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Sherman Mills Fairchild*

Memorial Address

Sherman Mills Fairchild
7 April 1896—28 March 1971

Today, in the midst of the whirlwind of activity associated with this, the forty-sixth Annual Meeting and Convention of our Society, we take time out as we continue, once again, the practice of recognizing and honoring another of our science's colorful and devoted pioneers. The stories of the lives and works of these illustrious pioneers, when put all together, make up a captivating history of the origin and early development of this science that we take so much for granted today. Thus, through the medium of these several memorial lectures, we have not only had the opportunity to learn and appreciate the details of many of the significant milestones in the evolution of the complex science of photogrammetry, but have also inherited a valuable record for posterity.

Now, I would like to invite you to join me in a bit of reminiscing, as we take a time-machine journey back three-quarters of a century to a time near the beginning of the world of photogrammetry, where we may pause and reflect awhile on the fascinating story of the subject of our 1980 Memorial Lecture—Mr. Sherman Mills Fairchild.

To many people, he seemed to be "an enigma"—or "somebody from another time." He was once described as "a cross between a rich Edison and a modern Leonardo da Vinci"—rich Edison because of his inventiveness and inherited wealth—da Vinci because of his rare combination of artistic and engineering talents. He would not accept the word "impossible." Why not invent matches that won't blow out in the wind, or car locks that won't rip your coat, or pill bottles that won't spill open in your pocket? He became one of the most important businessmen in America, yet unlike ordinary executives, his dress and manner were quite informal—almost casual. He had no platoon of secretaries, no plush offices, or lets-get-down-to-business attitude. He didn't need those "executive tools" to run his businesses.

He was fortunate to be born at just the right time—on 7 April 1896, in the little upstate New York town of Oneonta. He was a little boy, just seven years old, when the Wrights made their successful flight at Kitty Hawk—and so pushed the button that started the glamorous aviation industry on its way. That coincidence permitted Sherman Fairchild and aviation to grow up together.

By way of some family background, he was the only child of George Winthrop and Josephine Mills Fairchild. His father had started as a printer and newspaperman, and had soon become the owner of the Oneonta Herald. He invested in an automatic printing press invented by David Eckerson, and became President of the Eckerson Printing Press Company. Later, he backed Willard Bundy, inventor of the first practical time recorder for businesses, and became a director of the Bundy Time Recording Company. This was the company that, in 1911, George Fairchild consolidated with other interests to form the Computing-Tabulating-Recording Company, which, in 1923, became the International Business Machines Corporation. Sherman's father was the first

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President and, at the time of his death, Chairman of the Board of Directors. He also served in the United States House of Representatives for 14 years (1907 to 1921). His mother, who came from a well-to-do, industrial family of the area, had become one of the active leaders in local society. Both parents died in 1924—just a little too soon to see their son's real success.

Young Sherman's early childhood and school years already began to give an indication of the impact he would later have on the technology of the world (Figure 1). It was evident very early that he had an extraordinary interest in photography and anything mechanical. He liked tinkering and shop work, and had an unusually well-equipped shop set up in his father's garage. As a boy, he was out of school a lot because of chronic sinus trouble, and as he grew older, his health got worse. In his early teens, his parents took him out of high school and sent him to Arizona. Even there, his sinus trouble was so bad he was in bed almost a third of the time. For the next several years, he was back and forth between Oneonta and Arizona, attending private schools and taking occasional courses at the University of Arizona when his health permitted, and using private tutors when it didn't. Finally, in 1915, he seemed improved enough to start studies at Harvard, but was forced to give it up in his sophomore year, and return to Arizona for the winter.

FIG. 1. Sherman Fairchild at age seventeen.

There are some interesting accounts of some of Sherman's exploits and accomplishments during his school years that illustrate the ingenuity and inquisitiveness that characterized his later business success. While he was in high school, he had designed and built a non-tipping, safety bob sled, and a self-focusing enlarger. When he was sixteen years old, his father bought a $10,000 Locomobile as a gift. Nothing was seen of Sherman for a few days, while he completely disassembled the car and engine "to see what made it tick." When he finally emerged from the garage, covered with oil and grease, he informed his father that "this overgrown flivver only has four bearings on the crankshaft." When he got to Harvard, he was elected to the bi-monthly magazine, *The Harvard Illustrated,* only to find that the magazine was broke. That didn't stop him. With his typical ingenuity, he ran a burlesque number for the next issue, using old cuts with new captions, and made enough money to operate as a monthly after that. He also became interested in night photography, and experimented with methods of supersensitizing plates. He developed a method of synchronizing the shutter with a blast of flash powder for indoor action shots. With this apparatus, he set out to get an action picture of a boxing match at the old Boston Arena. At a crucial point in the match, the crowd was startled by an explosion and a blinding flash. Sherman got his picture, but the referee had to stop the match until the two fighters got the "spots" out of their eyes. Apparently, his health wasn't bad enough to completely interfere with his love for gadgeteering, for, we are told, his college room was full of mechanisms for waking him up, putting up the blinds, turning on his bath water, and many other things—all controlled from his bed.

In the year 1917, when the United States found itself inexorably dragged into the war in Europe, Sherman tried to enlist in the Aviation Section of the Signal Corps. He was, of course, rejected. The next spring, after spending the winter soaking up Arizona sunshine and adding all kinds of inventions to his cameras, he tried again. When he was again rejected, he decided that if he couldn't enlist, he would offer his services to the government as an expert or consultant on cameras. At first, the response to this offer was a polite "No, thank you," but through his father's influence, he was given a tour of the Photographic Section's laboratory, where he was shown the British and French built aerial cameras of the day. His examination of these cameras, and the pictures they were getting, immediately convinced him that the focal plane shutter they used was completely unsuited for a camera subject to the vibration and rough air they were experiencing. His guide also told of a problem they were having with the film spacing in the American K-1 Camera being built by Eastman Kodak. The film take-up spool rotated a fixed angle for each picture, so that the space between pictures naturally got larger as more film built up on the spool. That problem was a snap for Sherman, and he sketched up a solution on the train ride back to Oneonta, and sent in a complete set of drawings for the mechanism four days later.

