

## The challenges and frustrations of a veteran astronomical optician: Robert Lundin, 1880-1962

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### Abstract

Robert Lundin, apprenticed in nineteenth century optical craftsmanship but employed in twenty century fabrication and engineering, suffered many frustrations during a nonetheless productive career. Son of Carl A R Lundin, a senior optician at the famous American firm of Alvan Clark & Sons, Robert grew up building telescopes. As a teenager, he assisted with projects including the 1-m [40-inch] objective for Yerkes Observatory. After his father's death in 1915, he became manager of the Clark Corporation and was responsible for many smaller, successful refractors and reflectors. Lundin also completed major projects, including a highly praised 50.8-cm achromat for Van Vleck Observatory, as well as a successful 33-cm astrograph used at Lowell to discover Pluto. In 1929, a dispute with the owners of the Clark Corporation led to Lundin's resignation and his creation of a new business, "C. A. Robert Lundin and Associates." This short-lived firm built several observatory refractors, including a 26.7 cm for E W Rice, the retired chairman of General Electric. But none was entirely successful, and the Great Depression finished off the company. In 1933, Lundin took a job as head of Warner & Swasey's new optical shop, only to experience his greatest disasters. The 2.08-m [82-inch] reflector for McDonald Observatory was delayed for years until astronomers uncovered an error in Lundin's procedure for testing the primary mirror. A 38.1-cm photographic lens for the Naval Observatory was a complete failure. Under pressure to complete a 61-cm Schmidt camera, Lundin seems to have attempted to deceive visiting astronomers. After retirement in the mid 1940s, Lundin moved to Austin, Texas, the home of his daughter, where he died. His difficulties should not obscure his success with many instruments that continue to serve as important research and education tools.

**Key words:** *telescopes, refractors, reflectors, Schmidt camera*

### 1 EARLY YEARS

C A Robert Lundin was raised in a great telescope making tradition. His father, Carl A R Lundin, was born in Vanersborg, Sweden, in 1851. After coming to the United States in 1873, Carl Lundin went to work with the Alvan Clark and Sons telescope making firm of Cambridgeport, Massachusetts, in 1874 (Obituaries, 1915; Poor, 1937).

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The following year Carl married, and his son, who was to go by his middle name, Robert, was born in 1880. But as the two men had the same name, the details of their lives and work have been frequently confused.

Robert said of his father, "One of the first things I remember ... was his return from Russia. He had been there to build a 76.2-cm refractor for the Pulkova Observatory. He had been commissioned by the father of the last tsar. I remember my mother saying as my father arrived in a carriage: 'Here is your father from Russia'" (Brammer, 1953).

As a young teenager, Robert spent some summer vacations studying lens making with his father and the elderly Alvan G Clark, who was the last survivor of the Clark family craftsmen (Lundin, 1930). Lundin's first notebook begins 1896 August 1, when he started serious work at the Clark firm. His first job was a 12.7-cm refractor for Baker University of Baldwin City, Kansas, which he completed in October of that year (Lundin, 1896-1928). It is clear from a surviving photograph that Robert Lundin had some youthful involvement with the great Yerkes 1-m [40-inch] objective, the largest in the world, installed by Alvan G Clark and Carl Lundin in 1897 (Warner and Ariail, 1995:28. Note that Robert Lundin is also shown, a few years later, in three group pictures inside the Clark shop – see pp. 24-26).

Clark died in 1897, leaving Carl Lundin as senior optician at the company. A large project during Robert's early career was a 1-m bent-Cassegrain reflector for Lowell Observatory (Hoyt, 1980:114-117; Putnam, 1994:134-139; Tombaugh, 1988). The younger Lundin was responsible for the installation of this telescope in 1909 and 1910, and surely was involved with the optical fabrication, at least to some degree. Although the instrument was housed to disadvantage in a pit suggested by Percival Lowell, the telescope was used regularly and was considered successful. Twenty years after its installation, Earl C Slipper (1929) wrote, "... [it] has been entirely satisfactory. ... [Robert Lundin] completed [it] ..." We thus suppose that Lundin gained some mirror-making experience from his start at the Clark firm (see Figure 1). Indeed, by 1922, Louis Bell (1981:222) described Lundin as an experienced maker of big mirrors.

