The Magazine from Carl Zeiss

ISSN 1431-8059

Innovation

13

- Anniversaries in Medicine
- Shapes and Colors in Art and Nature
- Images like Music

We make it visible.

Contents

Epochal Events Celebrated in 2003

Looking back at some of the outstanding events that took place a hundred and fifty, one hundred, and fifty years ago, there is much to celebrate and remember in 2003. Many of these discoveries changed our lives forever and will continue to have a decisive influence on developments and events in future.

Science and technology

Carl Zeiss has worked in the interests of health for more than a hundred years. Just fifty years ago, in 1953, it gave the world the first Carl Zeiss operating microscope made in Oberkochen.

1903 saw the birth of the company suggestion scheme at Carl Zeiss, and product development and manufacturing has been enjoying the benefits now for one hundred years. Suggestions for improvement assist in optimizing the product development cycle and cutting down on the supplies needed in the manufacturing process.

Celebrating its one hundredth anniversary this year, the world's largest exhibit of natural sciences and technology, the Deutsche Museum in Munich, was the model for numerous renowned institutions such as the Chicago Museum of Science and Industry and the National Science Museum in Tokyo. It provided the inspiration for *Umberto Eco's* world bestseller *Foucault's Pendulum*, and it was at the instigation of the Museum's founder, *Oskar von Miller*, that Carl Zeiss built the first projection planetarium in the 1920s.

A twelve-second flight in 1903 marked the beginning of the unstoppable progress of motorized aviation. On December 17, 1903 the brothers *Orville* and *Wilbur Wright* left the ground for the first time in human history in a motorized aircraft controlled by human hand.

But perhaps it was the brief article just one page long that appeared in the science magazine *Nature* on April 25, 1953 that announced the most profoundly groundbreaking discovery of the last century. In this article *James Watson* and *Francis Crick* described the structure of nucleic acids and called it a double helix. The three-dimensional model of the heredity material DNA looks like a twisting rope ladder, and the discovery of the structure cracked one of the most vital secrets of life to usher in the century of the gene.

Art and nature

One hundred fifty years ago the Dutch painter *Vincent van Gogh* first saw the light of day, and in his short lifespan of 37 years produced more than 800 sketches, watercolors and oils. Auctioned for a record price of 82.5 million dollars, the picture of his doctor *Paul Ferdinand Gachet* is still the most expensive work of art of modern times.

In 1853 the German emigrant *Henry Engelhard Steinway* established his legendary piano factory Steinway & Sons in Manhattan, New York. The first piano was sold for 500 dollars and is now exhibited at the Metropolitan Museum of Art in New York.

The Rochester Institute of Technology is celebrating one hundred years of photography courses at its school of photographic arts and sciences.

Politics and world history

The first mass uprising in the territory of the former Soviet bloc was an important landmark in German history too. The day before June 17, 1953, a handful of construction workers protested in East Berlin against the ten-percent increase in work norms. On June 17 protests, strikes and demonstrations were held all over East Germany. The uprising was one of the crucial events that affected the course of relations between the two Germanies until reunification in October 1990.

In 1953 for the first time in the history of the English monarchy a coronation ceremony was broadcast on television and radio. On June 2, 1953, hundreds of thousands of viewers watched as *King George VI's* eldest daughter was crowned *Elizabeth II* in Westminster Abbey in London.

In the same year came the long awaited news from the Himalayas that the New Zealander *Edmund Hillary* and his Nepalese sherpa *Tenzing Norgay* had conquered the summit of the 8850-meter high Mount Everest, the highest mountain in the world.

September 2003

Dr. Dieter Brocksch

1853

1903

1953

2003

Innovations for Health

The first Carl Zeiss product in the field of optical medical systems was the binocular corneal microscope, which was developed by *Siegfried Czapski* in 1898. This ophthalmic examination instrument was based on a stereomicroscope developed by Carl Zeiss in collaboration with *S. Greenough*. The xenon light coagulator was presented in 1957 and made it possible for the first time to use light not only for examination, but also directly for the treatment of the diseased eye – this formed the basis for Carl Zeiss' entry into the field of laser medical systems in 1984. Today, two out of three surgeons worldwide work with a surgical microscope from Carl Zeiss.

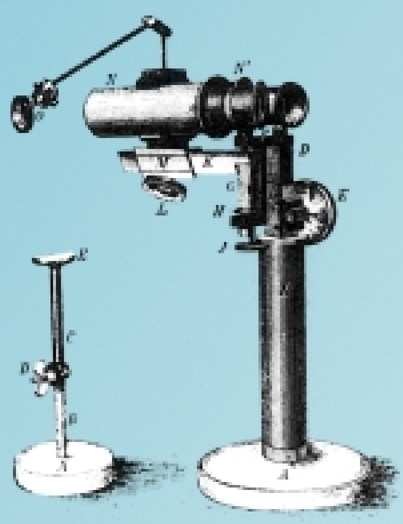
After the Second World War surgical microscopes and light coagulators from Carl Zeiss in Oberkochen made medical history. A new arrival was added to the already comprehensive range of medical instruments: in 1953, the **OPMI® 1** surgical microscope, developed at Carl Zeiss, laid the foundation for modern microsurgery. **OPMI® 1** was the first surgical microscope to offer coaxial illumination and stereoscopic viewing.

History and tradition

Surgery – derived from the Greek word "cheirourgikos", the craft of healing – is one of the oldest branches of medicine, and was even performed by primitive peoples. The Talmud mentions amputation, artificial limbs and wound suture. As early as the 2nd century the Indians knew about urethral extension and rhinoplasty. Since the time of the Greek doctor *Hippocrates* (460 – 370 BC) we have known about the "ubi pus ibi evacua" treatment principle (where there is pus, there evacuate). However, it was not until the 19th century with its discoveries and insights in the areas of antisepsis and anesthesia that surgery was able to develop into the essential and familiar branch of medicine that it is today.

Hippocrates was the founder of medicine as a science. He laid the theoretical and practical foundations for a form of medicine based on empirical and rational principles. Today the name *Hippocrates* is still associated with the oath that forms the basic moral code for the medical profession. The *Hippocratic* Oath obliges the doctor to do everything he can to benefit and protect the patient and to avoid any action that may disturb the mental and physical equilibrium of the person entrusted to his care.

Galen (129–199) (also known as *Claudius Galenus* or *Galen of Pergamon*), personal physician to *Marcus Aurelius*, was a Roman doctor of Greek origin who was regarded as a child prodigy because he had already written three books by the age of 13. To win fame, he demonstrated his surgical skill in public. *Galen* earned such a high standing for Greek teachings on the four humors that



they even became part of a religious dogma.

Abù'Alì al-Husayn Ibn Sina, known as *Avicenna* (980 – 1037), is regarded by many as the father of modern medicine. He was not just a physician, but also a philosopher, mathematician, mineralogist, geologist and poet.

The major textbook "Chirurgia Magna" was written by *Guy de Chauliac* (around 1300 – 1368) and is probably the most comprehensive compendium of all the medical knowledge of that time. The motto of surgery "Tuto, cito, jucunde" – "as safely as possible, quickly and as pleasantly as possible" – is found in the border of the title page of *Avicenna*'s "Canon Medicinae", printed in 1608.