Sherman, however, was convinced that what was really needed, was a new between-the-lens shutter, large enough for the lens aperture they were using, and fast enough to avoid the blur and distortions they had been getting. He had some ideas, and a couple of weeks later he took his proposed design for such a shutter to Washington. They were interested, but skeptical, and suggested he make some working models, and apparently even offered to give him a K-1 Camera to fit the shutter to—if it worked. His father made the facilities of the International Time Clock Company available to him and he went right to work. He soon found out that his first design, a rotary blade type, wasn't going to work, so he gave it up and started over again. He then devised a crank and link design for driving a set of oscillating blades. He turned over his new drawings to August Knistrom, the Master Mechanic, and left for Arizona again. This design worked, and the following March he returned from Arizona, and took the camera with his new shutter to Washington for a demonstration (Figure 2). All the tests went well, but it was 1919, and the war was over and the Army didn't need any more aerial cameras. Furthermore, nobody would accept responsibility for ordering the camera, so his father was stuck with the bill.

The story might have ended right then and there, except that his father, Congressman George Fairchild, came to his rescue, and took him to see George W. Goddard, a Lieutenant in the Air Service, and undoubtedly, at that time, one of the most knowledgeable men on aerial photography in the U.S. General Billy Mitchell had picked

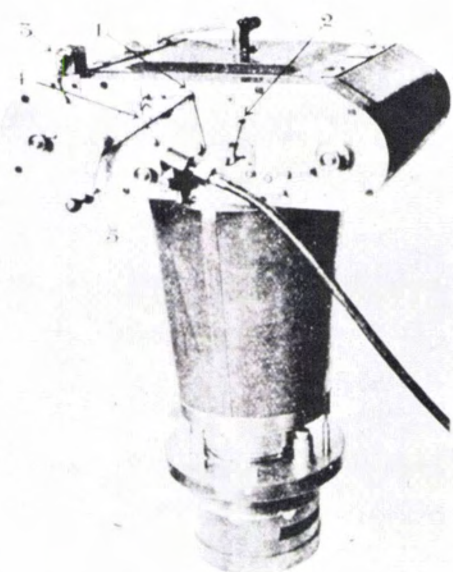

FIG. 2. The K-1 camera with Sherman Fairchild's first shutter—1919.

Goddard to handle the aerial photography to document his forthcoming "Bomber vs Battleship" tests. When Goddard and Mitchell looked over Fairchild's camera design, the General approved an order for an experimental camera. In filling this order, Sherman decided to include all of the ideas he had been accumulating for a fully automatic aerial camera. He also went to Europe to inspect and bring back several of the French, British, and German cameras.

Meanwhile, Sherman's determination to produce a new and better aerial camera, precipitated a small family disagreement at home. His father understood his need to pursue his convictions, and was willing to supply the money—up to a point. But his mother wanted him to finish his college education at Harvard, become more involved in social affairs, and enter his father's business, where he would ultimately move to the top. Sherman's enthusiasm for his ideas, and confidence in the future potential of aerial photogrammetry, combined with his offhanded indifference to his mother's social world, easily won out. He took his father's offered loan, hired R. W. Elton, a designer, persuaded W. L. Hamilton, a friend of his, to join him, rented space in a machine shop on forty-second street, in New York, and incorporated his operation as Fairchild

Aerial Camera Corporation on 9 February 1920. At last, he was off and running.

Having taken the positive step, he felt better. His recent frustrations over the Army's skepticism and refusal to honor what he considered a verbal contract and pay his shutter costs, and the strain of his battle with the shutter's formidable technical problems, sometimes by remote control from Arizona—all were now behind him. He put everything else out of his mind as he bent to the immediate task of making his new camera everything he wanted it to be. Whatever misgivings he may have had, easily faded into the background alongside of the twenty-three year old youth's rosy visions of the hordes that would soon be clamoring for aerial photographs and maps. When he had the camera working to his satisfaction, he took it to Washington and demonstrated it to the Army (Figure 3). It was an instant success. They tested it over Washington and they sent him up to the White Mountains for competitive tests with other makes. His camera outperformed them all in every respect. The Air Service wanted to order twenty cameras immediately.

He had done it—exactly as he had set out to do. There was no doubt that Fairchild's camera was a real design masterpiece. It was electrically driven—not hand wound. Its between-the-lens shutter meant sharper definition without distortion of the objects photographed. It also had an intervalometer that could be pre-set to take pictures at selectable time intervals. Within two years, the K-3 aerial camera, as the Army Air Service designated it, was to become the standard of the Army and Navy. It was truly a milestone in the development of aerial cameras, recognized throughout the world. By the late 1920's Fairchild Aerial Camera Corp. had what amounted to a monopoly of the aerial camera business in the United States. Likewise, outside of Europe, every foreign government in the world that was engaged in aerial photography used Fairchild cameras, including Japan, the Soviet Union, and Brazil. The brash young man of 1918 had become the business genius of the 1920's.

Within a short time, this product was joined by other models: the K-4, the K-6, and others—some smaller, some larger, and some with various additional features—but with minor improvements over the years, the K-3 became the K-3A (Figure 4), then the K-3B, and later the K-17, and finally the K-17B. Improvements were made every few years, as aircraft speeds and altitudes increased, and as better lenses and faster film became available. They included increases in shutter speed, enlargement of the format from 7″ × 9″ to 9″ × 9″, increases in the film magazine capacity, from 75 feet at first to 400 feet, and increases in the rewind rate, from an original of one picture every six seconds, to a final capability of two pictures per second by the end of World War II. With these various improvements, this type of camera was produced right up to the late 1950's—a production life for the basic design of almost 40 years.

Once launched as a camera manufacturer, Fairchild realized that he would have to prove to the world that a field existed for aerial photography in peacetime. The Army and Navy needed no convincing, and for years were the principal customers. But civilian agencies had to be won over, and Sherman felt that the best way to sell the camera was to put it into action and demonstrate its value. And so a plane was rented and a camera was taken aloft. The company made its first sale of an aerial photograph in the summer of 1920, when the owner of a New Jersey resort hotel was sold an aerial view of his establishment at a price of $150.

