# Carl Zeiss - A History Of A Most Respected Name In Optics.

From its inception through to the middle 19th century, lens making was a craft that was essentially passed on from generation to generation. Innovations had typically resulted from trial and error experimentation; this was a costly and time consuming process that could not factor in all of the possible variables in lens making materials and design. It would be left up to one who could employ scientific methods of study, and then devise the mathematical formulas to characterize the physics of optics to make the next important technological leaps possible. It would then be asked of a chemist to invent and manufacture those raw materials necessary to make the new designs possible. And it would be one man to bring this combination together to create a concern of unrivaled accomplishment.

Carl Friedrich Zeiss (b. 11 September 1816 in Weimar - d. 3 December 1888 in Jena) grew up apprenticed in the shop of Dr. Friedrich Körner, becoming well familiar with the operation of fine tools and machinery to make microscopes and scientific instruments. Körner was a machinist who provided such instruments to the German court. Zeiss attended lectures at the University of Jena where he studied mathematics, physics, anthropology, mineralogy, and optics. He traveled as a journeyman for some years and completed his practicals at the Physiological Institute in Jena under Professor Schleiden. On 10 May 1846 Carl Zeiss submitted the required application to the Weimar authority requesting permission to open a mechanical workshop. After this was approved Carl Zeiss opened on 17 November 1846 at Neugasse 7, Jena on the Saale River in the district of Thuringia in Germany for the production of simple microscopes, measuring instruments, and other precise optical and mechanical instruments. In the first year of operation he sold twenty-three microscopes, not bad considering the state of the economy and his not being well known at the time.

In September 1847 Zeiss moved to a larger facility at Wagnergasse 32 and hired his first apprentice. Among his customers was the University of Jena for whom he made and repairs scientific equipment. Zeiss began to make improvements in microscopes, offering simple microscopes and in 1857 introducing the first compound microscope (employing an objective and an eyepiece), the "Stand I". In 1861 Zeiss compound microscopes are declared to be "among the most excellent instruments made in Germany" and he is awarded a Gold medal at the Thuringian Industrial Exhibition. By 1864 the need to house some 200 employees results in another move of the workshop to a third larger site at Johannisplatz 10. In 1866 the 1000th microscope is delivered; the Carl Zeiss shop is recognized throughout European scientific circles for the quality of its microscopes. Carl Zeiss original workshop has been restored and remains a subject of attention to visitors to Jena today.

Up to this time advances in optical designs and materials relied heavily on inefficient trail and error efforts. Realizing that the improvement of optical instruments demanded advances in optical theory (Zeiss noted "the only remaining function of the working hand should be that of precisely implementing the forms and dimensions of all construction elements as determined by the design computation"), Zeiss engaged Ernst Abbe (b. 23 January 1840 - d. 14 January 1905 in Jena) as a free-lance research worker when he was a 26 years young lecturer of physics and mathematics at the University of Jena. It was Abbe who would become Zeiss partner and help launch the name Zeiss into the stratosphere of optics. Many of those who would become the most successful minds in optics were taught at the University at Jena, and then employed at the Zeiss Works. Ernst Abbe was without doubt a most gifted individual whose accomplishments place him in that rare category of person who can be said to have a profound impact on the rapid evolution of many optical theories and products.

Abbe grew up in poverty, his father worked as much as sixteen hours a day to support his family. Abbe earned his way through school by gaining scholarships, and with some assistance from his father's employer. As an undergraduate Abbe studied physics and mathematics at the University of Jena. He went to graduate school at the University of Göttingen where he received a Doctorate in thermodynamics. In 1863 Abbe joined the faculty at the University of Jena where he lectured on physics, and later where he would serve his professorship. Introduced to Carl Zeiss in 1866, Abbe became very interested in the optical challenges facing microscopy. Late in 1866 Zeiss and Abbe formed a partnership where Abbe became the director of research of the Zeiss Optical Works. Abbe laid out the framework of what would become the modern computational optics development approach. By 1869 their work produced a new patented illumination device, which provide illumination of the objects studied under a microscope in a manner superior to that of previous systems.

Among Abbe's most significant breakthroughs was the formulation in 1872 of what a wave theory of microscopic imaging that became known as the "Abbe Sine Condition". This approach made possible the development of a new range of seventeen microscope objectives - three of these were of the immersion type, all were designed based on mathematical modeling. In Abbe's words "based on a precise study of the materials used, the designs concerned are specified by computation to the last detail - every curvature, every thickness, every aperture of a lens - so that any trial and error approach is excluded."

As mentioned above, before Carl Zeiss and Ernst Abbe, lenses were made by trial and error. However, these objectives were the first lenses ever made that were designed based on sound optical theory considering the laws of physics. The comparatively high performance of the new Zeiss microscope objectives earned for the company international acclaim as an innovator capable of devising high performance optical products.

In 1881 Carl Zeiss son Roderich would become a co-partner in the Zeiss concerns.

Otto Schott (b. 17 December 1851 Witten - d. 27 August 1935) grew up in a family that introduced him to making window glass, his father became a co-owner of a glassworks in Westphalia in 1853. He became the father of modern glass science and technology. Schott left home after gaining a masterly understanding of the state of the art to study chemical technology at the technical college in Aachen, and later at the universities of Wijrzbur and Leipzig. Schott later earned his Doctorate at the University of Jena in 1875 for his work about defects in window glass manufacturing. In late 1879, Schott wrote to Ernst Abbe describing his success in devising a technique to formulate a new glass that incorporated lithium, and later Schott sent a sample of this glass to Abbe. Schott's work in his native town of Witten had by 1881 resulted in products with a degree of purity and uniformity that up to that time had been unknown. On 4 January 1881 Schott met with Dr. Abbe who prompted Schott to employ a scientific approach to the determination of raw ingredients to be used in glass formulations, and the development of manufacturing techniques of what would lead to the development of more than one hundred new types of optical and industrial glasses. Together Schott and Abbe would also work to improve the raw materials mixing and glass annealing processes. In 1882 Schott moved to a new glass-making laboratory set up for him in Jena. Schott joined Carl Zeiss to form the firm then known as Schott and Associates Glass Technology Laboratory, in Jena, Germany in 1884. Also in

1884 Schott founded the Schott & Genossen Glaswerke at Mainz to develop new types of optical and heat resistant glass, and crystals. Schott developed many new glass types, a number of which are still in use including Borosilicate Crown, also known as BK. Schott's glass innovation made possible the introduction by Zeiss in 1886 of the first "Apochromat" lens. His company pioneered not only new glass types but new uses, including "Jenare Glass" a domestic glassware line, and glassware for laboratory and industrial uses. He would become involved with social concerns, being elected to city council of Jena where he served from 1896 to 1899. Schott retired from his day to day activities in the glass works in 1926.

This collaboration resulted in the Jena Glass Works of Schott becoming the prime source of glass and filter materials for Zeiss products. This research and development effort bore its first noteworthy fruit in 1886 when Zeiss marketed the first "aphochromate" microscope objectives; this apochromatic microscope objective offered superior quality. Employing "fluorspar" elements this was the first use of crystal in an industrial optical application.

Zeiss now employs 250 workmen, and delivers its 10,000th microscope! Carl Zeiss lives to see this breakthrough, but soon after he dies on 3 December 1888.