The "Feldtbuch der Wundarzeney" by *Hans von Gersdorf* (around 1450 – 1529) conveys knowledge and medical tradition dating from the time of the transition from the Middle Ages to the modern era. Whilst his anatomical knowledge was still handed down from *Galen*, in the field of practical surgery he was an innovator. The illustrations in his "Feldtbuch" show a range of complex and technically sophisticated "extension devices" and a range of surgical instruments. The emphasis is placed on treatment techniques and sophisticated devices, the body appearing merely as a functional structure that can be "fixed" mechanically. There is no mention of elementary emotions, cruelty and pain during operations.

One of the first surgeons to succeed in bridging the gap between academic medicine and skilled practice, thereby enhancing the status of the profession, was French surgeon *Ambroise Paré* (1510 – 1590). In 1543 he published his findings in French under the title "The Treatment of Gunshot Wounds". These went directly against the methods of treatment previously employed and triggered a scientific controversy.

An early treatise on "plastic surgery" appeared in *Gaspare Tagliacozzi*'s (1546 – 1599) publication "De curtorum chirurgia" in 1597. This described, among other things, the reconstruction of a nose after the punishment of having your nose cut off.

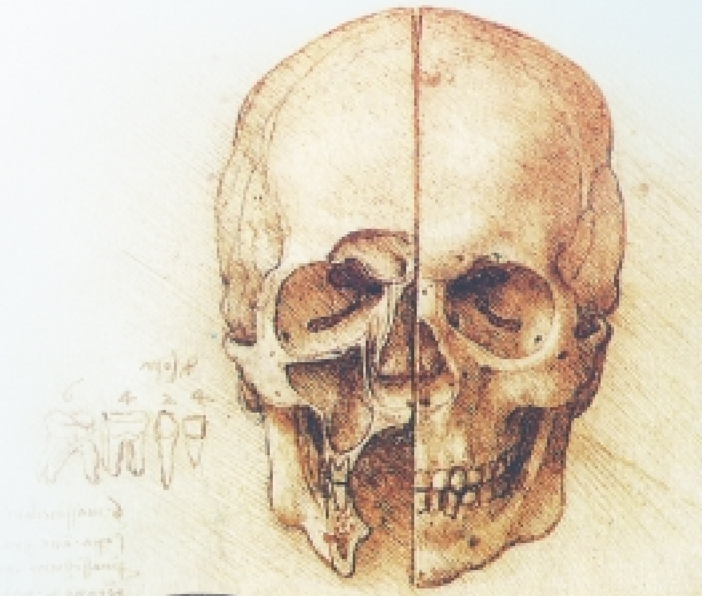
In medieval Europe surgery was practiced by barbers. Medieval surgery was surgery resulting from war and accidents. It was often limited merely to the cauterization of wounds, the setting of fractures and amputations. Surgery was considered a skilled trade rather than a profession. The "real" doctors – doctores medicinae – clearly disassociated themselves from this kind of "hands-on" work. The rise of surgeons to academic recognition was a gradual process that started in the 16th century, and was confined to certain regions. Specialist literature in local languages (French, Italian, German etc.) was not written and printed until the second half of that century,

"Once you have performed an operation using the microscope you will no longer want to do without it."

Carl Olof Nylén

Figs 1a to 1e:
(from left to right) Heinrich Westien's Binocular Corneal Loupe, Heinrich Westien's headset magnifier, Siegfried Czapski's corneal loupe, loupe from Carl Zeiss and the OPMI® 1 surgical microscope from Carl Zeiss.

Figs 2a to 2c:
Maya scalpel,
“Cranial section” from the “Atlas of anatomical studies”, *Leonardo da Vinci*, “Serratura” (leg amputation) woodcut from the “Feldtbuch der Wundarzeney” by *Hans von Gersdorf*.



Surgery

Surgery is regarded as the science of operative treatment and is one of many specialist areas of medicine. It comprises wound care and the operative treatment of illnesses or physical defects by means of mechanical or instrumental intervention in the living human body. Surgery is divided into the specialist fields of abdominal surgery (or visceral surgery), chest surgery (thoracic surgery), cardiovascular surgery, pediatric surgery, oral surgery, head and nerve surgery (neurosurgery), cosmetic (plastic) surgery and accident surgery (traumatology).

Microsurgery

Microsurgery is a surgical technique that makes it possible to perform operations on the smallest vessels, nerves and organs with the help of special optical aids such as loupes or surgical microscopes. Microsurgical techniques are employed in particularly sensitive areas, such as the eyes or cranial region, and are essential for eye surgery, organ transplants and the reattachment of severed body parts.

and consequently only then became available to lay surgeons. It was not until 1743, with the founding of the “Académie royale de Chirurgie” in Paris, that surgeons achieved equal status with physicians.

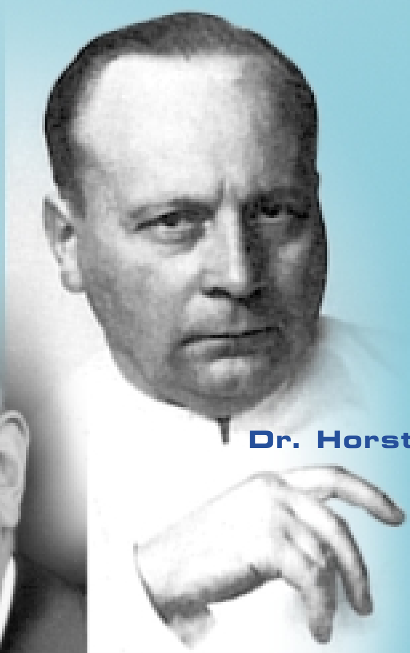
The main upholders of education in medieval Europe, the clerics and monks, were not allowed to practice any medical activity. The 4th Lateran Council in 1215 expressly prohibited all clerics in major orders from carrying out any kind of surgery. After a long ban on dissection during the Middle Ages, the attitude of the Church changed: *Pope Alexander V* was dissected in 1410. Eventually, in 1556, the theological faculty of the University of Salamanca declared that “the opening up of the human body is useful and therefore permitted to Christians”.

Leonardo da Vinci made more than 750 anatomically accurate drawings. His aim was to attempt to understand man as a whole. This serves as an example of man’s awakening interest in the human body in the 16th century. Nevertheless, *da Vinci*’s anatomical studies remained by and large unfamiliar to most of his contemporaries. His findings did not follow on from any tradition, and did not bring about any change in science.

Pioneers of microsurgery

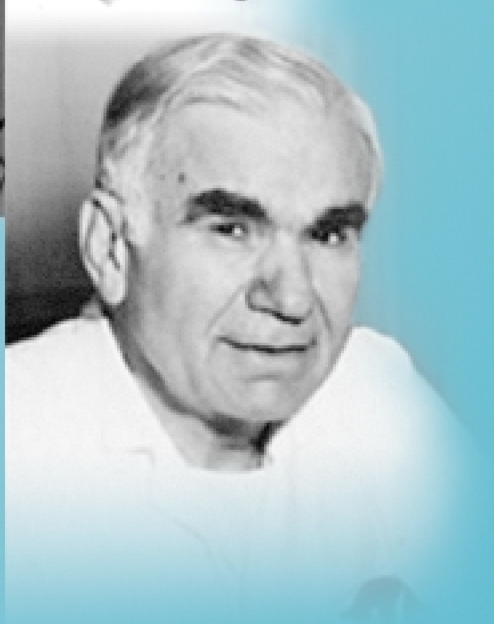
Surgery took an upturn in the 19th century as a result of the discovery of ether (1846) and chloroform (1847), the discovery of microbes as pathogens in wound suppuration (*Louis Pasteur, Robert Koch*) and the discovery of antisepsis and asepsis.

