help but love him. He was completely dedicated to the success of the nine-lens camera system. And he was a genius in the design and production of large implements of unusually high accuracy.

Attentive listeners to the Memorial lectures.

G. Carper Tewinkel talking about Capt. Reading.

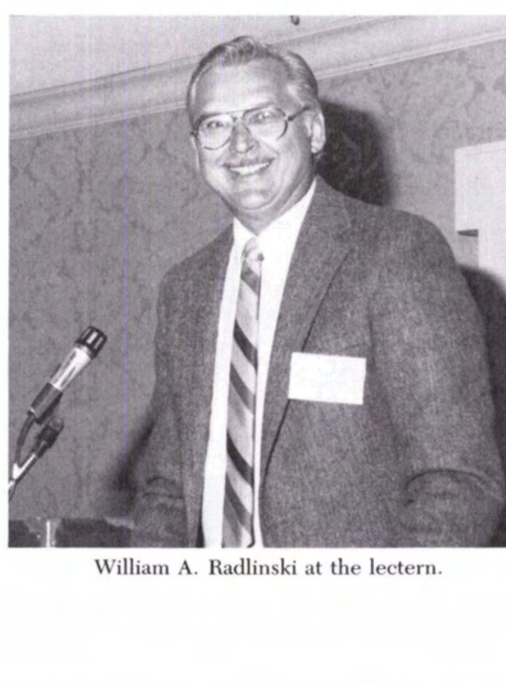
Memorial Lecture Ceremony

Memorial Lectures honoring both Russell K. Bean and O. S. Reading were held on Tuesday, March 12, 1985 in the Washington Hilton. G. Carper Tewinkel gave an inspiring talk about Captain Reading, and William A. Radlinski then spoke about Russ Bean.

It was exciting to welcome members of Russ Bean's family who came to the ceremony. Rad did a super job of relating some of Bean's many experiences and accomplishments in the short period of time allotted. Although members of Capt. Reading's family were unable to attend, we know they would have appreciated Carp Tewinkel's glowing tribute to him.

After the lectures, a reception was held complete with tea and scones. During the reception attendees were able to meet members of Russ Bean's family and talk with both Rad and Carp Tewinkel about experiences they had with both of these great men.

For the first time, the Memorial Lectures were held in conjunction with the Past President's meeting during the convention. This worked out well, and we expect the meetings to be handled this way in the future.



William A. Radlinski at the lectern.