In 1912, presumably secure in his profession but still able to tap his father's rich experience, Robert married. No more record-breaking refractors were made, but the mystique of Clark workmanship was as established then as it is remembered today. For example, the late Burton L FitzGerald, who inspired many current Clark collectors, wrote of being a "True Clark Believer" (FitzGerald, 1986), which was in part a faith that every lens issued from the Clark shop was superlative.

But the practical reality of a working businessman-optician did not always match that ideal, as revealed by Robert Lundin's older sister. Laura M. Lundin, a graduate of MIT and an instructor of mathematics at Wheaton College in Norton, Massachusetts, wrote to her college president regarding a second-hand refractor available through the Clark company. "I do wish the college could secure this telescope with its perfect glass," she wrote. "My father and brother think it much too fine an instrument to fall into private hands as it now seems likely to do" (Lundin, 1914).

## 2 ASCENDANCY AT THE CLARK FIRM

The following year, 1915, Carl Lundin, who had been suffering heart trouble, died at his home in Cambridge. Robert became head of the Clark optical department and soon entered a period that we suppose was his most gratifying. Glass for a 47-cm objective for Wesleyan University's Van Vleck Observatory was ordered in 1914, but World War I delayed the contract (Slocum *et al.*, 1938). When the order was renewed in 1920, the disks that arrived later that year were 53.3 cm in diameter and of good quality to the edge. Lundin figured the material into a 50.8-cm objective, which was installed in 1922 and was tested extensively by Hartmann's photographic procedure. A