In spite of constant improvements in microscope technology, until the end of the 19th century nobody regarded the use of a microscope as really necessary in surgery. The loupes developed at this time were used in clinics for diagnostic purposes and sometimes also in operating rooms.



Dr. Horst L. Wullstein

Hans Littmann



Dr. Mahmut Gazi Yasargil

The French optician *Chevalier* designed a loupe in 1838 and 1843 that made it possible to achieve 6-10x magnification at a free object distance of up to 7 cm. Rostock court engineer *Westien* developed double loupes that could be attached to the head and worn during surgery. In 1886 *Westien* built a binocular instrument for the Berlin zoologist *Schultze*, to be used for dissection work. The Director of the Rostock University Eye Clinic, *Karl Wilhelm von Zehender* (1819 – 1918), modified this instrument for ophthalmic diagnosis purposes. *Von Zehender* paved the way for the University Eye Clinic in Rostock and is today regarded as the founder of ophthalmic surgery. He was the first ophthalmologist to operate successfully using the Binocular Corneal Loupe, a binocular, microscopic magnifying optical system (in 1886). The forefather of the surgical microscope was thus born, and *von Zehender* is consequently described today as one of the pioneers of microsurgery. This was the beginning of the slow, gradual further development of surgical methods and specialist optical instruments that culminated in the modern surgical microscope.

It was more than thirty years after *von Zehender*'s report on the use of optical systems during operations before other reports of microsurgery with the help of optical instruments appeared. *G. Holmgren*'s assistant, *Carl Olof Nylén* (1892 – 1978), built the first surgical microscope from a simple, binocular, slightly modified stand microscope at the University Ear, Nose and Throat Clinic in Stockholm in 1921. The instrument was used during microsurgery for the first time in November of that year, to deal with two cases of chronic otitis with labyrinthine fistula. Since then *Nylén* has also been regarded as one of the fathers of microsurgery.

50 Years of Surgical Microscop

Nylén's superior and tutor *G. Holmgren* (1875 – 1954) took up his student's idea. In 1922 he modified a binocular microscope from Carl Zeiss by adding a light source and a stand device that allowed it to be used for fenestration operations.

Almost another thirty years later *Horst L. Wullstein* (1906 – 1987), who was unhappy with the inflexible dissection microscopes being used at that time, built a surgical microscope of his own that offered much improved movement. It was mounted on a stand, equipped with a rotating arm and offered 10x magnification for ear surgery.

One of the few women to make history as a microsurgical pioneer was *Rosemarie Albrecht* (1900 – 1996) from Jena. Even before 1950 she was using a colposcope for the diagnosis and early recognition of cancerous changes in the oral cavity and larynx region. In 1950 developers at Carl Zeiss in Jena modified the colposcope for laryngeal diagnosis at *Albrecht*'s suggestion.

The first surgical microscope

Under the guidance of physicist *Hans Littmann* (1907 – 1991), initial prototypes of the **OPMI® 1** surgical microscope were produced at Carl Zeiss in Oberkochen in the early 1950s. This microscope was soon developed to meet all of the fundamental requirements of surgical technology at that time: an adjustable working distance, coaxial illumination, magnification changer (*Galilean* changer), binocular tubes with various angles of inclination, and possibilities for mounting co-observation and documentation devices.

Horst L. Wullstein also contributed ideas to the development of the surgical microscopes designed by *Littmann*. The **OPMI® 1** surgical microscope then had its first public appearance in 1953 when *Wullstein* presented it at the world congress in Amsterdam. This was the decisive public breakthrough for the surgical microscope in the field of otology.

It quickly caught on in existing areas of microsurgery. *H. Herrmann* (1900 –1996) introduced the **OPMI® 1** into nasal surgery as early as 1958. *Heinrich Harms* (1908–1987) and *Günter Mackensen*, the co-founders of modern ophthalmic microsurgery, improved the possibilities for using the microscope in ophthalmic microsurgery from the 1960s onwards with their suggestions on technical modifications to the **OPMI® 1**, such as the arrangement of instrument components, illumination, adjustment and focus.

With the development of the **OPMI® 2** surgical microscope in 1965, motorization arrived in the operating room. Motorized focus and zoom systems simplified and facilitated microsurgery considerably.

The optical possibilities offered by the surgical microscope formed the basis for the development of new specialist fields, such as neuro-microsurgery. *Mahmut Gazi Yasargil* (*1925) is regarded as the father of neuro-microsurgery and was elected

es from Carl Zeiss

"neurosurgeon of the century" by the American Association of Neurosurgeons in 1998. In 1967 *Yasargil* performed the first intracranial vascular anastomosis and developed special microsurgical instruments and methods for recording operations. This period also saw the development of the **NC 1** stand by Contraves and Carl Zeiss. Weight compensation makes it possible to move the optics to the desired position easily during the operation. This stand technology is still recognized as the gold standard in neurosurgery today. The electronic piloting system on the **MKM** surgical microscope (1992) offers the user targeted navigation around the operating area during neuro-microsurgery. The **OPMI® Neuro Multi Vision** surgical microscope (2000) creates the ideal basis for the ergonomic integration of a range of additional information. The doctor has all the key data from other instruments involved in the procedure, such as endoscopes and data from tomography systems, available "online", in a similar way to a pilot using the display instruments in his cockpit.

Today all surgical microscopes stand out thanks to their optimum user comfort, optical brilliance and seamless integration into the operating environment. Numerous accessories, such as foot and mouth switches and camera systems for documentation, expand the possible areas of application in all fields of microsurgery.

[*www.zeiss.de/surgical*]

Fields of application and initial use of microsurgical techniques		Milestones in the design of surgical microscopes at Carl Zeiss
1921 Microsurgery of middle ear 1923 Colposcopy	**1920**	
	1930	
1942 Ophthalmology	**1940**	
1953 Facial surgery 1955 Microlaryngology 1958 Paranasal sinus surgery	**1950**	1953 OPMI® 1 First surgical microscope
1961 Vascular microsurgery 1962 Neurosurgery 1968 Microsurgery in gynecology	**1960**	1965 OPMI® 2 First motorized focusing and first motorized zoom
1971 Microsurgery of lateral skull base 1973 Cochlear implants 1973 Reconstructive and reimplantation surgery 1977 Urology	**1970**	1976 Contraves NC1 Stand Effortless motion through counterbalancing
	1980	**1984 Wide angle optics for OPMI®** **1985 Voice control for OPMI®** **1988 OPMI® CS** for ophthalmology
	1990	**1992 MKM** Navigated neurosurgery with electronic pilot system **1994 OPMI®ORL** for ENT microsurgery **1996 SMN Navigation System** for microsurgery **1996 OPMI® PRO** for oral and maxillofacial surgery
	2000	**2000 OPMI® Neuro MultiVision** Superimposition and projection of digital diagnostic data directly into the eyepiece **2001 OPMI® Vario/ NC 33** for minimally invasive spine surgery **2002 OPMI® PROergo** Dental Microscope **2002 OPMI® Sensera** for ENT surgery

The Spiral-shaped Ladder of Life

Ursula Loos

Exactly 50 years ago, *James D. Watson* and *Francis C. Crick* described the double helix forming the 3D structure of DNA – for which they received the Nobel Prize a few years later. As carrier of hereditary information, DNA or deoxyribonucleic acid controls the development of a fertilized ovum into a complex, fully functional organism and has permitted the wide variety of life forms to develop throughout the course of evolution.