Abbe was interested in improving academic and research resources. His efforts resulted in the establishment of the Institute of Mineralogy at the University of Jena. Abbe was also interested in social reforms culminating in the formation in 1889 of the "Carl-Zeiss-Stiftung" (something akin to a foundation) to operate the various Zeiss concerns, with a mission to ensure the Zeiss firm follows the social vision of its founders. By 1900, the employment benefits at Zeiss were uncommonly good in their day; these included an eight-hour work day, paid holidays, some forms of health benefits, profit-sharing, and a retirement plan. It is our understanding that one provision of the Stiftung Statutes was that the top salaries at Zeiss could not exceed that of the foremen by more than a factor of ten. Such concerns of employees’ well being was rare at the time, but it was returned to the company with increased employee loyalty and by attracting better-qualified candidates for employment.

The original constitution of the Stiftung provides that the profits of the Zeiss firms go to the foundation which, after making grants for scientific research and cultural activities, distributes the funds back to the firms to finance growth and employee benefits programs. In 1891 Abbe (and later Roderich Zeiss) bequeathed his shares in the Zeiss Optical Works factory and the Schott Glassworks to the "Stiftung". In 1923 Schott also added his stock shares in the Glass Works to the foundation.

Among the first notable optical accomplishments by the Zeiss works were that by 1870 Abbe had independently reinvented image erecting Porro prisms (sometimes referred to as the "Porro-Abbe" design), and by 1873 a prototype instrument had been completed. However, due to the limitations imposed by available crown glass at the time Abbe did not proceed much further until later in his career. The original prism design was developed by an Italian Ignazio Porro (1801-1875). By 1888 Schott improved the optical characteristics of Crown glass such that Abbe resurrected an earlier project, by 1893 he had created and patented (back dated to July 9 at the German Imperial Patent Office) a 8x 20mm "binocular telescope with increased objective separation". The significant improvements over then competing designs being that he employed the improved glass prisms in an air spaced fashion in the form of the now traditional Porro binocular permitting a wider separation of the doublet objective lenses thereby resulting in markedly improved depth perception. This patent remained in force until 1908. The mass production of prism binoculars by Zeiss then began in 1894.

In 1886 Abbe met Horatio S. Greenough, an American biologist. Greenough drew out a sketch of a promising concept for Abbe; by the end of 1897 the first stereomicroscope ever made is completed at Zeiss providing true three-dimensional views.

Franz A. Meyer (b. 6 June 1868 Hamburg, d. 29 May 1933 Jena) became the first college educated engineer employed at the Optical Workshops at Jena; a person of his qualifications was deemed necessary by Abbe for the design and construction of large astronomical instruments although he played part in many other areas of production at Jena.

By the end of the century Zeiss had negotiated limited partnerships with overseas companies including "Bausch and Lomb" of Rochester, N.Y., an American firm to make complementary products, or Zeiss products under license. Sometimes having a product made within the country where it would be sold could bypass expensive tariffs; for example the U.S. federal government relied mostly on income from import tariffs prior to the introduction of the Income Tax in 1913.

By 1900 Zeiss employs 1,070 people. In 1903 Abbe retired from active management due to ill health, he would die on 14 January 1905 and was then succeeded by Prof. Dr. Siegfried Czapski.

Carl Zeiss employed a number of persons whose names have become familiar to those who use optical instruments. Among them is Albert Koenig (b. August 1871, d. April 1946) who as a student of mathematics and physics at the Universities of Jena and Berlin became acquainted with Dr. Abbe. Albert Koenig came to work for Zeiss Jena in October 1894, and by 1895 he completed the work for his Ph.D. After his arrival at Zeiss Koenig promoted quickly to become responsible for leading a design team which would develop numerous optical systems including eyepieces, prisms, and telescopic objectives. The most notable of his astronomical telescope achievements may be the designing of the Zeiss "B-Objektiv" (Type B Objective), design an f/15 air-spaced triplet apochromat. Made in apertures of from 60 mm to 200 mm, the Type B was the first refractive telescope objective to achieve such a high degree of perfection of color correction and of spherical aberration and it remained well regarded from the turn of the century until World War II. From the turn of the century, he became head of the department at Zeiss that developed terrestrial telescopes, binoculars, long distance microscopes, range finding and measuring instruments. Koenig was responsible for the development of new ocular designs, some which featured apparent fields of view of up to ninety degrees. And his eyepiece designs over the years included several lens arrangements: combinations of singlet and doublet lenses, of varying glass types, etc. And although there are some contemporary makers who advertise a "Koenig Eyepiece", this is in fact not a design that is known as having one particular lens arrangement. Those represented as a "Koenig Eyepiece" tend to be wide-angle designs of from 65 to 70 degree apparent field of view, and these work best when used with telescopes of longer focal ratios. His remains one of the more remarkable careers in optics, spanning some 52 years with Zeiss, achieving noteworthy patents in terms of quantity and of quality. Koenig was a man of remarkable intellect and with management style ideally suited to achievement in his times.

Another famous Zeiss employee was Heinrich Erfle (b. 1884 - d. 1923) who in 1917 Patented a practical design for a wide angle ocular that since 1918 has appeared in many binoculars and telescopes.

Before the turn of the century management adopted a policy that most common Zeiss products would bear code names that clearly identified the product, this would facilitate cabling information and the placing of orders. By 1902 Carl Zeiss was pioneering new advances with camera lenses, introducing names that remain respected today by the modern descendants such as the "Tessar", a lens introduced in 1902 that was marketed as the "eagle's eye".

While first commercial Zeiss binocular made were the 4x 11 mm and 6 x 15mm models introduced in 1894 and total production numbered 205 according to Zeiss records. By the beginning of World War I Zeiss had developed a total of about fifty-nine models of hand held binocular for consumer and military use. With serial numbers up to about 30,600 by 1900 sales soon skyrocketed to over 200,000 by 1910, and by 1914 their serial numbers approached 500,000. A consumer 12 x 40 might carry a designation "Teleduz", while the military contract version carries a "D.F. 12x40" designation for example. Between 1907 and 1914 Zeiss listed at least five 6x 30 mm binoculars in production: "Jagdglas", "Silvarem", "Silvamar", "Maringlas", and a military "D.F. 6x20" with the D.F. indicating Doppelfernrohr (literally "far from double pipe"). Giant binoculars of 60mm, 80mm and even 110mm aperture introduced for the consumer market in the 1920's bore the names "Starmorbi", "Asembi", "Asenglar". A particular 80mm telescope with an alt-azimuth stand, fitted wood storage case, and accessories might carry the name "Asestaron", while the same telescope on another mount would bear another name. By the end of World War II, Zeiss would have produced some 2,260,000 binoculars for military and civilian use!

Up to this time Zeiss products bore the inscription "Zeiss" or "Carl Zeiss" in cursive lettering. But on 24 June 1904 the issuing certificate for a new Zeiss trademark was issued; this logo was fashioned with "Carl Zeiss" within in the border of an achromatic doublet lens outline designed by a consultant Erich Kuithan (b. 1875, d. 1917). Kuithan was an accomplished artist and designer residing in Jena since 1903. This trademark was to become world famous and remained in use throughout World War II. After World War II this logo remained the corporate trademark employed by Carl Zeiss Jena (with some protest from the West

German Zeiss) until the reunification of Germany and the Zeiss companies in the 1991.