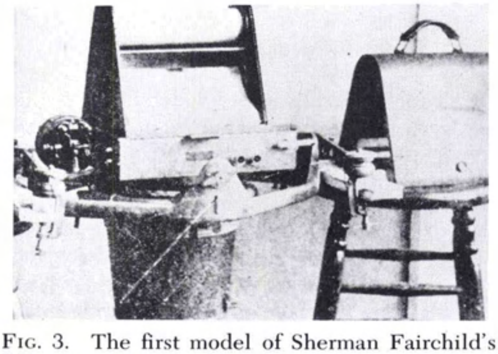

FIG. 3. The first model of Sherman Fairchild's fully automatic aerial camera—1920.

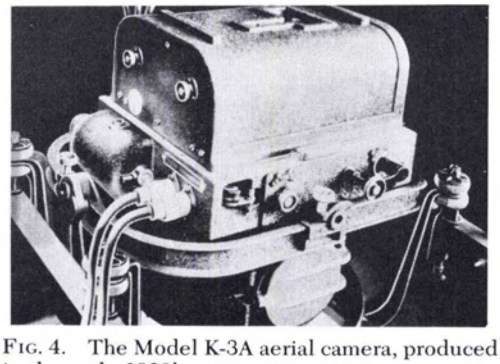

FIG. 4. The Model K-3A aerial camera, produced in the early 1920's.

The photograph, according to Sherman, turned out to be a "fuzzygraph," but the hotel owner was convinced by good salesmanship that it was an outstanding picture. However, by the end of 1920, the company had taken over 400 aerial pictures, but sold only about 50. It was becoming obvious that there wasn't much profit in simply taking aerial views.

In spite of this, Sherman Fairchild still believed that aerial photography had a future—particularly if the photographer pointed his camera straight down to document what was on the land below. By taking a series of overlapping pictures of the ground, a mosaic map could be created that would show every feature of the land and every structure and road upon it. It made no difference if the terrain were inaccessible or impassable from the ground. It would all be seen and recorded from the air. The only real problem he expected with aerial mapping was the accuracy that would be required in maps to be used for survey or engineering purposes. That accuracy wasn't easy to achieve from a small plane bouncing around at 10,000 feet in the air.

Although Fairchild was truly an expert on the subject of cameras, because of the years spent on his hobby of rebuilding and improving every one he got his hands on, he was just as truly a neophyte with respect to the making of an accurate aerial map, as he was soon to find out. By the summer of 1921, he had his camera working fairly well, and was ready for his first attempt. He sent his experienced pilot and aerial photographer, Lewis McSpaden, aloft to take a series of 100 overlapping photographs of Manhattan Island. McSpaden spent about an hour in the air to get the pictures, and then spent six months in the lab trying to piece the photographs together, hopefully to make the streets meet where they should. A lot of the photographs had to be retaken when they were found to be out of scale. However, when finally finished, the result was a map of Manhattan that proved extremely useful to various New York City agencies, businessmen, and others who flocked to buy it. It was Fairchild's first real commerical success, and soon led to other aerial mapping opportunities. In 1922 he secured a contract to map the bay area of the City of Newark, New Jersey. An aerial map of one Connecticut town revealed 1800 buildings that weren't on the tax rolls, and town officials had a field day. Another town, East Haven, wanting to reassess its real estate to prepare for a bond issue, found that a ground survey would take five years and cost $80,000. Fairchild did the job in 60 days and for a fee of $7,000.

In 1922, Fairchild formed the first of several companies to exploit aerial photography as a business, when he was convinced that his camera would be invaluable in mapping the vast, largely inaccessible forest areas of Canada. The idea was proposed by Ellwood Wilson, Chief Forester with the Laurentide Paper and Pulp Company, of Grand Mere, Quebec, who came to New York to personally investigate the K-3 camera. The result of that meeting was formation of Fairchild Aerial Surveys, Ltd. in Canada. Within the first year of operation, they had mapped 510 square miles of forest, demonstrating conclusively the value of aerial timber surveys over the ground methods. The company prospered, bought more planes, hired more pilots, and expanded so rapidly that within five years, it was the largest general aviation company in Canada.

In 1923, the City of New York contracted with Fairchild to produce a giant aerial map of all five of its boroughs. It took three months to photograph the area and many more months to assemble the photos and make the map. The job was completed in 1924 and delivered as an impressive eight-foot square wall map covering some 620 square miles of territory (Figure 5), plus a set of 140 photomap sheets at a scale of 600 feet to the inch. In the same year, Sherman founded Fairchild Aerial Surveys, Inc. in New York, to exclusively handle the aerial

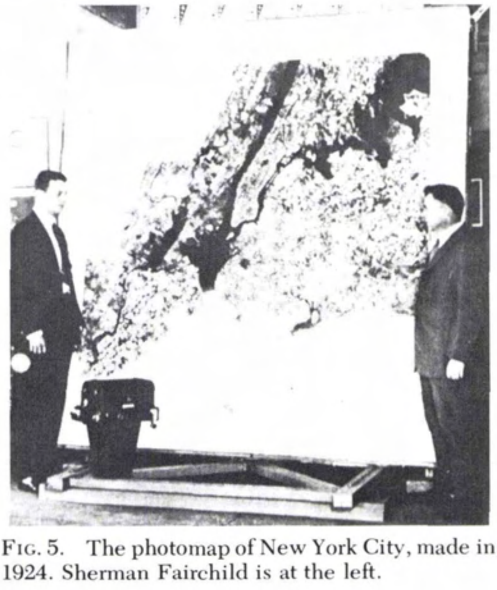

FIG. 5. The photomap of New York City, made in 1924. Sherman Fairchild is at the left.

map-making business, operating as a subsidiary of the Camera Corporation.