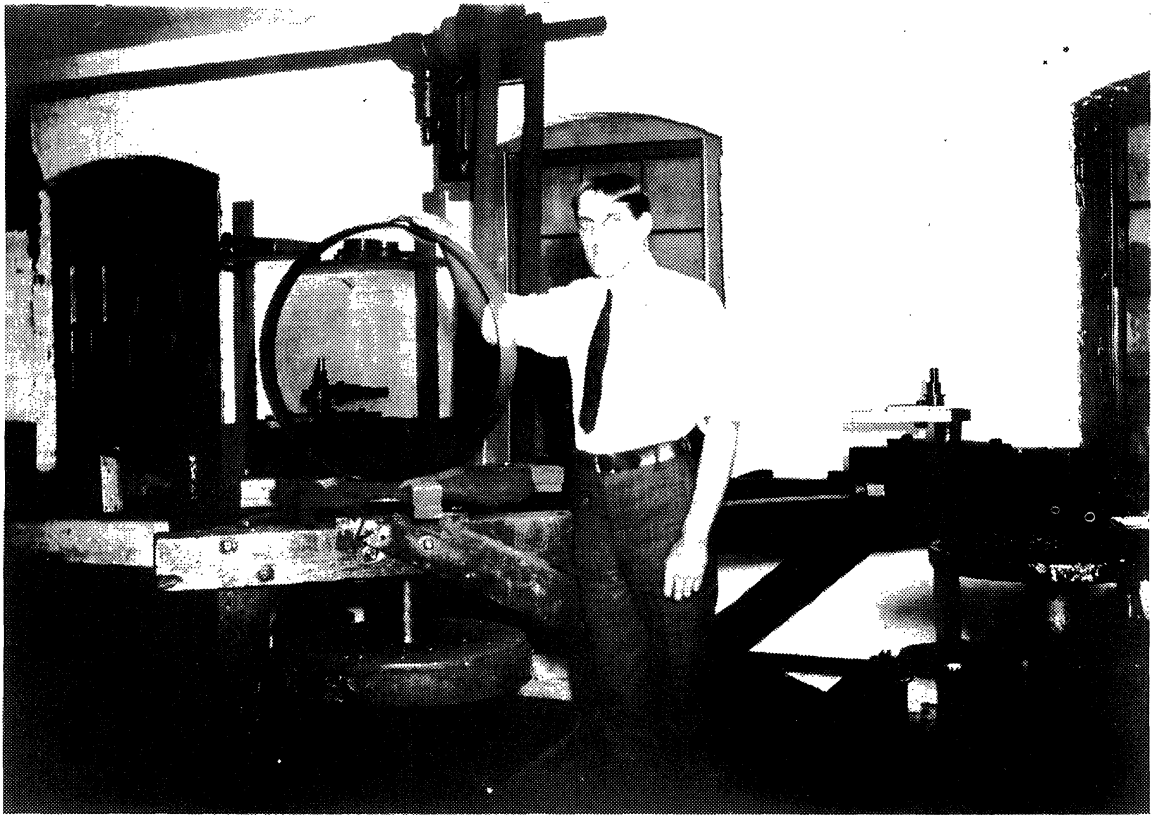


Figure 1. Robert Lundin in the Clark optical shop with a mirror blank and a large grinding machine in the background. Probably the blank was for the Harvard 24-inch reflector, completed in 1904, now at Swarthmore University.

resulting criterion,  $T$ , indicated the quality of the lens, where  $T$  was the mean diameter of a point image, expressed in terms of a one-hundred-thousandth of the focal length. While a figure as low as 0.25 to 0.20 was practical perfection, the 50.8-cm objective averaged 0.084, and the Van Vleck astronomers were thus extremely pleased (see Figure 2).

Robert's next eminent success came in 1929, when his 33-cm Cooke triplet astrographic objective was installed at Lowell Observatory. The fabrication had been started by Joel H Metcalf, a Unitarian minister who left the project unfinished at his death in 1925. (Metcalf, in fact, had officiated at Carl Lundin's funeral [Obituary, *Boston Herald*, 1915].) Although it was over budget and produced somewhat astigmatic images, Lowell astronomers were delighted with the wide, relatively sharp field of the lens. A little more than a year after the arrival of the objective in Flagstaff, Clyde W Tombaugh discovered Pluto on plates he had taken with the instrument. Roger L Putnam, the Trustee who headed Lowell Observatory, sent Lundin a personal announcement of the discovery of "the trans-Neptunian planet" on the same day the news was released by Harvard College Observatory, and the veteran optician replied with congratulatory letters to him and to Director V M Slipher at Flagstaff (Putnam, 1930; Lundin, 1930). Follow-up astrometry was secured with the Lowell reflector, now some 20 years old. Tombaugh, famous for the discovery, wrote much later, "I never had the opportunity to meet C. A. Robert Lundin. He certainly made the Cooke-triplet 13-inch a superior astrograph - smallest star images =  $1/25$  to  $1/30$ th of a millimetre in diameter = resolution of 4 arc-seconds with a 66-inch focal length" (Tombaugh, 1988).

### 3 A SUDDEN DEPARTURE

Even with this success, serious tension was growing at the Alvan Clark & Sons Corporation, as the firm now signed its instruments. The last straw seems to have come over an order relating to a now obscure 25.4-cm equatorial for the Elgar Weaver Observatory of Wittenberg College (Harp, 1933).



Figure 2. Robert Lundin and an unidentified man, with a lens Lundin made, probably for the 20-inch refractor at Van Vleck Observatory, Wesleyan University, completed in 1922.

The instrument in question was to be a collaboration between Roland W Sellw, a consulting engineer, and Robert Lundin. Sellw had in fact already designed and presumably subcontracted the mechanical fabrication of instruments for the Clark Corporation, in particular the 31.4-cm refractor built in 1927 for Columbia University (Sellw, 1929; Clark Corp. [undated]). A 1917 graduate of the Sheffield Scientific School of Yale University, he had further collaborated directly with Lundin on a 20.3-cm equatorial that was under construction for the Kellogg Observatory of the new Buffalo Museum of Science (Both, 1970). Unlike the Columbia telescope, however, the Buffalo and Wittenberg instruments were not to be signed with Clark Corporation nameplates.

The Wittenberg astronomer, Hugh G Harp, proceeded carefully in his consideration of just what instrument to buy, seeking advice from many experienced telescope users. Among the correspondents, Harvard's Harlow Shapley (1929) replied, "... I would unhesitatingly recommend the work of Mr. Lundin, at least with regard to optical parts; but some of the earlier work done by Mr. Sellw was characterized more by cleverness than by the ability to complete his contracts."