Soon after the turn of the century, studies financed by Zeiss demonstrated the typical adult eye when dark-adapted would dilate to about 7mm diameter. After considering the efficiency of visual optics in low light applications producing a 7mm diameter exit pupil, Zeiss introduced the first 7x 50mm binocular prototype in 1910. This formula remains the world standard for marine and astronomy uses. By 1914 Zeiss had introduced the 7x 50 "Binoctar" to the consumer market, this is the binocular that was to become the model in terms of optical arrangement and external appearance for generations of marine and low light binoculars to come. The individual focus Binoctar would remain in production with some improvements in materials and design until 1971.

By World War I, Zeiss had established the "Carl Zeiss, Jena Optische Werkstaette" with marketing branches in Berlin, Frankfurt, Vienna, London, and Hamburg with other sales agents around the world. Other firms offered Zeiss products including: Eastman Kodak who manufactured a Zeiss "Anastigmat" lens under license for its cameras; and Ross Ltd. of London. From shortly before World War I, up to World War II the Carl Zeiss firm established subsidiaries in European countries to produce optics; some of these (particularly between the wars) produced military optics, which might have aroused international concern. It is not unusual to find the traditional Zeiss trademark with the city of origin listed as "Petersburg" Russia for example in place of Jena on the logo, or "Zeiss Nedinsco" both being located outside of Germany. It is ironic that the systems manufactured by subsidiaries in European countries might have then been employed to equip the Wehrmacht and SS armies that would later occupy them.

In 1908 Carl Zeiss placed responsibility for the design of a revolutionary prescription spectacle lens in the hands of scientist Moritz von Rohr (b. 1868, d. 1940). The result was that in 1909 Zeiss  Punktal / lenses were patented. Bt 1912 the new Punktal spectacle lenses were introduced to the market and for the first time a prescription lens could be bought that would provide identical visual quality over a wide field of view. By 1904 Zeiss had developed and manufactured the "stereo comparator"; an instrument that would permit the measurement of relative distances, and reveal changes within a star field by comparing one image against another simultaneously. This tool would become invaluable for the discovery of many celestial wonders including asteroids, comets, and another notable achievement: the discovery of Pluto by Clyde Tombaugh.

Among the areas of prominent growth in the sciences was the field of astronomy; demand for larger and more complicated telescopes and mountings could be met only by a firm with well-integrated resources. Among the areas that Zeiss pioneered and dominated before World War II was the development of planetarium instruments - even though these were never really a profit center for Zeiss, it was a matter of social responsibility and corporate pride that caused Zeiss to continue production. A concept put forward in 1913 by Dr. Max Wolf, Director of the Heidelberg Observatory. Zeiss patented the device in 1922, and the first planetarium instrument in the world was placed into public service in 21 October 1923 located at the new German Museum at Munich. A planetarium instrument is housed in the center of a room with a hemispherically domed ceiling; the instrument projects points of light to the ceiling to simulate the night sky from various perspectives including seasonal, or historical views of the Earth-sky relationship. These instruments were single handedly responsible for motivating many young people to explore and understand astronomy and celestial navigation. Even after World War II both Zeiss companies would establish planetarium production at their headquarters, and their domes would figure prominently in the skyline of their factories.

Possibly to avoid past or future legal litigation, after World War I Carl Zeiss Jena established a distributor in New York "Bennett & Co." at 155 West 23rd Street, New York City operated by a Carl Zeiss Jena employee. In December, 1925 this organization was incorporated as "Carl Zeiss, Inc." at 485 - 5th Avenue, N.Y., N.Y. Regional representative agent offices were then established in Chicago, and Los Angeles. Interestingly enough Carl Zeiss Inc. continued doing business in New York throughout World War II. After December 1941 Carl Zeiss Inc. sold all remaining imported merchandise and provided services as possible, and eventually becoming involved with the manufacture of products in the USA. Throughout this time Carl Zeiss Inc. remained under the management of Dr. Karl Bauer, the corporation's first president and a citizen of Germany.

The growing production capability at Jena continued into diverse areas including manufacture of automobile acetylene headlights beginning in 1911, which were ground of crystal glass with a silver plated parabolic reflector. By October of 1912 this was incorporated into "The Auto Department". By 1921 electrical headlights were in production at Jena. Shortly after World War I the demand for these components increased with production expanding between 1927 and 1929 into related areas of spot lamps, and fog light headlamps. But, by 1933 Zeiss sales in these areas had declined to insignificance as may other companies entered the market, at times with improved designs and often selling at far lower prices.

By 1913 Dr. Hans Lehmann at the Ernemann Werke at Dresden prototyped a very high speed movie camera that produced images that when played back on a conventional projector, it allowed the study of motion. This would be marketed by the Instrument Department of Zeiss Ikon as the "Zeitlupe". The original hand driven commercial camera operated at about 300 frames per second but, with improvements over the years Zeiss eventually produced cameras capable of many thousands of images per second. By 1926 the Ernemann Werke in Dresden was acquired fully by Zeiss Ikon. Zeiss Ikon would grow to also include the Ica factory in Dresden, two Goerz factories in Berlin (which also made searchlights, medical instruments), and the Contessa Werke in Stuttgart.

By 1923 Carl Zeiss Jena manpower was up to about 5000 employees. And in spite of the worldwide economic recession and depression of the 1920's the Zeiss company continued to grow.

In 1849 Moritz Carl Hensoldt (b. 1821 - d. 1903) and his brother-in-law Carl Kellner (known best for his eyepiece design) began a business for the fabrication of telescopes. By 1850 Hensoldt formed his own company "M. Hensoldt & Soehne AG" for the manufacture of optical instruments. By 1928, the Hensoldt company with its factory in Wetzlar had the Carl Zeiss company as a shareholder. Zeiss thereby acquired a partnership with a manufacturer best known for their roof prism binoculars introduced in 1897, and in 1905 the "Dialyt" series of Abbe-Koenig in line prism binoculars, and rifle scopes. Hence the similarity between the appearance of traditional Hensoldt roof prism binoculars made since about 1905 and several Carl Zeiss roof prism products up to today. Improvements continued, including the 1933 shift from binocular housing construction of brass and zinc to light weight metals including aluminum and magnesium.

Zeiss had become involved in camera lens design and fabrication giving the world such famous names as "Tessar", "Biotar" and "Sonnar" with the latter having been developed by Dr. Ludwig Bertele - another famous name in optics design. In 1926 Carl Zeiss Jena combined five companies including "Contessa" to produce cameras and lenses. 1926 "Zeiss Ikon, AG" based in

Dresden began to produce box cameras; in 1932 Carl Zeiss entered the 35mm camera market that was pioneered by rival Leica. Zeiss first entry was the "Contax" range finder camera; this was also built in Dresden. These in prewar and postwar configurations earned worldwide respect and admiration leading to the development of the Contarex and the Contax RTS camera series some of which are now fabricated by Yashica-Kyocera of Japan under license to Zeiss specifications. Lenses made by Carl Zeiss were made for sale with cameras manufactured by other firms such as Rollei and Exacta at Dresden. Zeiss lenses made in Germany and by Yashica continue as the choice for several camera manufacturing firms including "Hasselblad" of Sweden - even though in the mid 1970 Hasselblad seriously contemplated offering "Nikon" lenses. And Zeiss lenses to this day also remain available for use with many commercial products including copiers, photogrammetric cameras, comparators, etc.

The 1930's were an exciting time of change and discovery in the world, and exhilarating time of productivity for Carl Zeiss Jena Astronomical Instruments section. By 1930 the first Planetarium had opened in North America; the "Adler" Zeiss Planetarium in Chicago. This was to introduce several generations of youngsters and adults to a rare treat - a tour of the heavens. To this day Zeiss Planetarium instruments continue to inspire awe at facilities around the world including that planetarium projector at the Smithsonian Air and Space Museum "Einstein Planetarium" in Washington, D.C.