When both of his parents died, in 1924, Sherman was left with a fortune of over $4 million, and he now began to set his sights on more actively participating in the fledgling aviation industry. First, he was determined to establish his company as the major one in the aerial survey and mapping business. As such, he recognized the lack of technical expertise his company had in all aspects of this complex field. To remedy this situation, he acquired, in 1925, a small Los Angeles organization, Pioneer Aerial Engineering Company, which had developed more effective and more accurate methods than his. Leon T. Eliel, who ran Pioneer, soon proceeded to teach Fairchild's people how to make really good aerial maps.

As both the camera and aerial survey business expanded, it became clear that one of the major problems was not his aerial camera, but the aircraft available at the time. In many respects, the open-cockpit biplanes of the day were almost totally unsatisfactory aerial platforms. The first plane he had purchased was an open-cockpit Fokker C-2 "Express" biplane (Figure 6). This model had had a crude cabin added onto the rear bay to keep the two passengers warm, and Fairchild hoped it would keep his photographer warm too. They cut a hole in the bottom of the fuselage to enable the camera to photograph the desired area directly below. But the Fokker was simply not suited to serve as a commercial camera plane. Its speed, range, and altitude capabilities fell far short of what was needed for mapping large cities and similar areas. After trying several other makes and models, the company bought several open-cockpit Huff-Daland "Petrel V" biplanes, and modified them extensively for aerial photography (Figure 7). Still, Ken Saunders, Chief Pilot at the Canadian operation, found them lacking, even in normal day-to-day use, let alone extreme weather conditions common in Canada.

An interesting incident occurred when Fairchild made a one-year deal to market the modified version of the plane in South America on a 20 percent commission. Fairchild himself enjoyed telling the story: "Four days after the contract was up, I got a wire from the Brazillian Government for one plane—the first I had sold. When I turned the order in to Huff-Daland, they wouldn't give me the commission because the contract had expired. So I wired right back to Brazil and asked if they would like Model 2, an improved version, at the same price instead. Naturally, they took it. Then I went to Igor Sikorsky and asked him to build the plane." Sikorsky had just immigrated from Russia a short time before, and was struggling to get a start in the American aviation industry. He went right to work on it and, in short order, built the plane—with, as Sherman told it, "a hand drill and a hack saw." Sherman, of course, took a loss but enjoyed the episode immensely. While construction was going on, Sherman haunted Sikorsky's shop, and watched the proceedings with great interest. He was amazed to find that a great number of wing arrangements and tails of various sizes had to be tried before the plane could fly properly. He felt there should be some more direct way of doing it.

Meanwhile, the complaints of his pilots and photographers about the unsuitability of their present airplanes became so insistant that he was forced to do something about it. After surveying all the models being produced by the American aircraft industry, he found none really suited to his needs. He therefore decided to build his own, and in

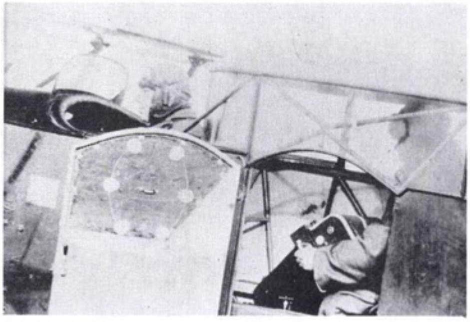

FIG. 6. The camera installation in the Folker C-2, the first plane used by Fairchild for aerial surveying.

FIG. 7. The Huff-Daland biplane, used by Fairchild Aerial Surveys in 1924.

August 1925, formed and incorporated the Fairchild Airplane Manufacturing Corporation for the purpose of developing, manufacturing, and selling commerical aircraft suitable for aerial mapping work. A month later, in order to reflect the broader activities he had developed in the aviation industry, he formed a new "parent" corporation, Fairchild Aviation Corporation, to take over and operate all of his various enterprises as subsidiaries.

With the help of his chief pilot, Richard Depew, and chief photographer, E. P. Lott, he prepared a list of features that a good photographic aircraft should possess. These included good visibility for pilot and photographer, excellent stability at high altitude, good responsiveness to controls, ability to operate out of small rough fields, good comfort for the crew, and ability to convert to floats or skis for use in remote northern reaches of the world. He hired Norman McQueen, an experienced aircraft designer, to transform these design inputs into a practical aircraft. He also retained Professor Alexander Klemin of the Guggenheim School of Aeronautics at New York University as a consultant to conduct wind tunnel tests on models, until an inherently stable design was achieved.

The result of these efforts was a high-wing cabin monoplane—one of the first practical ones in the world. The enclosed, heated cabin offered protection from the weather for both the pilot and photographer, as well as the camera equipment. Large slanting window panels provided excellent visibility, particularly in a forward, downward direction. The plane, uniquely, had foldable wings to cut down on the required hanger space, and to improve the chances of withstanding high winds when the plane was tied down out in the open. The folding wings also provided roadability and ease of towing from one place to another. As the design neared completion, facilities for its fabrication were obtained in the old Lawrence Sperry plant at Farmingdale, Long Island. The FC-1, as it was designated, had a 44 foot wing span and was powered by a 90 horsepower Curtis OX-5 engine (Figure 8).

On 14 June 1926, The FC-1 was towed over the roads to Roosevelt Field, twelve miles away. There its wings were unfolded, in just a few minutes, and Dick Depew gave her the gun and took her off on her maiden flight. When he landed, twenty-three minutes later, Sherman Fairchild knew that he was now definitely launched in the airplane business—with the best product in the field—just as he had started in the camera business six years earlier.

FIG. 8. The Fairchild FC-1, first flown on 14 June 1926. Sherman Fairchild is standing nearest the airplane.