Columbia's W. J. Eckert (1929) replied, "[Our] telescope and dome are in general satisfactory, but several of the criticisms which have been made for all the work done by these men apply equally well to our equipment. It seems that both of these men are somewhat of the artistic temperament and are apt to slip over details and, thus spoil a good job by some minor negligences." (Eckert went on to complain about his circle lights, the paint job, and other small matters.)

But the most scathing reply came from Yale's Frank Schlesinger (1929):

On my return from Europe a few hours ago I find your letter of August 15. I have no hesitation in saying that I should be very reluctant to entrust your telescope to Mr. Sellew. He made drawings for our South African telescope ... but it would have been impossible for him to do this without constant guidance, supervision and restraint... I should say that Mr. Sellew needs much more experience in all fases [*sic*] of telescope-making before his work will be acceptable.

Warren K Green (1929) of Amherst College was kinder regarding Lundin's chosen collaborator:

The work that Mr. Sellew did for me here [for the design of our mechanized observing ladder] ... was very satisfactory. Since this was his first attempt at astronomical work, he required a great deal of minute direction; but, with the experience that he has had since, he should be able to go ahead on his own initiative (see also, Sellew, 1924).

However Sellew's difficulties reflect upon Lundin's judgment, C H Sawyer at the Clark company was evidently growing concerned about Lundin's outside collaborations. In a letter of January 22, Sawyer (1929) gave the president of Wittenberg University price quotations for 20.3, 25.4 and 30.5-cm refractors. A month later, Sawyer (1929) and Lundin (1929) both independently answered a single letter from Harp, the Wittenberg astronomer. Two days later, Sawyer sent Harp a draft of a contract, adding, "Kindly address your reply to the writer at 20 Thorndike Street, East Cambridge [his home address] (Sawyer, 1929). And two *more* days later, Harp read from Lundin, "For the next few weeks, should you wish to write me please address me at my home 173 School Street, Watertown, Massachusetts" (Lundin, 1929). Finally, on April 8, Lundin wrote to Frederick Slocum, director of Van Vleck Observatory, "I wish to say to you that I have severed my connections with the Alvan Clark & Sons Company and am establishing myself in business under [my own name] and address." (Lundin, 1929).

The Kellogg and Weaver Observatory instruments were eventually completed by Lundin and Sellew, though the Sellew mountings were unsatisfactory by some standards. After Lundin's departure from the Clark firm, Howard M Sawyer, writing to Wittenberg College (1929), evidently had no choice but to say, "We thank you for giving [the Clark company] the opportunity to quote, but regret that circumstances do not permit us to do so at this time."

Lundin's daughter later recalled:

My father's leaving Alvan Clark and Sons was certainly not amicable. I do not remember hearing what the exact reasons were but there was an accumulation of problems over the years. There was a dispute as to which items in the factory belonged to whom. The Clarks sued father. The case was tried by a Master who divided up the materials involved. I always had the impression that father got most of the items he claimed (Douglas, 1988).

Lundin had a postcard printed announcing his new business under the name "Robert Lundin Company," located at 173 School Street, Watertown, Massachusetts (his home address, near Cambridge). Whether or not he had any employees is uncertain, but he described his firm as makers of refracting and reflecting telescopes, visual and astrophotographic objectives, plane, spherical, and "parabolic" mirrors, prisms, eyepieces, and optical test plates. He also solicited "special optical work." Lundin stated his qualifications as "... over thirty years experience on the World's Largest Telescopes..." and requested all the astronomers who received the card to file

it for future reference (Robert Lundin Co., 1929). Unfortunately his timing could not have been worse; the "Black Thursday" stock-market crash of 1929 triggered the Great Depression of the early 1930s. Without a sales force, business organization, or capital, he was completely dependent on new orders, but few observatories, universities, colleges, or formerly wealthy amateurs were in a position to provide them. Lundin learned the perils of starting a small business at first hand. By 1933, near the depths of the Depression, he was ready to give up.