By 1933 Zeiss had manufactured several proven refractors of the "E", "A" and "AS" achromatic doublet designs, and apochromat triplets of the "U.V." and "B" (Koenig) designs. These telescopes were offered in apertures of up to 65cm (25.6 inch) aperture f16 requiring a 14.5 meter diameter dome, a 60cm (23.62 inch) "Doppelrefraktor" (double refractor) f16 was available employing two objectives mounted in parallel within one tube - potentially the largest "binocular" ever made, a 36cm "Dreifacher" employing three telescopes (a "trinocular") with two U.V. triplets of 36cm with a 30cm "E" objective guidescope for astrographic uses, and numerous smaller refractors of 40cm, 30cm, 25cm down to 6cm achromatic models for use by amateurs and schools. Large pedestal or tripod mounted binoculars of from 60mm up to 15cm with 20x, 40 and 80x magnification oculars mounted in a turret were in production. Mirror telescopes of Newtonian, Cassegrain and Schmidt designs included models up to 1.25 meter aperture in single, or double or even triple configurations for astrographic applications. Zenith telescopes, spectrographic instruments and attachments, micrometers, photometers, comparators, coelostats of at least up to 65 cm diameter, and sundials of up to at least 90cm diameter rounded out the product line. And of course the production of telescopes was accompanied by the fabrication of mounts and drives to move them, and the domes to house them.

Another noteworthy milestone was on November 1, 1935 when Alexander Smakula a staff member at Zeiss developed and then patented anti- reflective (T  Transparenz /) coatings thereby improving light transmission dramatically over uncoated lenses in binoculars to over 80 per cent, reducing ghost images and finding other applications for the advances of optics in many other fields. The AR coatings remained a military secret until about 1940. By 1990, Zeiss Oberkochen would improve the anti reflective coatings to transmit more than 90 percent of the light entering a binocular (the T* designation). In 1988 "Phase Correction" coatings were introduced on all Carl Zeiss Oberkochen roof prism binoculars. Phase Correction facilitates a more uniform throughput of light across a wide portion of the visual spectrum thereby resulting in further improvements of resolution and contrast of systems incorporating roof prisms.

And Smakula was also involved in the development of crystals grown from solutions in a laboratory environment. By the end of the 1930's he had developed the first KRS five mixed crystal (thallium iodide-thallium bromide) that remains in use in infrared technology applications.

By the mid 1930's Zeiss offered a very wide selection of camera lenses and filters for use with print, and movie cameras, including some particularly unusual models such as the "Quartz-Anastigmat" of 120mm or 250mm focal length described by Zeiss as a "rapid special lens for criminological and scientific photography particularly with ultra-violet light".

The 1937 literature indicated Zeiss had established marketing branches in Berlin, Vienna, Cologne, Hamburg, Brussels, London, New York, Los Angeles (under New York), Buenos Aires, Rio de Janeiro, Sao Paulo, and Tokyo with other firms acting as sales agents in Montreal, Calcutta, Bombay, Madras, Singapore, Melbourne and Sydney, Bangkok, Cairo and Haifa, Johannesburg, Stockholm, Amsterdam, Paris, Milan, Madrid, Shanghai.

By 1937 Zeiss listed about twenty high quality monocular, binocular and stereomicroscope configurations in their literature. And they also marketed a wide selection of optional attachments and illuminators including at least thirty-three objectives of from 2X to 120X including six Fluorite models, and about twenty eyepieces of Huygens, Orthoscopic, and Compensating designs of from 3X to 30X.

It was the quality of design and manufacture of products by the German firms including Zeiss, Hensoldt, and Leitz (presently marketed as "Leica") to name a few that over the course of the early half of the century served to cement the international perception of the preeminent quality of German optics mechanical design and manufacture as a whole.

Carl Zeiss Jena had become a Social-Democratic bulwark. Yet from 1933 and through World War II the management of the

Carl Zeiss industrial complex had generally supported the Nazi regime as did most major German industries, although there are examples of personal risk taken in favor of high moral principles. By 1937 the corporate priorities were obviously changing. In Dresden where camera production had been dominant, civilian products and development were gradually discouraged in favor of those products such as bombsights, which met the more immediate goals of the government.

When World War II began (arguably) in September 1939 there was an air of invincibility in Germany, and in keeping with traditional practice, most Zeiss products and those of other manufacturers in Germany had proudly borne the makers trademark and city of origin of the product. However, by 1941 it became clear that the Allies would be able to identify factories and then bomb targets in Germany. So in February 1942 the German Armaments Ministry assigned three letter code marks to each of those companies engaged in fabricating military hardware. The codes identified the manufacturer and their facility location. Carl Zeiss Jena products employed code marks including "blc", Leica "beh", and so on.

There were forced foreign laborers (Fremdarbeiter) who were brought to work at Carl Zeiss Jena and other German manufacturing facilities. And it is certain that not all Germans were sympathetic to the Nazi regime, in fact there are known examples of intervention by the Zeiss Personnel Department to obtain the release from prison of some foreign laborers. Some Germans might warn a newcomer to "watch what you say" around certain others who might be Nazi supporters. One foreign laborer at Jena recalls visiting a couple whose son was at the Russian front and while there he dialed their radio to listen to the news from London; he was later warned such conduct could lead to the death penalty.

Zeiss optics figured prominently in the success of many weapons systems. For examples there were the pressure resistant U-Boat targeting bearing transmitter binoculars, ultra wide angle large aperture binoculars, the stereoscopic range finders and sights used to direct fearsome weapons such as the outstanding 88mm anti-tank guns. One of the most published early photographs of the war shows Adolf Hitler outside of Warsaw, Poland in September of 1939 observing through a pair of artillery director periscoping binoculars (commonly used by a battery director to evaluate and correct artillery ranging) as the city is leveled by German artillery and air forces.

However, with the end of the "Third Reich" in sight, the advancing allied forces would discover interesting products of German research and development efforts in many areas including optics. Among these was the "liberation" of two of the probable three or more "Doppelfernrohr" (double telescope) 20 + 40x 200 mm binoculars completed by Carl Zeiss Jena in 1944 or possibly 1945. Each refractive system incorporates 45 degree inclined wide-angle eyepieces providing 2.25 and 4.5 degrees actual field of view. Each binocular weighs about 460 lbs (209 kg), and with stand may have weighed about 1200 lbs! One instrument remains in the United Kingdom, the other (serial number 3) is property of the Smithsonian Institution Naval Historical Museum. After sitting in a warehouse for some fifty years, the U.S. example underwent a comprehensive restoration by Mr. Kevin Kuhne in Sandy Hook, Connecticut. Since there was no appreciable interest to display them the USA, the restored example was loaned by the US people to the custody of the Wehrtechnischen Studiensammlung military museum in Koblenz, Germany where they are now on proper display.

Intricate examples of complex lens making were found bearing Zeiss code marks indicating production after November 1944, even though the need for such sophistication and refinement on one product in a nation beset by lack of raw materials and manpower could be questioned. In Company Seven's collection for example we have a finely crafted hand held Zeiss 7x 50 mm binocular with very sophisticated optics marked "rln", two custom made sets of filters, finely sewn leather case with straps and eyepiece rain guard engraved "Benutzer" (user) that was made at a time while other Zeiss hand held military binoculars made were being shipped with painted prism housings instead of the pebble grain exteriors and no accessories.