Sure enough, the plane was an instant success and orders poured in right away. The production model, the FC-2 (Figure 9), with its many variations, was enlarged somewhat and offered with higher power engine options—up to 450 horsepower. Everybody, it seemed, was buying the plane and using it for every conceivable use—flying mail, airline use, as well as aerial photography, and a host of other things. One accompanied Chrales Lindbergh on his 23,000 mile tour of the U.S. following his return from his flight to Paris. One, the "City of New York," set a record for a flight around the world in 1928, of 23 days and 15 hours, including the time of the boat trips across the Atlantic and the Pacific. Another was the famous "Stars and Stripes" used by Commander Richard E. Byrd for photoreconnaissance flights over the Antarctic. The plane was so well suited for the rugged conditions in Canada, that to meet the Canadian demand, Fairchild first licensed Canadian Vickers, Ltd. to produce it (in 1928 and 1929) and then built his own plant and set up a new company, Fairchild Aircraft Ltd., in Longueil, Quebec. Within

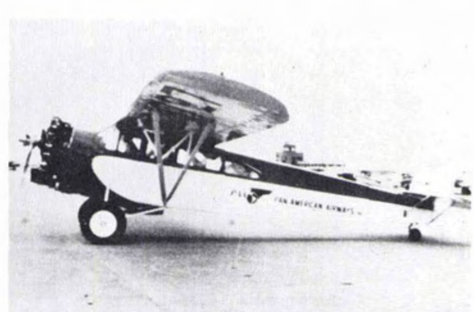

FIG. 9. The production model FC-2—1928.

three years, he was the leading manufacturer of cabin monoplanes in the world.

That was 1929 (Figure 10). And in that year, the bubble was about to burst for Sherman Fairchild and his aircraft enterprise. In a year and a half, that entire enterprise was virtually completely shattered, and Fairchild had suffered the most staggering set-back of his entire career. The details of that disaster—how he lost control of Fairchild Aviation to the bankers that ran the giant Aviation Corporation (AVCO)—the ingenious scheme he devised, in desperation, that eventually rescued it—the price he paid to get it back again—and the details of how he set about to rebuild and reestablish his aeronautical empire—are really not a part of our story today.

That is another story. And it is an interesting and an amazing one. But, let it suffice that he set about to rebuild—and rebuild he certainly did—with ingenuity, skill, and determination—from the tiny Kreider-Reisner Aircraft Company in 1931 to the company that finally, in 1971, became Fairchild Industries, Inc. And in the process, he left an impressive record of achievements, including the first aircraft specifically designed to airline specifications; the first all-metal semimonocoque transport, and, incidentally, the first transport capable of exceeding 200 mph; the first air-cooled in-line engine with pressure cooling; the first U.S. Army aircraft specifically designed to carry military cargo; the first practical low-wing primary trainer; and the first U.S. produced turbine-powered airliner used in commercial passenger service.

I have thought it appropriate to include these admittedly sketchy highlights of Sherman Fairchild's interest and involvement in the aircraft part of the aviation world, even though it had little to do with photogrammetry. It did represent an area that received a major share of Fairchild's time and energy for a large portion of his career. It was also a domain wherein he and his companies made significant contributions to the state-of-the-art.

One thing has always seemed a little strange to me. The accounts of the manner of his getting into the aircraft business make it appear as though he was almost reluctant. His pilots complained about their planes for four years before he moved to do anything—and then only as a last resort. In view of the enthusiasm he later showed for the business, and his reputation for improving on anything that he found wasn't perfect, I am surprised he wasn't anxious to build his own plane with his own ideas right from the start.

But let's return now to 1925 and the aerial camera and aerial survey business. Up until this time, the bulk of his aerial survey work had been the making of photo-maps (mosaics), and demand for these continued to grow right on through the 1920's and 30's, as more and more agencies recognized the quality that was now routine in these surveys, and the value and savings they offered. However, with the gains in acceptance of aerial surveys, came increasing demands for more sophisticated and more accurate products. The tremendous advantage of wider angular coverage in the photography, in terms of savings in number of flight lines and flying time, reduction of ground field work, and improved accuracy, was well understood. So the next ten years was a period of intense development of multi-lens mapping cameras by the Aerial Camera company.

First came a redesign of the T-1 tri-lens camera that Major James W. Bagley had experimented with starting in 1918, and the production of a number of units. This model used three 6 inch lenses on 5.2″ × 5.4″ formats, with one lens photographing vertically downward and the other two taking obliques to the right and to the left at 35 degrees from vertical. A transforming printer was used to re-photograph the oblique photos to the geometry of an equivalent vertical. The three photographs, when reconstructed as a composite equivalent vertical, gave a transverse coverage of 120 degrees.

In aerial mapping, there is an obvious advantage in extending the air base (the line connecting adjacent picture centers) through several successive prints. To get the full benefit of this advantage, a fourth lens was soon added to take another oblique picture, this one looking forward and slightly overlapping the verticle. This produced the model T-2 four-lens camera in 1927, which was then used extensively for several years.

The next stage in the evolution was to add a fifth lens (looking rearward). At that point the camera was completely redesigned, or more correctly, a complete new camera was designed, using the C. P. Goertz 6 inch F/6.8 Aerotar on a 5.5″ × 5.5″ format for the vertical and on 5.5″ × 6″ formats for the obliques, which were offset 45 degrees from vertical to each side and fore and aft. This five-lens camera, the Model T-3A (Figure 11), was introduced in 1933, together with its accompanying Model B-7 transforming printer. This system produced an equivalent vertical composite print of the terrain resembling a Maltese cross and covering 140 degrees, both laterally and in the flight direction.

And then, in 1935, Fairchild put two of these together in a rigid frame within a gimbal mount (Figure 12), with one of the two offset 45 degrees in azimuth with relation to the other, to fill in the gaps of the Maltese cross and produce a composite having an octagonal shape. Also in 1935 and 36 a number of the T-3A cameras were retrofitted with a new set of electrically-driven shutters to improve the time synchronization of the exposures by the various lenses.