***Watson* and *Crick* pushed science that decisive step forward, which ultimately led to the rapid development of genetic engineering. This is why 1953 marks a milestone in the history of biology. While this branch of science was rather insignificant in the first half of the twentieth century, it now points the way to the future of medicine thanks to its numerous application possibilities, and has also become a promising branch of industry.**

The role of DNA

However, the history of molecular biology begins a good 100 years earlier. *Watson* and *Crick* would never have achieved what they did without the many discoveries made in the second half of the 19th century and the first half of the 20th century. After all, it remained to be clarified at that time which molecules in the cells actually store and pass on the hereditary information.

The Augustinian friar *Johann Gregor Mendel* found out that certain traits (later called "genes") can be passed on independently of each other. The molecules found in the cell nucleus were named nucleic acids. DNA consists of very long chains of many linearly connected elements (nucleotides). There are four different nucleotides in DNA – depending on which of the following bases they contain: adenine, guanine, cytosine and thymine.

However, it was not until the middle of the 20th century that clear evidence was provided that genetic material definitely consists of DNA – and not of proteins which were long considered as candidates for this role. Furthermore, various observations permitted the conclusion that one gene contains the information for one protein. Later on, *Linus Pauling* showed that a modified (mutated) gene can cause changes to a protein and thus result in a disease. It still remained to be clarified how the hereditary information is passed on to the next generation.

Only after the Second World War did the electron microscope become a standard instrument in science. Experiments revealed DNA as a long, thin, non-branched molecule. In the early fifties, chemical examinations finally showed how the DNA modules, the nucleotides, are linked to each other, thus revealing the backbone of the long molecule. However, the question of spatial arrangement of the nucleotides remained completely in the dark. Is there regular repetition of the four different bases? How can DNA store the required information and play its role as the carrier of hereditary information?

In 1951, *Erwin Chargaff* observed that the bases are not available in identical quantities: adenine was about as frequent as thymine, while the quantity of guanine approximately corresponded to that of cytosine. He also observed that DNA of different species contains different base combinations. In fact, *Chargaff*'s findings implied that genetic information must be stored in the base sequence.

1844–1895

Friedrich Miescher

130 years ago, the Basel physician Friedrich Miescher *for the first time isolated a substance from human pus cells, or more precisely from their cell nuclei, which he called nuclein.*

However, the importance of his discovery was not to become obvious until many years later. Today, we know this substance as nucleic acid and as the carrier of genetic information.

1873

1877–1955

Oswald Theodore Avery

Oswald Avery *was the first to show that the agent responsible for genetic transferring is the nucleic acid and not protein.* Avery *and his team extracted a substance from a bacterium with a smooth surface and introduced it into a rough-surfaced bacterium. When the rough-surfaced bacteria transformed into the smooth-surfaced type,* Avery *knew the substance he had extracted contained the gene that coded for the smooth surface.* Avery*'s team purified this substance and found it was pure DNA.*

Double helix – the answer to the question

X-ray structure analyses were used to finally clarify the spatial structure of linear DNA. In the early fifties, *Maurice H. F. Wilkins* and *Rosalind Franklin* examined the diffraction patterns of DNA, and Franklin finally found the decisive clue to the helix structure. However, the diameter observed was too large for a single molecule: DNA had to consist of two intertwined chains!

By building 3D models of DNA, *Watson* and *Crick* finally discovered the spatial arrangement of the two chains of nucleotides and how they are held together: the two chains form a double helix. The base sequence is irregular and specific to one person only – and can thus store the specific hereditary information of every individual with a high degree of variability.

It was magnificent that this DNA structure also seemed to make it clear how genetic information can be doubled: the individual chains of a double helix are the matrices for the daughter strands to be newly formed. In 1962, *Watson* and *Crick* won the Nobel Prize in Medicine together with *Wilkins*. Later on, *Watson* wrote a vivid description of the race for the DNA structure in his book "The Double Helix".

Genetic engineering made possible

Further discoveries followed in rapid succession: in 1958, the mechanism for the replication of genetic information could be definitely verified, details of gene regulation became known in the sixties, and the genetic code was cracked soon after.

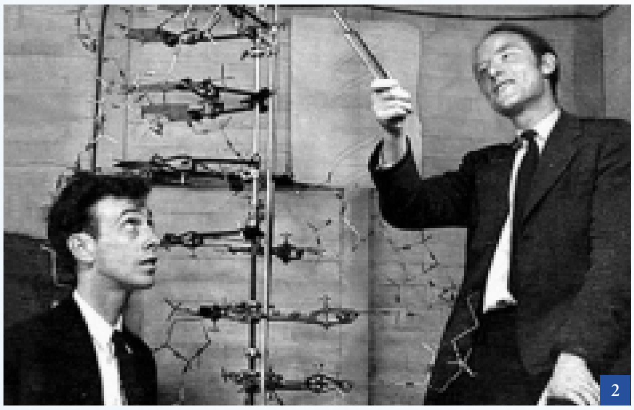
Since a DNA molecule is too long for further analyses, enzymes were searched which are able to cut DNA into short, defined fragments. The first of these so-called restriction enzymes could be isolated in 1970, which permitted the cloning of genes and therefore opened up the way for all further developments in genetic engineering. For the purpose of cloning, a certain gene – the human insulin gene for example – is inserted into a bacterium. If the bacterium divides, the human gene is also multiplied, and finally the bacteria – acting like a tiny factory – generate the relevant gene product, i.e. the protein. In the late seventies, *Stanley Cohen* and *Herbert Boyer* cloned the gene for human insulin in this way.

However, scientists were worried about the reliability of such biological experiments at a very early stage. In 1974, an appeal to all scientists was therefore published in the renowned "Science" journal to continue these

Fig. 1:
Rosalind Franklin's X-ray structure-analyzed structure B.

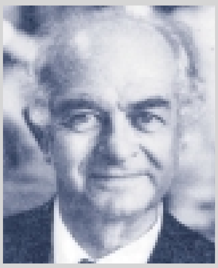
Fig. 2:
James Watson and *Francis Crick* with their molecule model.

1



2

1901 – 1994



Linus Carl Pauling

Linus Carl Pauling *examined the structures of crystals and molecules. His research results basically changed the idea about molecular structures, for which he was awarded the Nobel Prize in chemistry in 1954.*
On the basis of data obtained from X-ray diffraction analysis he developed the hypothesis in the 1940s and 1950s that proteins might be arranged in a helical pattern.