Major German cities were bombed during the war. Stuttgart for example was bombed in 1944 with the central district being obliterated while the Contessa factory in the Henslack district suffered only minor damage. Jena was bombed by the U.S. 8th Air Force several times during the course of the war, with increasing severity. In one bomb raid of 19 March 1945 witnessed by Lucas VanHilst "I was standing outside a zig-zag "Schutzgraben" looking up to 'my friends', the first wave of whom just passed by so to speak. Then suddenly a German soldier on leave grabbed me by the arm. "Mach' schnell, 'runter!!". The suction of an explosion threw me down the stairs. He may well have saved my life. In the center section several persons were killed or wounded. The last bombardment was the worst. The sight of carts loaded with dead bodies was shocking - as it would anywhere. That air attack did substantial damage to some Zeiss and also to Schott buildings (where one of my Dutch friends was killed). The rather small "Alte Stadt" was totaled. Visiting in 1994 it still was a sad sight."

There is evidence that the disruptions of raw materials and transport were having some chain reaction effect at Zeiss facilities, and those who depended on products coming from Jena. In March 1945 the completion and delivery to the military of several new "Jagdtiger" (Hunting Tiger) tanks were being held up by the late delivery of the special shock resistant, precision sight components from Carl Zeiss Jena. The heaviest operational tank of the war, these tanks are armed with a high velocity long range 128mm gun, and armor so thick and well engineered that they could resist almost anything that ground forces or opposing armor could shoot at them. Some allied ground troops can thank the air forces for sparing them from more of these opponents.

Towards the end of the war in Europe one of the last decisions made in the selection of targets for the allied air forces was whether to bomb Schweinfurt (known for its ball bearing production, and a October 1943 bombing campaign that resulted in tragic losses for the U.S. Army Air Forces and the German Luftwaffe), or Jena with its Zeiss and Jena works. Schweinfurt was selected even though by then more than 35% of its production from the five factories had been dispersed to other facilities.

On April 6, 1945 90th Infantry forces of the U.S. Third Army came upon the Kaiseroda salt mine near Merkers (a few miles inside the border of Thuringia). The mine housed currency (including 98 million French francs, 2.7 billion  Reichsmarks /) and gold and coin including the entire gold reserves in 550 bags each of 55 to 81 lbs. totaling nearly 250 tons from the Reichsbank / in Berlin (including 711 bags  boldeach /bold filled with $25,000 in U.S. $20 gold coins), and silent testament to victims of the Nazi's: stacks of valuables taken from those at the death camps (jewelry - wedding rings, watch cases, gold-filled glasses, teeth with gold and silver fillings, etc.), 400 tons of art from Germany and works plundered from conquered nations, dozens of complex microscopes and other optical instruments made by Zeiss and others. The entire 712th tank Battalion and the 357th Infantry regiment were also diverted to guard the mine in preparation for removal of the items to the  Reichsbank / building in Frankfurt.

One humorous aside to this was that on the morning of April 12, Generals Eisenhower, Bradley, Patton and Maj. Gen. Manton Eddy took the elevator ride 1,600 feet down into the shaft. When the elevator doors opened at the bottom of the shaft a Private on guard stumbled to salute, and in the tomblike stillness was heard to mutter "Jesus Christ!"

Among the most disconcerting discoveries made by the unprepared allied soldiers were the concentration death and labor camps. On April 11 U.S. Third Army XX Corp forces overran Buchenwald near Weimar and Jena where some prisoners were employed as slave labor for the manufacture and assembly of components including military binoculars with Zeiss code marks. As the soldiers approached prisoners were observed throwing binoculars over the fence to the passing GI's.

The U.S. Third Army continued its advance, and on April 13 the regimental combat team 80th Division cleared Jena where they found the Carl Zeiss factory complex. It had sustained what they described as "surprisingly little effective bomb damage". By then the original large planetarium test dome was gone, even though nearby on another roof top a small telescope observatory dome remained. The Yalta agreement fashioned between the allies political leadership had determined that Germany would be partitioned into four areas, each under control of a major ally: England, France, Russia, and the U.S.A. All of the Zeiss facilities but the Contessa works in Stuttgart (then occupied by the French but designated for U.S. control) were in what would become the Russian zone of occupation. And so the U.S. forces at Jena proceeded to evacuate manufacturing assets and documents over the course of several days.

At least some foreign laborers went with the U.S. Third Army to act in capacities such as "member-translator" of outfits such as the "Civic Affairs Team TA-4" traveling as far east as Vimperk (Winterburg), Czechia. With the rapid advances into areas being newly occupied the letter of the law or procedures were not always adhered to; just imagine running into a person in U.S. army uniform carrying a carbine, bearing a Dutch passport!

The members of the Carl Zeiss Jena board of management and the most vital staff including Professor Dr. Ing. Walther Bauersfeld (b. 1879, d. 1959) Scientific Head with the company since 1908, Dr. Ing. Heinz Kuppenbender, Professor Dr. Joos, Paul Henrichs, and about 130 engineers and technicians were evacuated to western Germany occupied by allied forces to what would become the Federal Republic of Germany. American officials advised the evacuees (reportedly in an early version of "make them an offer they can not refuse") that they would be moved to the American Zone of occupation. There are accounts that some went voluntarily while others were given no choice. U.S. Army trucks were assigned to move the families who were afforded only enough time to pack a suitcase. The 65 year old Frau Bauersfeld was allowed to take (as a last minute concession) one armchair for the long ride in the back of the truck. Months later, with the help of a neighbor and some luck one of Prof. Bauersfelds daughters moved from Jena the family Steinway piano on a railway car to Heidenheim. Zeiss Administrator Joos later went on to the United States.

Within as little a few weeks after the fighting concluded, some Zeiss facilities were back at work. The Contessa works at Stuttgart resumed production of Ikonta and Nettar film cameras. German military and civilian optics of the period remain among the most sought after "war trophies" taken home by occupying forces; to this day many people represent undocumented binoculars as being the personal Zeiss of Field Marshal Erwin Rommel.

Shortly afterwards, in compliance with the Yalta agreements the U.S.military forces departed. In June or early July the Russian military forces occupied Jena and the remainder of what became East Germany (German Democratic Republic). By one year later, the Russians had evacuated much of the remaining technical and management staff and about 92% of the Carl Zeiss

Jena manufacturing facilities to the east. Other German manufacturing assets were also confiscated under the reparations provisions; these gutted many factories mostly in the Russian occupied zone. At Dresden, the Contax rangefinder camera dies and some staff were taken to Kiev. It is likely the Russians wanted to emasculate Germany and gather whatever reparations they could against a Germany that had decimated Russia's population (less so than Stalin). Further, the Russian fear of possible further conflict with the western allies rendered moving any production capability into a more defensible Russian province a logical strategic step.

After the war the "Zeiss Stiftung von Jena" was established at Heidenheim with the "Opton-Optische Werstatte Oberkochen GmbH" factory at Oberkochen on the banks of the Kocher River near Stuttgart. The Schott Glass Works subsidiary was located at Mainz. The most important provisions of the organization are:

• The Carl-Zeiss-Stiftung is the sole owner of Carl Zeiss and Schott Glaswerke • Financial resources must be obtained independently by Zeiss Stifftungs own efforts • No external influences e. g. by private persons, and no capital from external sources or the government •

By 1947 the enterprise at Oberkochen was doing business as "Zeiss-Opton-Optische Werstatte Oberkochen GmbH". Soon, the Hensoldt facilities at Wetzlar resumed production, while microscope production resumed at the Winkel factory at Göttingen, and eyeglass production in Aalen. On March 3, 1948 the transfer of Zeiss Ikon headquarters from Dresden to Stuttgart was formalized. In 1951 the Zeiss Ikon factory facility at Stuttgart would be about doubled in size to accommodate the headquarters and production operations.