What was probably the last instrument in the saga of Lundin-Sellew collaboration was an 22.2-cm refractor made for E W Rice, Jr., the honorary chairman of the General Electric Company. Unlike the earlier mountings that were signed "Towner-Sellew Associates ... Objective and Optical Parts by C. A. Robert Lundin," the Rice instrument was signed simply "C. A. Robert Lundin and Associates." Rice (1932) wrote of Lundin, "I have seen quite a little of Lundin in connection with the mounting of my 9-inch glass. I like him very much, but I am under the impression that he is not really very well posted scientifically. He is certainly not an astronomer and I imagine that his work is purely empirical and based upon practical experience, without any deep theoretical knowledge."

In the few years Rice pursued astronomy on Fishers Island, New York, before his death in 1935, he upgraded his lens to a Lundin 26.7 cm that boasted a Hartmann criterion of 0.11, but then he finally replaced his entire mounting with a sturdier one made by Warner & Swasey (Rice, 1934; Stearns, 1933).

#### 4 NEW WORK – BUT TROUBLE – AT WARNER & SWASEY

Lundin finally teamed with Warner & Swasey to lead their new optical shop, and arrived with his family in Cleveland, Ohio, on 1933 September 15 ([Lundin], 1933-40). Although Warner & Swasey had been operating at a loss since 1931 (Warner & Swasey Co., 1940), Lundin's job was based on their new contract to build a large



Figure 3. Robert Lundin in the Warner & Swasey optical shop, with the recently-delivered glass blank for the 82-inch McDonald Observatory reflector, 1934  
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reflector for the McDonald Observatory. The disk that the Corning Glass Company made for the primary, accepted in the fall of 1934, turned out to be large enough for a 2.08m [82-inch] mirror (see Figure 3). Warner & Swasey had estimated a year would be enough for Lundin to turn it into a finished paraboloid, but the job dragged on for more than four years. The optician had it close to the correct figure by 1937, but not quite close enough. From then, there was no progress, only oscillations about the desired shape. Finally in 1938 March, Otto Struve, the director of Yerkes and McDonald Observatories, arriving at Warner & Swasey with staff members George Van Biesbroeck and Gerard P. Kuiper, and demanded a full demonstration of Lundin's test procedures. They discovered that he had been misinterpreting the results of the Foucault knife-edge tests! If the mirror was not perfect (and it never was), Lundin incorrectly interpreted the error in the *slope* of the mirror, revealed by the test, as if it gave the error in the *depth* of the mirror. Hence his attempts at figuring the disk never converged to the desired paraboloid.

Struve insisted that Warner & Swasey allow him to send his own expert, young optical designer E Lloyd McCarthy, to work with Lundin, interpreting the knife-edge tests for him and carrying out more sophisticated ones. Under this new arrangement, Lundin finished the mirror in another seven months, and the telescope, the second largest in the world at the time, went into operation the following year (Evans and Mulholland, 1986; Osterbrock, 1997). Lundin must have been just as frustrated as Struve by the long delay, for the optician had expressed great interest in the project as early as 1927 May, while he was still manager of the Clark optical shop (Frost, 1927).

Before the 2.08m disk arrived at Cleveland in 1934, Lundin had begun rough-grinding a 38.1-cm Cooke triplet astrograph, a Warner & Swasey job for the United States Naval Observatory ([Lundin], 1933-40). It turned into an even greater disaster. Designed by Kodak, the three-element objective lens was installed at Washington by Lundin after nearly ten months of work on it. As reported in a retrospective memorandum:

From the first, the lens failed to perform satisfactorily and for the next six years [Lundin] tried continuously to improve matters – the lens was repeatedly disassembled and repolished at the Observatory in Washington and, on six separate occasions, was sent back to the factory for more extensive optical and mechanical modification. Finally, on 1941 January 24, after a declaration of best effort on the part of Warner & Swasey, a Naval Observatory Board of Inspection recommended that the 15-inch lens not be accepted. (USNO, 1978).