1935

1906 – 1981

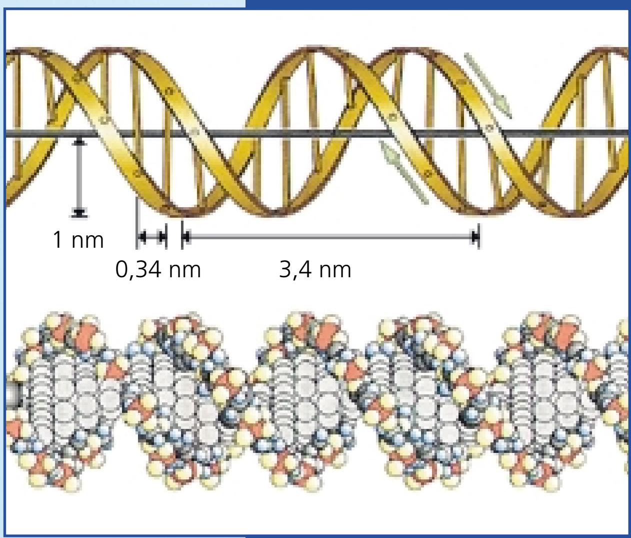
Max Delbrück

Max Delbrück *organized a meeting of scientists, physicists and biologists in Berlin in the 1930s, to which he also invited the Russian geneticist* Timoféeff-Ressovsky *and the physicist* Karl Guenther Zimmer. *In 1935 they jointly published the ground-breaking paper "On the Nature of Gene Mutation and Gene Structure" which has now become classic reading material. In this publication, Delbrück proposes for the first time a gene model. By linking two sciences – biology and physics – which so far had existed only side by side, he also made a first step towards modern molecular biology. In 1969 he was awarded the Nobel Prize in medicine together with* Alfred Herschey.

Details

DNA – deoxyribonucleic acid

The DNA contained in almost every cell nucleus is the hereditary substance of almost all creatures. The DNA molecule is made up of two intertwined molecule strands between which approx. 100,000 parallel connections are arranged like the rungs of a ladder. The two longitudinal strands alternately consist of the deoxyribose sugar molecule and a phosphate group.



The rungs of the ladder are made up of four different bases: adenine, thymine, guanine and cytosine. If the genetic information is considered as a text, the bases correspond to the letters of the alphabet. The sequence of the various bases on the DNA strand forms the words of the "genetic text". Three successive bases (triplet) in DNA form the code for a certain amino acid. Other triplets of DNA contain start or stop information for proof-reading enzymes. These produce copies of parts of the genetic information which on their part serve as building instructions for proteins. If the entire DNA of a human cell were linearized, it would measure about 2 meters. It consists of about six billion individual components. If printed, the resulting library would contain 2,000 books each of 1,000 pages à 3,000 words.

experiments only if the health risks can be calculated. As a result, a worldwide moratorium was founded for certain experiments involving recombined DNA. During a conference in Asilomar in February 1975, more than one hundred internationally renowned scientists discussed possible risks and recommended concrete guidelines. For example, it was allowed to use only those bacteria which are unable to live outside the test tube.

Finally, human insulin could be produced in large quantities through genetic engineering. For the first time now, it was possible to use a genetically produced drug! Until then, insulin drugs had been isolated from pigs or cattle, and many patients showed an allergic reaction to these drugs. Genetically engineered insulin, however, is identical to human insulin and therefore causes no rejection reaction. The expectations and hopes in research and industry for medical and economical success had thus been met for the first time.

In the USA, this was followed by a boom in the biotechnology industry, with many new companies being founded. After this, there was a consolidation phase with company mergers, bankruptcies, and acquisitions by large drug manufacturers.

1920–1958

Rosalind Elsie Franklin

Rosalind Franklin *is considered to be the real discoverer of deoxyribonucleic acid (DNA). In 1950, she started to set up an X-ray crystallography unit at King's College in London. Furthermore, she did research work in the field of DNA as part of a research program headed by* Maurice Wilkins. *In early 1953,* Franklin *correctly interpreted the images she had obtained herself as an indication of a spiral-shaped DNA structure.*

* 1916

Maurice Hugh Frederick Wilkins

In 1950, Maurice Wilkins *started x-ray diffraction studies of DNA and sperm heads and discovered the DNA molecule seemed to have a defined double spiral structure.* Rosalind Franklin *was also a member of his research team. Together with* Francis Crick *and* James Watson *he was awarded the Nobel Prize in Physiology in 1962.*

1953

The attempts of the German biotech industry to catch up with the American market were finally crowned with success in the late nineties, also leading to a boom in the founding of start-up companies, partially state-subsidized – and again a consolidation phase is expected to take place in the course of the next few years.

Chances and risks

In medicine, in molecular diagnosis for example, genetic methods led to enormous improvements in the differentiation of diseases. For example, a differentiation between certain forms of breast cancer can only be made in molecular biology. However, this is crucial for the patients. The genetic change defines the therapy and the prognosis. This is similar with other diseases where various techniques facilitate the diagnosis.

One of these techniques is the polymerase chain reaction, PCR. In the mid-eighties, *Kary Mullis* had a brilliant idea which revolutionized genetic engineering. PCR dispenses with cloning, and permits the direct and therefore time-saving replication of a specific DNA fragment. Furthermore, this highly sensitive method permits the detection of minute DNA quantities: in forensic science, for example, tiny drops of blood or a single hair found at the scene of a crime are now sufficient to convict a suspect. And DNA fragments from insects trapped in amber for millions of years help in providing evolution biologists with the answers to their questions.

Fluorescence in-situ hybridization (FISH) is a very attractive optical technique in prenatal diagnosis and also in the follow-up care and therapy monitoring of cancer diseases. Fluorochromed probes permit the visualization of genetic changes. Individual genes can be traced on the chromosomes and fluorochromed, or entire chromosomes can be fluorochromed and compared under the microscope.

Many hopes are pinned on gene therapy treatment of diseases currently considered incurable. If the change of a gene in a certain disease is known, scientists can try to repair the gene defect by insertion of the "healthy" gene, for example. Here, the so-called stem cells could play a special role because they are still able to transform into very different cells. It is hoped that this will enable the cultivation of replacement cells for therapeutic use.

However, molecular diagnosis and medicine have not only positive aspects, but also provide problems of ethics. Who would like to know at an early age that he is likely to get an incurable disease later on? How should anyone cope with this knowledge? A further aspect is that it cannot be excluded that medical data is misused by employers and insurers.

The public opinion about "green" genetic engineering, i.e. the use of this technique in agriculture, is often unfavorable and the subject is discussed critically. Research targets include, for example, resistance to varmints or weed killers; possible risks with the insertion of new genes in plants include allergies to new substances in the food chain and harmful effects for the environment and other organisms.