Shortly after the war Carl Zeiss, Inc. in the United States resumed the import of products from Zeiss Jena and Zeiss

Oberkochen. And by 1960 the U.S. based company was again fully owned by Carl Zeiss of West Germany. Dr. Bauersfeld continued to work until he passed away in 1959 at age 80!

While Jena had resumed the manufacture of some products (by 1947 binoculars were back on line for example) it was on June 1, 1948 that the East Germans now independent of Carl Zeiss Oberkochen formally reorganized the original factory in Jena as a state owned corporation to be known as "V.E.B Carl Zeiss Jena" (peoples owned corporation). The reorganized Carl Zeiss Jena under the direction of the East German government gradually resumed production of microscopes, measuring instruments, astronomical telescopes, photographic lenses, military optics. By 1949 in Dresden cameras such as the Contax II single lens reflex with a new 42mm threaded mount, and camera lenses such as the "Sonnar" were in production with all internal and external air to glass surfaces being "T" anti-reflection coated. The occasional similarity of appearance, of design, and the interchange ability of Zeiss Jena and Oberkochen components such as components for microscopes, and cameras was more than by accident. For example, some binoculars marketed by Carl Zeiss Oberkochen (bearing the trademark "Optron") were actually made by Carl Zeiss Jena.

As diplomatic relations between East and West were closing, both Zeiss companies sought out new sources. During the time up to about 1952 there were hopes for a German reunification and so the Zeiss counterparts actually worked to help each other recover to some degree. The hopes for reunification were dashed as the East German political leadership assumed firm control of all commercial enterprises; from now until reunification the Communist Party and its system of promotion by political achievement (which selected the top management) would determine the course of company policy.

By 1954 the Zeiss Jena works had reestablished their ability to produce world-class planetarium projectors, the first completed unit being delivered in 1954 to the Volgograd Planetarium in Russia.

One interesting experiment at diversification by Jena occurred in the mid 1950's; Carl Zeiss Jena produced four variants of a model two-cycle diesel engine ("Aktivist") for hobbyist applications in model cars, planes, and boats! In 1956 Zeiss introduced the "Jena Review", their own publication to highlight their accomplishments in a manner similar to the "Zeiss Information" published by the West. In another footnote, by 1956 Carl Zeiss Jena binocular production was moved from the Jena works to Eisfeld. Among new facilities were those opened in 1961 at Eisenberg near Jena for the manufacturing of synthetic optical crystals for use in the fabrication of optical components within microscopy, astronomy, photography, medical and laser technologies, and more. And by 1963 Jena was manufacturing numeric measuring systems for the precise measurement of angles and length.

In West Germany camera and camera lens production were underway at the "Contessa" camera factory in Stuttgart. In May 1950 at the Photokina camera show, Zeiss introduced their new "Contax IIa" 35mm rangefinder camera bearing the "Zeiss Ikon Stuttgart" mark.

By 1953 it could be argued that microsurgery was rendered possible with Zeiss Oberkochen surgical microscopes. In 1953 Oberkochen introduced a publication "Zeiss Information" to highlight the latest innovations at Zeiss. In 1954 the Oberkochen facility produced its first binocular: an innovative very compact 8x30mm Porro Prism model made possible in part by their development of the air spaced objective. In 1958 Zeiss Oberkochen introduced an improved wide angle eyepiece designed by Horst Kohler and Helmut Knutti; designated by the binocular model designation suffix "B" (for Brillentrager /

spectacle wearer) this allowed persons wearing prescription spectacles or sunglasses to see the field of view with none or little vignetting. Also in 1956 they developed a new flexible gasket system for their central focus binoculars which substantially improved the sealing of the interior optics against dust, dew, light rain. Beginning in 1962 space missions are flown with Zeiss optics; Jena providing for Russia, and Oberkochen the West. And now the unified Carl Zeiss continues to do so to this very day.

By 1954, Carl Zeiss Oberkochen had acquired a majority stock holding in Hensoldt. By 1964 Zeiss of West Germany had moved all binocular production to its Hensoldt subsidiary works in Wetzlar. Then in 1968 Hensoldt became a fully owned member of the Carl Zeiss Oberkochen group. To this day, binoculars and riflescopes made there bear either the Zeiss or Hensoldt trademarks - the Hensoldt trademarked products being offered primarily for the military and law enforcement markets.

Binocular innovation by Carl Zeiss at Oberkochen and Wetzlar continued with the introduction of an even more compact in line Schmidt (or Pechan) prism design for binoculars in 1964 bearing the trademarked "Dialyt" designation. While Zeiss had a tradition of offering "theater glasses" (low magnification, compact binoculars for use at concerts, etc.) dating back to before World War I, it was in the early 1960's that Zeiss introduced high quality pocket size "compact binoculars", that could fit easily in to a shirt pocket; the first being an 8x20mm model introduced in 1969.

In the early 1970's tensions between the two firms peaked (as they did between East and West) with each of both companies claiming the exclusive rights to the patents, trademarks and traditions of "Carl Zeiss". This culminated in a series of legal battles around the globe, among these was one resolved by U.S. Supreme Court granting rights to the name "Zeiss" to the West

German Zeiss firm. As a result of court decisions, and marketing agreements marketed for products sold in the United States the trademark "ZEISS" or "CARL ZEISS" appeared only on products manufactured by Carl Zeiss based in Oberkochen, West Germany.

The bold logo employed by Zeiss West Germany products until 1991

The East German products manufactured by the Jena firm were marketed in the United States only under the "aus JENA", "JENOPTIK", or "JENOPTIK JENA" trademark. The original "CARL ZEISS JENA" trademark appeared on East German products sold in the former communist block nations, and in Canada, England, and some other countries. And to add to the confusion, in some countries both trademarks were recognized. However, both East and West continued to employ the name "Carl Zeiss" throughout the postwar era until the reunification of 1990 wherever possible.

Zeiss Jena maintained an office in New York City, with distribution of microscopes (and incidentally - planetarium instruments) through a private company in the mid U.S., binoculars and microscopes through a company in Pennsylvania, and surveying instruments such as Theodolites through another firm in Florida. These firms were completely independent of one another.

Zeiss West Germany continued to develop precise electro-optical equipment for distance and height measurements that found applications in sports events; their Recording Electronic Tachemeter measuring systems and their variants were used at international sports since 1970 events including the Olympic Games held in Munich in 1972 and those in Montreal in 1976.

In 1976 the West German Chancellor Schmidt presented the

Carl Zeiss Oberkochen Mark IV Planetarium projector to the National Air and Space Museum "Einstein Planetarium" in Washington, D.C.. Among the invited guests were Ruth Van Hilst b. Bauersfeld daughter of the former head developer of Zeiss planetarium instruments. The Zeiss instrument remains one of the highlights at the most visited attraction in the United States.