Three months later there was a further recommendation that Warner & Swasey be paid for the cross-axis mounting only (\$11,000), and that they quit any claim for collection on the optics. The Naval Observatory thus assumed responsibility for seeing to the final completion of the lens, which, after some iteration, was accomplished by Halley Moge, the respected optical expert at Perkin-Elmer, in 1950 – 17 years after the raw glass had arrived at Lundin's Watertown, Massachusetts, workshop! This episode thus compares with that of Ramsden's notorious 10-foot vertical circle for Dunsink Observatory (see King, 1955).

Harvard astronomer and optics design expert James G. Baker recalled talking to Lundin about his problems with the 38.1 triplet. Baker (1993) wrote: "When tested, the photographic performance showed unacceptable coma, whereas Lundin said that he had achieved a coma-free image in the lab. It was clear that he was auto-collimating at 1:1 which kept him from seeing the coma."

Baker met Lundin during a 1941 visit with Jason J Nassau to the Warner & Swasey shop to check progress on the 61-cm Schmidt camera being built for Case Institute of Technology (see Figure 4). Baker (1993) records:

During the morning visit we saw only the [artificial] star image rather than a Foucault test and that was practically of diffraction-limited quality. At lunch [having reflected some on the impracticality of such a perfect image] I told Jason Nassau that something was seriously amiss and that our overly delighted response to the test in the presence of [a senior Warner & Swasey manager] was misplaced. On our return to the lab I examined the set-up and found that a small stop had been placed in the eyepiece such that we were seeing the image at perhaps  $f/5$  instead of the full  $f/3.5$  required. [The manager] was so disturbed by the 180-degree reversal (for with the stop removed, the image was poor) that he ushered Jason and me out of the building [in a rage] muttering '[You] astronomers are never satisfied.' (See, also, Launie, 1997).