The year 1936 also saw the delivery of a giant nine-lens camera (Figure 12) and its associated transforming printer built to specifications formulated by Lt. O. S. Reading of the United States Coast and Geodetic Survey. This camera also produced transverse and in-flight coverage of 140 degrees. It used nine specially matched Ross 8¼ inch F/4 lenses, one photographing vertically downward, and the other eight taking oblique photos fore and aft, laterally, and at 45 degrees to the flight direction. All lenses in this design were mounted with their axes vertical—one in the center, and the other eight at 45 degree intervals on a surrounding concentric circle. The center lens photographed the ground directly, and the others photographed the adjacent areas obliquely, by reflection, from a set of eight inclined front-surface mirrors. All nine lenses were imaged onto a single web of special 21 inch wide film held by vacuum to a large platen above the lenses. The entire structure carrying the eight mirrors, the nine lenses and the film platen was machined from forgings made from a single ingot of stainless steel, specially heat treated and stabilized. The printer had a large vacuum platen at the bottom for the printing paper, and two lenses above it—one, at the center, for the fixed-ratio printing of the vertical, and the other at the side, for transforming and printing the obliques adjacent to the vertical image. The vertical was printed first, and then the negative holding assembly was moved to the transforming position where it could be rotated and indexed, as the paper platen was also rotated and indexed, to sequentially print each of the eight oblique pictures exactly in its correct position on the 45 inch square piece of sensitive paper. This system was used for many years by the U.S. Coast

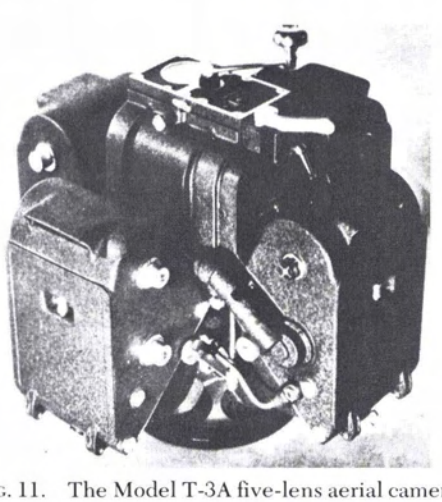

FIG. 11. The Model T-3A five-lens aerial camera.

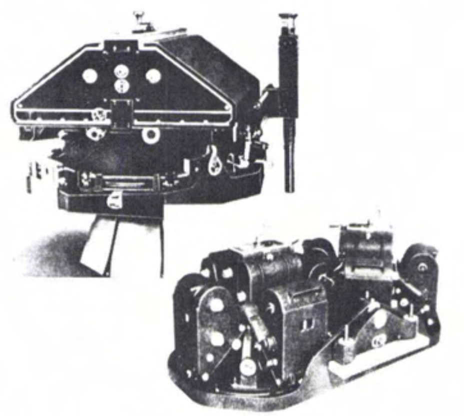

FIG. 12. Upper left: The Fairchild 9-lens camera built for the U.S. Coast and Geodetic Survey. Lower right: The Fairchild 10-lens camera, consisting of two 5-lens cameras in a special tendem mount.

and Geodetic Survey for their most precise topographic mapping work.

Meanwhile, within Fairchild Aerial Surveys during this period, an accompanying technical revolution was taking place. In 1931, Fairchild acquired the Aerotopograph Corporation of America, and with it exclusive rights in the United States, Canada, and Mexico, to the patents of Zeiss Aerotopograph, of Jena, Germany, covering their new method of making topographic maps from aerial photography. As each of the new multi-lens cameras became available, they quickly adopted it. They first used the T-3A five-lens camera to map the entire State of Massachusetts in 1933. They were the first to use the Tandem T-3A ten-lens camera in 1935, in an aerial survey to establish a precise network of control, which they then used for control of single-lens photography in a photo-mosaic map of a large area of the southwestern part of the United States. This project, for the Soil Conservation Service of the Department of Agriculture, was the largest aerial survey undertaken up to that time, taking three years and covering 144 million acres, or about eight percent of the total area of the country.

By the mid-1930's, Fairchild Aerial Surveys had become the largest and most capable commercial photogrammetric organization in the United States. In the laboratory, they were constantly improving their methods and adding new equipment for the implementation of new techniques or meeting new requirements. Often, it was necessary to devise their own new techniques, and to design and build their own equipment. When they acquired a new Zeiss four-lens camera, they wanted to print the four separate obliques together, as a composite rectified vertical view of the terrain. Since no printer was available that would permit this, they designed and built their own. Incidentally, it was in that project that they developed the registration techniques that the Camera Company later incorporated into the nine-lens camera printer. In the early 1930's, they perfected a new more efficient technique for locating and assembling the many aerial photographs for a precise map, known as the slotted template method. This gave a higher order of accuracy, and still only required less than half of the ground control of previous methods. Also, with the first and, in fact, the only Stereoplanigraph in the United States until well after World War II, they were superbly equipped for efficient topographic mapping.

Likewise, in the air, they had been hard at work to improve their navigation methods, to help them to obtain the right amount of side lap, and above all avoid any gaps. By 1936, they had developed and perfected the Solar Navigator, an instrument combining a sun compass and drift meter, to automatically compute exact steering indications for the pilot. With the Solar Navigator compensating for wind drift, and even variations in drift, they were now able to fly flight lines of a hundred miles and more, while deviating less than ¼ degree from their pre-planned ground track.

By the last half of the 1930's, it was becoming clear that the geometry of a 6 inch focal length lens on a 9″ × 9″ format, was close to the optimum for the bulk of the aerial mapping requirements, and that equipment built to those parameters would be the workhorse of the future. The American Society of Photogrammetry had drawn up a specification for aerial cameras, setting forth the features and precision necessary for acceptable photogrammetric work. Fairchild responded with the Model F-51 (Figure 13), equipped with a new 6 inch Ross F/5.5 lens, a 9″ × 9″ format and carrying up to 500 feet of film. Special precautions were taken to prevent degradation of the camera's precision with use. The lens elements were mounted in stainless steel cells to match the temperature coefficient of the glass. These, in turn, were installed in a circularly symmetrical, stabilized aluminum cone structure, using a piloted flange mounting technique, instead

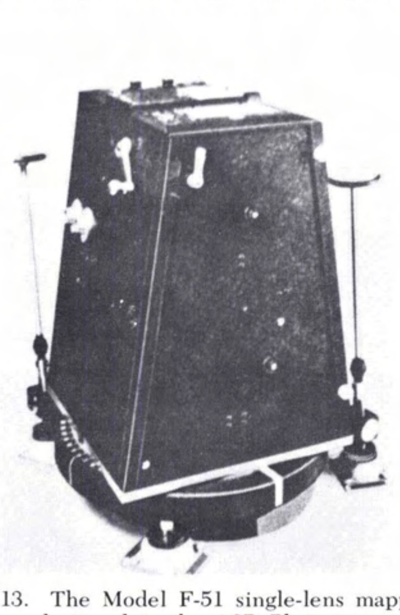

FIG. 13. The Model F-51 single-lens mapping camera, designed to the ASP Photogrammetric Camera Specifications.