Zeiss West Germany continued to set the world standards for microscopy in many areas. In 1973 Carl Zeiss West Germany announced the first high precision UMM 500 3D coordinate measuring machine. In 1976 Zeiss announced the first microscopes specifically designed for the examination of living cells, these were the IM 35 and ICM 405. In 1982 Carl Zeiss West Germany announced the world's first LSM Laser Scan Microscope - the quantum leap in microscopy. And then in 1984 a new era in electron microscopy was introduced, the EM 902 with energy filter.

In 1995 the NASA space probe "Galileo" reached Jupiter and then on July 13 it dispatched a probe into Jupiter's atmosphere. A "Helium Abundance Detector" interferometer on the probe made by Zeiss at Oberkochen also contributed to the success of the effort during the 75 minute descent. Delivered by Zeiss in 1984, this was the first instrument in space made by Zeiss at Oberkochen, and so far is the farthest that Zeiss has traveled from Earth.

All the while Carl Zeiss Jena continued to make innovative products including electro-optical equipment for distance and height measurements in sports events including the Olympic Games of Moscow in 1980, Los Angeles in 1984, and Seoul in 1988. Also developed was the "Cosmorama" computer controlled planetarium projector in 1984, and later the "Fundus" camera and their workstations for ophthalmology. The value of the western currencies figured prominently in what success the eastern products enjoyed in the west.

In 1988 Zeiss Oberkochen announced the "P-Coatings" (invented by Adolf Weyauch); a "phase correcting coating" applied to a surface of roof prisms. This corrected the phase shifts as light passes through the system resulting in a sharper and clearer image. This and other innovations continued culminating with the introduction in 1990 of the "Design Selection" series of compact binoculars. And also in 1990 the 20x60 S - the world's first hand-held, mechanically stabilized binocular (this too was invented by Adolf Weyauch).

On June 1, 1990 the "ROSAT" X-ray satellite was launched from Cape Canaveral; at the time it featured the world's smoothest mirrors and was the largest X-ray telescope ever made (83.4cm aperture); it conducted the first X-ray survey of all the skies.

While in 1986, Carl Zeiss Jena resumed production of cameras.

Carl Zeiss West Germany grew to become the world's largest optics research and development firm with marketing organizations in at least 28 Western countries. It features state of the art microscopes, several of the world's largest or most complicated telescopes, specialized scientific instruments, measuring instruments, military optics (including submarine periscopes), spectacle frames and lenses, rifle scopes, photographic lenses, cameras ("Contax" made under license by Yashica/Kyocera) and binoculars.

In 1990 Carl Zeiss Oberkochen introduced the "20x60 S" binocular; this employed a Zeiss developed, revolutionary "cardanic" dampened stabilization mechanism that does not rely on electronic or hydraulic mechanisms. The 20x60 S allows a person to hand hold the binocular with such apparent steadiness by the reduction of vibration that one has the sense of looking though a much lower magnification binocular of 4x or so! The 20x60 development has earned for Carl Zeiss the "R&D Magazine" award for developing one of the 100 most important technical innovations of 1992.

Carl Zeiss Jena continued to rely on a far less sophisticated network of independent agents. The director of Carl Zeiss West Germany was quoted in a "Wall Street Journal" newspaper interview as stating that western style marketing "simply doesn't exist" in the east, "everything that is produced is dictated by the plan". Yet by 1989 Carl Zeiss Jena was the largest of East Germany's 120 state owned corporations ( Kombinate /). However, Zeiss employees in the east worked an average of six (6) more hours per week at less than half the salary of a western worker. The eastern technology was falling behind the west, now being relatively primitive and too inefficient to compete in a modern economy. While the western facilities were more automated, energy efficient, and more ecologically sound in terms of worker conditions and production of waste materials. In too few areas the west's relatively higher labor costs and demands were a handicap in competition against the east, although after the reunification Germany is exporting jobs to third world economies (such as the U.S.A.).

The German reunification of 1990 was symbolically realized with the literal collapse of the Berlin Wall, and the practical fall of Communism. But while the West German economy was robust, the East German economy was so stagnant that the transition has been turbulent and fraught with uncertainty for displaced workers. At the time of the reunification Carl Zeiss Oberkochen had a logical desire to acquire only the best technical and most historic assets of the East German Zeiss firm. Zeiss Oberkochen then had approximately 31,700 employees who were generating $2.18 billion in sales; Oberkochen did not wish to acquire Carl Zeiss Jena liabilities (as most West German firms were hesitant to do) such as the staff and pension expenses for a grossly overstaffed (totaling about 70,000) and under productive (sales of about $390 million) work force. Furthermore, Oberkochen wished to avoid manufacturing and personnel redundancies. And so an initial merger plan was not accepted by the Carl Zeiss Jena firm.

Since shortly after World War II Zeiss Oberkochen products bore the trademark "ZEISS West Germany". Within weeks after the reunification of 1990 new Zeiss letterhead and products bore the trademark "ZEISS Germany".

The logo employed by a unified Zeiss for products made after 1991

When economic realities settled in at a now near bankrupt Carl Zeiss Jena (and other eastern manufacturers across a united Germany), negotiations were concluded by June of 1991 with Oberkochen to acquire only certain selected assets including the original facilities Jena. However, only a little more than 10% of Jena's peak 70,000 person labor force of 1989 (down to about 27,000 in May 1991) would be incorporated into Zeiss Oberkochen. And even then contrary to optimistic plans, the remaining labor force would be reduced even further over the next few years.

For an example: in July, of 1991 the German privatization authorities concluded the purchase of the Carl Zeiss Jena V.E.B. binocular and riflescope manufacturing works at Eisfeld by Docter-Optic GmbH of Wetzlar. Eisfeld was not acquired by Zeiss Oberkochen as the Eisfeld manufacturing techniques were considered primitive and inefficient by Oberkochen standards; Oberkochen already having an efficient binocular plant at Wetzlar. It could be argued that Zeiss Oberkochen lost an opportunity to retain some of the best Porro prism designs made such as the Zeiss Jena "Nobilem". The passing of Eisfeld ended a

Zeiss tradition of almost 100 years of making 80mm large binocular series, the last being the "Aspectem" series a relatively new model of which maybe 100 to 200 units were made, and possibly the best 80mm ever offered by Zeiss and yet with much potential remaining for improvements. And Oberkochen passed on other innovations produced by notable Jena employees such as Dr. August Sonnefeld.

The Eisenberg facility continued with the development and growth of synthetic crystals to support its own products. By 1991 Jena offered at least 19 different materials grown from melts and solutions, having made something on the order of 250 tons of materials in its recent 30 years of production. One of the most important products for the advanced amateur and institutional astronomy markets to come of this was the growth of high quality Calcium Fluoride ($CaF_2$) crystals from Stockbarger melts which made possible the "APQ" Apochromatic objectives that Jena offered for sale in 105mm, 130mm and 150mm apertures; a 206mmf8 "APQ" telescope was advertised but Zeiss was never able to complete a single instrument before the small telescope manufacturing group at Jena was cut back further. And at least one 80mm x 500mm "APQ" objective was made, possibly for use in terrestrial and compact astronomical telescopes, and in the large binoculars previously manufactured at the Eisfeld plant.

Since the reunification, the groups involved with research and development, and the growth of synthetic crystals and fluorides, and marketing have been incorporated in Eisenberg plant (established near Jena in 1961) as part of the "Optics Division". Although a large marketing force for other Zeiss groups including consumer optics remains at Aalen. The groups from Oberkochen and Jena involved in the design and manufacture of precise height and distance measuring devices such as those employed at Olympic Games continue under the name "Zeiss Optics".