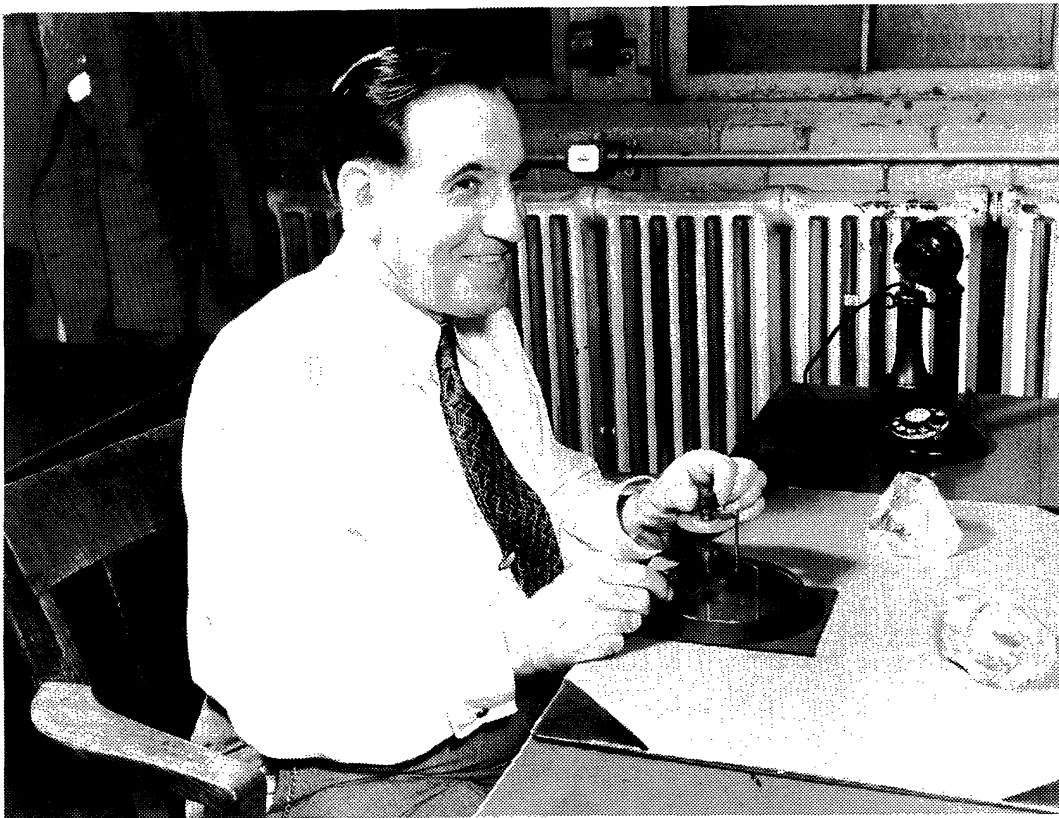


Figure 4. Robert Lundin using a spherometer at his desk in the Warner & Swasey optical shop, Cleveland, probably about 1940.

Baker's intervention helped, for he advised Lundin directly on how to test these Schmidt optics as he figured them, a then new, unfamiliar, and quite difficult task. The telescope, completed and dedicated in late December, 1941, fully met its specifications and was considered to give excellent images (McCuskey, 1942; Nassau, 1945). Walter Baade, the most experienced user of Schmidt telescopes in the United States, was impressed by enlargements of some of the first plates taken with it, and wrote to Nassau: "Lundin certainly did a fine job and you got the optics into accurate adjustment in no time." However, a quarter of a century later the Perkin-Elmer Corporation refigured the primary mirror and made a new corrector plate, which apparently improved the images significantly, particularly after the telescope was moved to Kitt Peak (Baade 1942, Pesch 1978).



The McDonald telescope, also, was highly praised in the end, which must have been some consolation to Lundin. Said J. S. Plaskett at the dedication exercises of the McDonald Observatory (1939):

No part of the 82-inch mirror, nearly 5,000 square inches of glass, is so much as one-millionth of an inch, seven-tenths of one-millionth to be exact, from the true theoretical form. This is about one-thirtieth of a wave length of visual light, and indication of the perfection of the optical surface.... Tribute should be specially paid, in this description of the optical parts, to the remarkable skill of Mr. C. A. R. Lundin – among the foremost of living opticians.... It was his skill and long experience in the figuring that was mainly responsible for the magnificent quality of the optical surfaces.

Plaskett further reported that the McDonald primary mirror could boast a Hartmann T criterion of 0.05, which was 2.5 times better than that published for any other reflector to date. His praise was equally high for the Cassegrain secondary mirrors, though these were later refigured by French optician Jean Texereau, who found Plaskett's characterization of the optics unreasonably optimistic (Evans and Mulholland, 1986).

Lundin was indeed expert in figuring optical surfaces, but except for the simple, standard Clark refractors with which he was familiar from his youth, evidently he did not really understand how to test complete systems on his own, and how to diagnose the residual errors in them, so that he could correct them.

## 5 RECOLLECTIONS OF FINAL YEARS

Responding to an enthusiastic user of some of her father's telescopes, Ruth Lundin Douglas (1988) wrote:

I'm afraid that you know more about my family than I do. I was an only child and am now the sole surviving member of the family. I have not thought about our life in Watertown for almost fifty years.

During his retirement father was involved with new friends and interests. He talked little about the past.... I believe my father went by Robert rather than Carl because he wanted to avoid being called Junior. He seemed to have a dislike for his long name. He gave me the shortest name he could think of and refused to let me have a middle name.

I regret that I have so little to tell you. My father worked very long hours and there was not much time for family communication. I gathered most of my information from listening to him talk to my mother. Your letter was a great help in revitalizing my memory.

And what of Robert's reflections, thinking back of his experience? "I'm retired now," he said, "and I'm glad of it. Nowadays, rich men aren't interested in astronomy like in the old days. Now, they've got television and radio. It's cheaper than telescopes." (Brammer, 1953).

C. A. Robert Lundin retired in the mid-1940s, probably just after World War II, and in 1956 he moved to Austin, Texas, to live out his last years with his daughter and her husband. He died there on 1962 March 25, at the age of 81; his body was returned to his native Cambridge for burial in Mount Auburn Cemetery (Texas, 1962; Douglas, 1988). Lundin's difficulties with the three Warner & Swasey projects at the end of his career should not obscure his success with many instruments that continue to serve as important research and education tools.

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