Bioinformatics and the chip technology

The nineties saw the beginning of a new era when the systematic sequencing of the entire human genome started. Two major groups formed which were competing with each other: an international, government-funded group (the so-called HGP – Human Genome Project headed by *Francis S. Collins*) on the one hand, and the company Celera Genomics with *J. Craig Venter* as

1905 – 2002

Erwin Chargaff

It is Erwin Chargaff *to whom we owe the first basic knowledge about the chemical composition of DNA. He discovered the regularity of the base composition of DNA for different species. In all organisms, the amount of adenine equals that of thymine, and the amount of guanine equals that of cytosine. Together with the X-ray crystallography image data of DNA from* Rosalind Franklin, Chargaff*'s scientific findings formed the basis for one of the greatest discoveries of the 20th century, the double helix structure of DNA.*

*** 1928**

James Dewey Watson

In cooperation with Francis Crick, James Watson *discovered the structure of DNA at the Cavendish laboratory of Cambridge University in 1953. This marked the birth of modern genetics on a molecular level. Together with* Francis Crick *and* Maurice Wilkins *he was awarded the 1962 Nobel Prize in Physiology.*

1962

Figs 3a to 3c:
Chromosome analysis, Brightfield image (**3a**). False-color image (**3b**). Assortment and allocation of chromosomes for analysis (**3c**).

director on the other hand. After years of bitter competition, *Collins* and *Venter* announced in mid-2000 that they are able to jointly present the draft version of the three billion base pairs of the human genome.

The data flood obtained by sequencing requires entirely new methods of data storage, analysis and interpretation, which created the new bioinformatics field of science. Biologists and IT specialists are now jointly researching biological problems using IT methods.

The human genome has now been sequenced more or less entirely. But what does this mean? Although we know the pure DNA sequence – approximately three billion chemical letters – we do not yet understand its meaning. Only three percent of DNA correspond to genes – and some of these 30,000 human genes have yet to be identified. It remains to be discovered for which proteins these genes are coding, what tasks these proteins perform in the organism and what role they play in diseases, for example. In these cases, they might be the starting point of drugs. Therefore, these questions are not only of academic interest, but there is also hope in the biotech and pharmaceutical industries that this molecular data will provide information about diseases and possible drugs. Here, there is promise of business totaling billions of dollars where diseases such as cancer, diabetes, rheumatism or Alzheimer are concerned. Already about twenty-five percent of all the drugs available on the market are produced biotechnologically.

Two further technical developments – miniaturization and automation – facilitate the functional analysis of the human genome. DNA chips permit thousands of measurements to be performed simultaneously, e.g. to clarify the question which genes are active in which cells or what does the gene pattern of a certain patient look like? By now, it is known that drugs can have a positive or negative effect, depending on the genetic disposition of the individual concerned. So-called pharmacogenomics are aiming for the tailor-made drug. If the specific genetic pattern of a patient is known, it might perhaps be possible one day to provide him with the perfectly fitting drug. But that's all still pie in the sky.

Dr. Ursula Loos, Biologist
Ursula.Loos@gmx.de

*** 1916**

Francis Crick

Francis Crick cooperated with James Watson in the discovery of the DNA structure which was published in 1953. They used X-ray crystallography and models to show that the basic structure of DNA molecules is a double helix, or an intertwined ladder. Together with James Watson and Maurice Wilkins he was awarded the 1962 Nobel Prize in Physiology.

1983

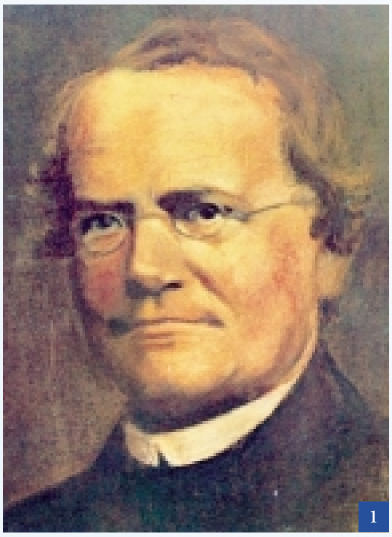
*** 1944**

Kary Banks Mullis

In 1983, Kary Mullis developed the polymerase chain reaction (PCR) and, in 1993, was awarded the Nobel Prize in Chemistry together with Michael Smith for the development of outstanding methods in DNA chemistry. The PCR method has revolutionized DNA technology. PCR amplifies very small amounts of DNA sequences, and the amplification produces an almost unlimited number of DNA molecules suitable for analysis or manipulation. PCR has allowed screening for genetic and infectious diseases. Analysis of DNAs from different populations, including DNA from extinct species, has allowed the reconstruction of phylogenetic trees including primates and humans.

Genetics Founded by an Augustinian Friar

In 1865, the Augustinian friar *Johann Gregor Mendel* (1822–1884) held two lectures in Brno/ Czechoslovakia that were unspectacularly entitled "Experiments with plant hybrids" (cross-breeding experiments with plants). His audience was sympathetic, but uncomprehending. In 1866, the paper was published in the "Verhandlungen des Naturforschenden Vereins in Brünn für das Jahr 1865" (Proceedings of the Natural History Society in Brno). The journal was distributed to 120 university libraries and natural research associations. *Mendel* himself sent 40 reprints of his paper to experts he knew. And yet nobody realized that a system of genetic information units still valid today had been discovered then. *Mendel* called these units "factors". Today, they are known as hereditary factors or genes.

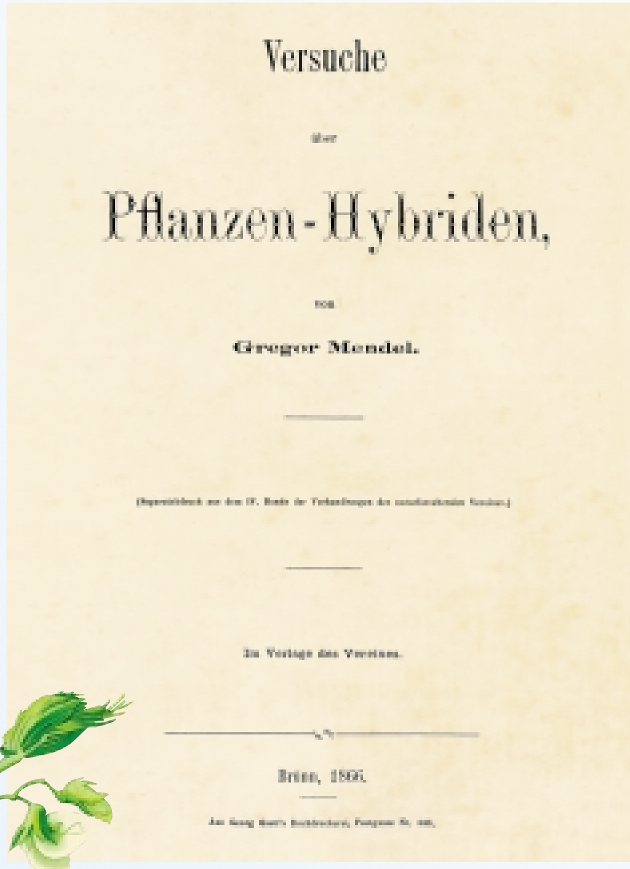


1

In 1854, *Mendel* started selecting suitable species of garden peas, or Pisum sativum, from the abbey's garden, which he could use for cross-breeding experiments. He focused his studies on such characteristics of the pea plants or seeds which can be clearly differentiated: white flowering or red flowering, yellow or green seeds. *Mendel* performed the cross-breeding by transmitting pea pollens of one species to pea stigmas of the other species.