The group at the Jena works who were involved in production of astronomical telescopes was retained, while the planetarium production team at Oberkochen was moved to and incorporated with existing Jena facilities. The production of large, observatory telescopes continued at Jena with the first joint Zeiss telescope project being a contact signed in November of 1991 to produce a 1 meter telescope (the 13th instrument of the design made at Jena since the first one made in 1971) with control system and a 12.5 meter dome for the European Space Agency. The Carl Zeiss Jena GmbH Division of Astronomical Instruments worked with the Carl Zeiss, Oberkochen APS Division.

Although the production of relatively small achromatic and apochromatic refractor telescopes of up to 15cm, and catadioptic systems of up to 18cm, all with a variety of accessories at Jena would continue until 1994 when it was realized that Zeiss could not compete in the world market; the Zeiss "APQ" refractor telescopes optics were among the finest in the world but the inability to Zeiss to adapt these products promptly to the realities of a free marketplace assured their demise.

In mid April of 1992 at the "Opto 92" European optoelectrics symposium in Paris, the optical metrology departments of Carl Zeiss, Oberkochen and Carl Zeiss Jena displayed their products as a unified Zeiss for the first time. Also in 1992 the publication "Zeiss Information" and the "Jena Review" were combined to produce the publication: "Zeiss Information with Jena Review" bearing the copyright logo and "Carl Zeiss, Oberkochen, and Carl Zeiss Jena, GmbH, Jena". Also in 1992 the "Reta-Sport A" measuring instruments was announced bringing in a new generation of distance measuring instruments geared especially to sporting events such as those held at the Olympic Games.

In the meantime, research and development continued to show results. In 1994 Zeiss announced navigated microsurgery with

MKM which permits more accurate and gentler brain surgery with an "electronic pilot". In 1994 Zeiss also announced the "Night Owl" series binoculars in 7x45B, 8x56B, and 10x56B. These represented a new level of technological achievement. Featuring wider angle views than predecessors, a new "super achromatic" objective lens, "Phase Corrected" Abbe-Koenig prisms, light transmission of at least 91%, and nitrogen filled composite housings reinforced with fiberglass to assure high endurance. In September 1994 Zeiss announced the first "Contax" 35mm rangefinder camera with interchangeable lenses made since 1959; the "G1" features include auto focus with any of four optional lenses, TTL metering, automatic film advance of up to 2 frames per second, and a luxurious titanium body.

Zeiss Sales Volume and Employees Worldwide Trend from 1989/90 to 1994/95

For 1995, the tradition of innovation continued with the introduction by Zeiss of the "Axiophot 2", the world's first computer controlled photomicroscope.

In May 1995 the high-tech companies Leica in St. Gallen (Switzerland), and Carl Zeiss in Oberkochen (Germany) signed a letter of intent to pool their electron microscopy resources in an independent joint venture. The focus of the new company is the onward development, manufacture, sales and service of scanning and transmission electron microscopes.

The shareholders' agreement for the founding of the new joint venture "LEO Electron Microscopy Ltd." (LEO) was formally signed on September 12, 1995, ahead of the originally envisaged schedule. LEO officially commenced trading on October 2, 1995 following the approval of the German antitrust authorities (Bundeskartellamt, Berlin). The contract incorporating the new company was signed at the German Society of Electron Microscopy annual meeting in Leipzig by the CEOs of the parties, Dr. Peter Grassmann (Carl Zeiss) and Dr. Markus Rauh (Leica). A parallel announcement of the founding of the new company was made at the EMAG conference held at the University of Birmingham.

Leica and Carl Zeiss each hold a 50% share in LEO, with operating subsidiaries in the UK, Germany, France and the USA. Dr. Peter Grassmann, CEO Carl Zeiss was nominated Chairman of the Board of the new company; Raghuvir Kalbag, a UK national, Chief Executive Officer. R. Kalbag comes to the company from the international headquarters of Leica in St. Gallen where he is a Member of the Corporate Management, and brings with him experience in the field of electron microscopy going back to 1976. They were supported by a management team drawn primarily from Carl Zeiss and Leica. Worldwide representation is provided through the existing Leica and Carl Zeiss sales channels and a network of independent dealers.

The existing facilities in Cambridge and Oberkochen for R&D, production, marketing and service of electron microscopes would be carried over into the new company. This decision maintains the long history of expertise and knowledge in transmission and scanning electron microscopes in the two sites where these technologies were pioneered. It was envisaged that LEO will employ about 350 people world-wide, including those in the distribution and service networks, with a turnover of over 50 million pounds sterling.

Carl Zeiss dissolved their amateur telescope division located at Jena in the Fall of 1995.

By 1996 Carl Zeiss indicated an organization of five groups: Microscopy, Medical Systems, Consumer Optics, Industrial Metrology, and Opto-electronic Systems.

In 1996 Zeiss announced new lens systems for semiconductor production to permit future fabrication of 256 megabyte DRAM memory chips, and the "SILEX" experiment with Zeiss telescopes for the testing of optical telecommunication in space.

A number of events and products commemorate the 150th anniversary of the Carl- Zeiss-Stiftung (Carl Zeiss, Oberkochen and Schott Glasswerke, Mainz). Several of these events were noted at our ./news.html"Current Zeiss News" Internet Site page. Also, Carl Zeiss announced a limited edition binocular specially produced to commemorate the 150th anniversary. The binocular chosen is possibly the most successful, and popular of the Zeiss Dialyt series. Only 1,000 binoculars will be made. Finished in the finest grade of Nappa Leather in brown, with the serialized current ZEISS logo in 18 carat gold, the eyepiece and objective rings in 18 carat gold plate, in a deluxe brown leather case with snap closure, and a personalized wood presentation box bearing the owners name for $3,395.00.

With the high living and salary standards of the West German economy, and the pressures on that economy to subsidize and modernize the former East Germany, and need to meet the competition from abroad (most notably from Japan, and the United States), there has never been so many challenges to the once dominant Carl Zeiss firm. In fact 1996 finally showed a profit for the unified Zeiss thereby indicating a good measure of recovery from the impact of unification.

In April of 1997 the Astro-Physics Company, Baader Planetarium, and Company Seven announced the availability of a limited quantity of new production Carl Zeiss "Abbe Orthoscopic" oculars for astronomical telescopes. This marked the first production of such accessories since when Zeiss dissolved their amateur telescope division in the Fall of 1995.

There is little doubt that Zeiss will continue their traditions of excellence and innovation. Today the Carl Zeiss trademark remains a symbol of traditional values and innovation in optics technology.

Today, the unified Carl Zeiss Stiftung is a worldwide organization with representation in over 100 countries.

The author of this article (Martin C. Cohen) can not accept credit for much more than compiling the information in this paper, as credit for the content actually better placed with a variety of sources of knowledge and enthusiasm. Among these are the contributors to the Zeiss Historical Society journal (most notably by Larry Gubas, Nicholas Grossman, Wolfgang Pfeiffer, William Stone, Joachim Arnz, Charles Barringer, Thomas Schreiner, Maurice Zubatkin, Hans-Jurgen-Kuc, and many other fine authors) and other publications geared to enthusiasts and historians, U.S. military records, and ultimately to the current and former employees of the Carl Zeiss organizations including Lucas VanHilst, and their families.

Corrections or additions are invited. The writer also wishes to clarify that this by no means a comprehensive discussion, and that many individuals deserving credit for innovation and Contents