of the normal screw thread mounting method, in order to achieve the most precise centering and spacing of the optics. The upper surface of the cone was machined to the exact location of the best focus, and the emulsion side of the film was pressed against the surface after being drawn flat against the vacuum platen. Perhaps the most important innovation was the redesign of the shutter to a drawer type, with the thin leaf assembly cantilevered from the drive mechanism so it could be slipped into the narrow space between the lens elements and mounted from the outside of the lens cone. This design then permitted removal of the shutter for routine maintenance and repair without disturbing the optics and the camera's calibration.

The F-51 was soon followed by the T-5 camera, produced for the military, using the new 6 inch F/6.3 Metrogon lens that had been developed by Bausch and Lomb from the German Topogon design. This camera also contained a built-in drift sight and viewfinder, an automatic intervalometer, a built-in light meter, and a recording system that recorded altitude, time, frame number, and a data card between the frames of photography.

Next, just before the start of World War II, came the redesign of the standard K-3B to the K-17 reconnaissance camera series, with interchangeable lens cones giving a choice of lenses from 6 inches to 20 inches focal length. Here, also, the 6 inch focal length used the reconnaissance version of the B & L Metrogon. Thousands of these were produced, and although precision was considerably relaxed from that of the mapping camera specification, nevertheless, using the tri-metrogon configuration (one vertical plus a left and right 60 degree oblique), the Army Air Force was able to keep the field commanders well supplied with up-to-date field maps almost overnight all through World War II. During the war, the demand for aerial cameras of at least a dozen different types was tremendous, and Fairchild licensed a number of other manufacturers to produce either complete cameras or major components. And in 1944, as the war approached an end, the company name was changed to Fairchild Camera and Instrument Corporation, in preparation for a postwar business posture of a broadened nature.

In the years after the war ended, attention again turned to the mapping camera problem, and the goal of ultimate perfection in precision. Fairchild set up a special laboratory for the precise calibration of lenses and mapping cameras, at the sugge National Bureau of Standards, to facility of the burden of performing calibration of the large volume of production equipment that was scheduled. New and better optics came along. The Model KC-1B was produced in the 1950's using the Bausch and Lomb Planigon, with calibrated distortion greatly reduced to the region of 10 micrometres. In the same period, Dr. James G. Baker of Harvard Observatory introduced a reverse telephoto principle, and produced the 6 inch F/5.6 Geocon I lens, which greatly improved the uniformity of illumination. This was used in the Model KC-4 and several other military mapping models. Other features were added, and the mapping camera became more sophisticated. The KC-6A, introduced in the early 1960's, carried an improved Baker design lens, the 6 inch F/5 Geocon IV, with forward motion compensation and a grid pattern of reseau dots recorded on the film at time of exposure, to permit the later removal of any unpredictable and non-systematic film shrinkage. The camera was carried on a mount vertically stabilized by a precise inertial vertical reference, and at the instant of exposure, recorded a reticle, optically projected from the inertial reference, to indicate any residual error from true vertical.

Then, just before the end of the 1960's, design began on a special mapping camera for mapping the moon (Figure 14). It was to be carried by the orbiters of Apollo 15, 16, and 17 and, while the astronauts were exploring the lunar surface, was to take photography from its lunar orbit, for the making of an accurate, detailed topographic map of the moon. With advances that had been made in high resolution optics and film, it was possible to use a new 3 inch, F/4.5 Fairchild Ikogon lens on a 4.5″ × 4.5″ format. It carried 1500 feet of 2.5 mil topographic base film—enough for over 3000 exposures. Film was held under pressure against an optically ground and polished flat glass focal plane plate, which carried a re-

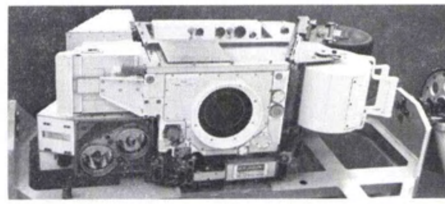

FIG. 14. The Lunar Mapping Camera, used on Apollo Missions 15, 16, and 17.

seau grid. The camera also took a simultaneous exposure of a section of the surrounding star field, using a separate 3 inch F/2.8 lens, for determination of attitude, and recorded the altitude above the lunar surface, determined by means of a built-in laser altimeter. The cameras were used on all three of the Apollo missions, and brought back photography from which accurate topographic maps have been produced covering over 8 percent of the moon's surface.

Sherman Fairchild's interests were by no means confined to aerial photogrammetry. Starting back in the early 1930's, he found he needed a way to accurately measure the small differences in take-off performance produced by changes in aircraft, engine, or propeller design and so experimented with many different configurations of cameras set up to record the plane's actual flight path profile. The model he finally selected for his own use, and also sold in some quantity in the late 1940's and 50's, was one that used the same 6 inch Metrogon lens as the aerial mapping cameras, photographing on an 8″ × 10″ glass plate. The camera was set up 2000 to 3000 feet from the runway, with the lens axis horizontal, and the focal plane parallel to the runway (Figure 15). In front of the plate in the camera was a movable carriage containing a shutter to expose a ¼″ × 8″ slit, and a curtain to mask the rest of the plate. The carriage was moved from one side to the other across the 10 inch width of the camera, and the shutter made an exposure each time the carriage moved another ¼ inch. This mechanism was linked to a sight so that, as the operator tracked the target, he got a series of pictures of it throughout its travel across the camera's field of view, together with a picture of a high-speed stop-watch at the instant of each exposure (Figure 16). Incidentally, the prototype and first production lot was manufactured in a machine shop Fairchild had installed in a section of his office suite on the 46th floor in Rockefeller Center, New York City.