What was new in *Mendel*'s cross-breeding technique was the large number of plants. From 355 artificial fertilizations he obtained 12980 hybrid plants, providing him with reliable results about the regular segregation of traits. His interpretation was new and ingenious.

The interrelation between inheritance and chromosomes (or the genotype or DNA) was not known in *Mendel*'s times. At first, no notice was taken of his pioneering achievement by other researchers. It was only in 1900, 16 years after his death, that other biologists independently rediscovered *Mendel*'s findings, confirmed them and made them generally known.



Versuche

über

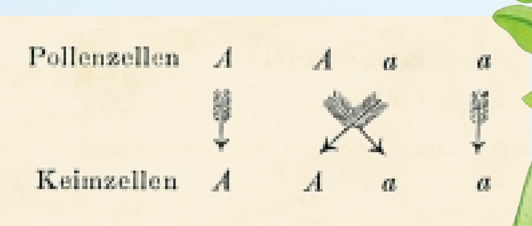
Pflanzen-Hybriden,

von

Gregor Mendel.

Im Verlage des Vereines.

Brünn, 1866.



[www.zeiss.de
www.mendel-museum.org
www.mpiz-koeln.mpg.de]

High Profile Measurement

Andreas Hahnen

Metal profiles can be found in many everyday products. They are not usually visible, but they provide the necessary reliability and stability. If they are made of aluminum, their weight is reduced and the stability is maintained or even improved. This is the reason why car manufacturers are tending to use more and more aluminum profiles in the construction of automobiles. Modern intercity trains are another important field of application. Aluminum profiles are used for cooling electronic components in radios, TV sets and computers, for guiding mechanical components in printers and for modernizing the design of window and door frames.

Fig. 1:
Whether in the automotive or electronic industry or in the construction trade – exacting demands are made on aluminum profiles.

Increase in time and cost

To ensure that aluminum profiles really meet the requirements made on them, it is absolutely essential that functionally relevant dimensions conform precisely to specifications, no matter how complex the profile contour may be. Deviations from the specified parameters caused, for example, by tool wear, temperature and material fluctuations, must be identified by quality assurance as soon as possible during the production phase. The immediate correction of dimensional shortcomings avoids the production of rejects – costs which would have to be borne also by the consumer.

The time presently required for checking the constantly increasing number of different profile shapes and the costs this entails are very high and are getting higher all the time. In part, this is also due to the different production quantities for varying requirements. Until now, several cost-intensive work stages were required for measuring aluminum profiles. First, a profile sample was extracted from the current production by a sawing process. To eliminate errors in the subsequent measurement on scanners or projectors, this sample had to be square, sharp-edged and shorter than 2 cm. This entailed a great deal of manual work before the actual measurement, with the added risk of injury to the operator due to the thin cutting sections. These checking methods used for years are no longer adequate to meet the critical demands made on fast and precise verification. The measuring instruments were sensitive to dirt, heat and dust, and therefore had to be set up in metrology rooms sometimes far removed from the production environment.

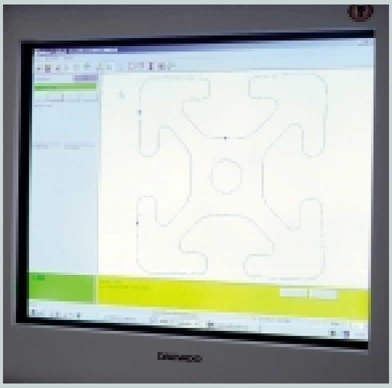
Hand in hand with users

Ascona Consulting and Applications GmbH of Meckenbeuren at Lake Constance was looking for a technology able to reduce the increases in time and cost that profile manufacturers are faced with. As a specialist for innovative optical 2D and 3D measuring techniques, Ascona GmbH developed a new method of measuring profiles that makes allowance for the market requirements of profile manufacturers. The measuring system can also be utilized in the steel and plastics industries, in other words, anywhere where profiles are produced and machined.

The "special optics" solution

The centerpiece of this measuring system called Contur Projector 290 is the **Visionmes®** telecentric objective lens specially developed by Carl Zeiss for such applications. It features an exceptionally large object field of 290 mm. The high-tech quality of the lens guarantees high measuring accuracy over the entire object field. The combination of hardware and software, integrated illumination and an array camera permit highly efficient measurement and analysis of different profile sizes, for example of extruded aluminum profiles, with unchangingly high quality.

Innovation starts right at the beginning when the sample is prepared. As the objective lens is mounted horizontally, the samples no longer have to be absolutely plane, right-angled and free from any sharp edges; the burr caused by the cutting process is simply removed by grinding or brushing. The preparation of each sample therefore no longer takes five minutes, but only one. This alone saves several hundred hours of valuable working time per year and lowers the overall costs considerably. The maximum permissible



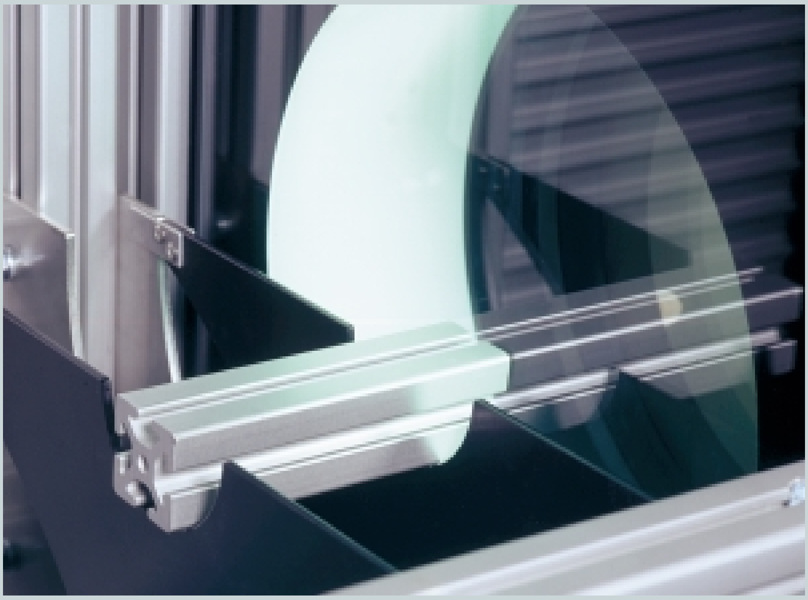


Fig. 2:
High-quality measured data is instantly available for evaluation and analysis.

Fig. 3:
The **Visionmes®** telecentric objective lens from Carl Zeiss with an object field of 290 mm. In addition to this special lens, Carl Zeiss offers other telecentric lenses for different profile sizes. Ascona GmbH offers dedicated solutions for these specific applications.

sample length is now 20 cm, which totally excludes the possibility of injuries during sample preparation.

Another major benefit is the actual measuring time itself: work that used to take 15 to 20 minutes with traditional projectors and mechanical processes can be done in two minutes using the telecentric objective lens from Carl Zeiss. This is the time required to capture and evaluate the complete contour of the testpiece, allowing you to implement immediate production control measures and, if necessary, to interrupt the production process if deviations develop in any functionally vital dimensions. This may amount to an almost 20-minute reduction in reject production with costly material.