Sherman was a born tinkerer and gadgeteer. When he decided he wanted a town house in Manhattan, toward the end of the 30's, he had a field day. He bought a house and promptly tore it down. The house he built in its place was a dream house. It was built in two separate three-story sections, one at the front and one at the rear of the lot, with a series of glass-enclosed ramps running from one section to the other, in place of stairs, so his Aunt May could walk from bottom to top without climbing a single step. It was completely air conditioned—not with an ordinary system, but one that he kept changing till it satisfied his idea of perfection—at a cost of $37,000. There were no windows looking out onto the street—the entire wall was of glass brick covered by a set of giant, motor operated louvers he could set to admit just as much sunlight as he wanted. The house was full of odd features he had thought of. In one part, he had a complete sound recording studio. To get the hard wood floor, which he insisted upon, to have just the right resiliency, he had the carpenters cut a series of parallel saw slots

FIG. 15. Flight Analysis Camera.

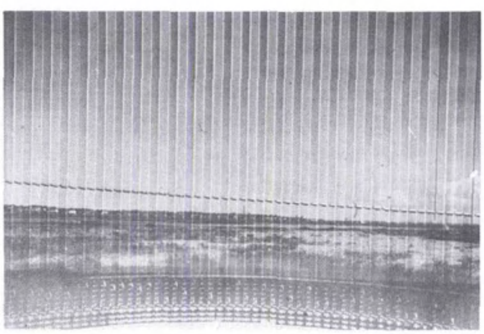

FIG. 16. A sample record made by the Flight Analysis Camera.

about ¼ inch apart for the entire length of each of the teak floor boards, cutting from the under face up to within about ⅛ inch of the top surface. They then cemented these boards into a thick layer of live rubber on the subfloor. The result was a hardwood-surfaced floor that felt like a thick carpet when walked on. In another room that he used as a den, he had a low round table with a top he could turn like a lazy Susan. He decided to have a telephone on the table, and drove the telephone company practically out of their minds putting in noiseless slip-rings for his phone so he could still turn the table all the way around.

Sherman was continuously bombarded by people with all kinds of new ideas or propositions. He would listen, and if one caught his fancy, would refer the person to one of his various companies. In 1957, the transistor was nine years old, but hadn't even come close to the potential predicted for it, and financial people were a little cautious. In that summer, a group of eight young scientists, led by Dr. Robert Noyce, believed they knew of a better way to make transistors, and were out looking for backing to put their ideas into practice, when someone suggested "Why not try Sherman Fairchild?"

Semiconductor technology was new to Sherman, and not altogether in the mold of the technologies he had fostered in the past. But, nevertheless, semiconductors had appeal. They were new and they appeared on the scene when far-sighted businessmen knew electronics was well on its way toward revolutionizing the American lifestyle; semiconductors were on the verge of revolutionizing electronics. There was a feeling of huge markets, somewhere out there, just waiting to be developed. Big money was needed. The eight young men had the ideas, and the technology. These ingredients, together with the projected market developments, made the proposition irresistible for Sherman Fairchild. They were the same factors that pervaded his own entries into the aerial camera and the airplane worlds many years before.

He agreed to back them, and on 10 October 1957 formed Fairchild Semiconductor Corporation—and thereby probably made the most advantageous deal of his entire career. In 1959 it became a subsidiary of Fairchild Camera and Instrument Corporation. Within two years, they had perfected their radically new "Planar" manufacturing process—a process that later became the standard in the industry, with Fairchild eventually licensing practically every other semiconductor manufacturer to use the process. In two more years, in 1961, the first of the "Micrologic" family of monolithic integrated circuits was introduced, triggering a radical revision in the trend of electronic apparatus design, and kicking off the revolutionary new integrated circuit industry. Within five years, the operation had become the largest producer of high performance silicon transistors in the world.

And then, in 1971—on 28 March—Sherman Fairchild died from an infection following an operation for cancer. And the story ended.

During his career, he had founded no less than three multi-million dollar enterprises—each one based on a major technological breakthrough—and, in two of these instances, launched an entire new industry.

He had devoted a half-century business career to the advancement of his beloved field of aviation technology,—and on 21 July 1979, his many outstanding contributions were given national recognition as he was enshrined into the Aviation Hall of Fame.

There is no doubt that he lived an interesting life. He would frequently become interested in some idea or invention and start another company to develop and produce it. It didn't matter too much if it made money—it was nice if it did—but the main reward, to him, was the satisfaction of finding and giving the world "a better way to do

FIG. 17. Sherman Mills Fairchild.

something." That was the same motivation that prompted him to donate the "Photogrammetric Award" to the American Society of Photogrammetry in 1943, as an incentive to photogrammetric scientists to search for "a better way to do things."

Apparently, the secret of his success was, first, the overpowering enthusiasm he brought to anything he got involved with, and second, the simple straightforward, direct common sense he applied to every challenge he faced.

He loved people, and he loved life. And he had to be in the middle of things—anything big or important that was happening—wherever the action was. Likewise, wherever he was, there was usually action. His enthusiasm was contageous. Often, those who worked with him were inspired—sometimes to feats beyond their normal capabilities. And there were also those, who were virtually "driven up the wall." At any rate, around Sherman Mills Fairchild (Figure 17), life was never dull.

Irving Doyle delivers the Sherman Mills Fairchild Memorial Address.

Specialty Conference on Civil Engineering Applications of Remote Sensing

The University of Wisconsin
Madison, Wisconsin
13–14 August 1980

The program for this conference, sponsored by the American Society of Civil Engineers and the American Society of Photogrammetry, can be found on pages 649 and 650 of the May 1980 issue of the Journal.

The conference will be preceded (on 11 and 12 August) by a two-day "short course" dealing with the fundamentals of remote sensing, to be offered by the University of Wisconsin-Extension. This short course is designed to give persons with limited knowledge of remote sensing sufficient background to be able to participate in the conference.

For further information regarding the conference and/or short course, please contact

Prof. Ralph W. Kiefer, Chairman
Conference Program Committee
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