Results the simple and direct way

Designed for use directly on the shopfloor, the Contur Projector 290 also reduces transport routes. It does not contain any sensitive mechanical and moving elements, and if it is optionally equipped with an anti-vibration and an air conditioning system, it can stand up to any environmental challenge.

Outstanding ease of use is a special plus of the system. Production operators place the profile in the measuring system without having to align it in any way, and the result is available for evaluation and analysis in next to no time at the push of a button.

The first Contur Projectors were delivered in 2002. In metrology processes alone, approx. 70 % of the previous costs were saved in this way, added to the reductions resulting from the much lower reject rate in production. Another benefit is the availability of more precise information for effective process control for Quality Management, providing the possibility of identifying and eliminating problems in connection with tools at a very early stage.

The new technology offers great potential for drastically reducing reject production in the profile manufacturing industry and for streamlining process control. In the long term, this will have a positive effect on the costs of all products incorporating profiles.

Andreas Hahnen is responsible for Marketing and Sales at Ascona GmbH.
ahahnen@ascona.de
www.ascona.de

Information on Carl Zeiss telecentric objective lenses and modules from Joachim Petermann, Optical Components
petermann@zeiss.de
www.zeiss.de/optics

Fig. 4:
The architecture of the building housing Hensoldt AG in Wetzlar, a company in the Carl Zeiss Group, is characterized by aluminum. Hensoldt has been manufacturing the Zeiss binoculars and riflescopes since 1964.

Exactly to the Point

Nina Berlin

The new FIVE product allows the revolutionization of the technology incorporated in variable message signs. Here, SCHOTT Fiber Optics and Carl Zeiss are working together hand in hand.

The display changed every few seconds: first the number "90" appeared in white, then a red "x", followed by a green arrow. It sounds like a traffic sign along the highway, but it is in fact a test device in the R&D laboratories of the Fiber Optics Division of SCHOTT Glas in Mainz. Here, researchers are working to fulfill a number of demands: "With this new technology, we want to achieve more than just traffic signs," says *Wolfgang Streu*, Project Manager at SCHOTT Fiber Optics. At exactly that moment, the display shows a yellow "smiley", a task which would be too much to handle for the conventional variable message signs now in use in Germany. FIVE – the new, future-oriented project at SCHOTT – is the big exception.

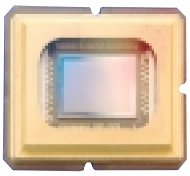


Fig. 1:
DMD chip from Texas Instruments.

Engineering genius

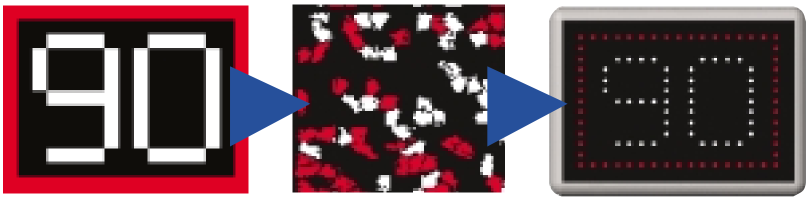
The catchy working title FIVE is an acronym for "Fiber Optical Information & Visualization Equipment", and in simple terms it means using a projector and a bundle of glass fibers to transmit information, which is then made visible on a display. This concept is not new, of course. Luminous traffic signs made with glass fiber optics are already in use today. But these signs have their limitations in terms of projection and resolution. Each light point can only be used for one signal. Red is always red, green is always green. This static approach only allows a limited number of signals.

SCHOTT's new development, however, has all sorts of untapped possibilities because developers have been able to overcome the weaknesses of the old systems. For one thing, a single light source is sufficient with FIVE. In a stroke of genius, SCHOTT engineers – together with their colleagues at Carl Zeiss – were able to break down the light beam into red, green, blue and white with the help of a so-called color wheel. From these primary colors it is possible to represent up to 16.7 million colors, a number that computer fans know from the color setting of their monitors. And thus FIVE is able to offer the same broad color representation. As it continues on its path, the dispersed light beam strikes a DMD chip, similar to those used in modern projectors. "This chip is about the size of a postage stamp," says physicist *Ekkehard Gaydoul*, who is one of the inventors of the FIVE system.

"Fingerprint" technology is the answer

However, the scientists still had one hurdle to overcome before achieving representation on the display: directing the path of the light through the glass fiber to the right position on the display. This procedure is not a problem, for example, when using a mini-matrix with four light points. The glass fiber that receives the light beam at the upper left also transmits it to the upper left of the display, and reproduces the light signal there too. "But even our test model had a matrix of 13 by 17, or 221 points. To connect each single point by hand is complicated and very time-consuming," explains *Wolfgang Streu* – and thus too costly. Furthermore, four to six times that number, i. e. between 800 and 1250 image points, were planned for the commercial application. "We had to find another method of correctly coordinating the image points," says *Streu*."

"Fingerprint" technology ultimately offered the solution. "In the first step, a fine light beam is used to determine the path it will take through the glass fiber bundle," explains *Gaydoul*. The beam with the entry coordinate A 1 will emerge, let's say,



Figs 2a to 2c:
This is how **FIVE** works: The image to become visible on the display appears on the computer monitor (**2a**). Special software then breaks down this image in apparent chaos… (**2b**)… which is then transformed back into the original image by the glass fiber matrix. (**2c**). The **FIVE** system permits displays which are unlimited in form and color.

at G 8. "The arrangement is completely random and because of the large number of glass fibers, different for every unit. That is why it is called a fingerprint."

Like a puzzle in a mixer

Software developed by SCHOTT stores this apparent chaos and then breaks down the image or the signal that one wants to represent with FIVE. In keeping with the above example, for instance, the light information that should appear at the G 8 field of the display will be directed by the software to the A 1 field, based on the stored fingerprint. Here it is fed into the optical system.

The effect is amazing. The signal fed into the unit looks like someone had thrown a puzzle into a mixer. But at the end of the process, which is performed just once for each display, the finished image appears on the screen with each point at the right spot. A patent has been applied for this process.

The advantages of the entire system are quite obvious:

- Every image point can assume every color.
- The outside temperature has no influence on the color intensity.
- The light intensity does not decrease over time (no light degradation).
- The housing of the display can be kept very thin, since only the fiber optic light guides – and no electronic components – are assembled there. Nor are any additional devices required (such as ventilators).
- The system is easy to maintain because the technical parts and the display are kept apart. The few working parts, and especially the lights, are easily accessible for replacements.

The possible applications extend far beyond traffic technology. One possibility would be to use this technology in signage with large numbers of individually triggered, light-emitting points, such as passenger information on railroad platforms. And because of the enormous optical flexibility, more sophisticated applications are also feasible, for example FIVE displays as advertising vehicles. Product Manager *Wolfgang Streu* is optimistic: "We have great expectations for our new development."

Nina Berlin, SCHOTT Glas, Fiber Optics Division
nina.berlin@schott.com

Ekkehard Gaydoul
ekkehard.gaydoul@schott.com
www.schott.com/fiberoptics

Norbert Diete,
Carl Zeiss, Optical Systems Business Unit
diete@zeiss.de
www.zeiss.de/optics

Details

For more than five years, what are known as Optical Engines – i.e. optical systems in data and video projectors - have been developed and produced at Carl Zeiss in Jena. The functional principle of this projection technology is called DLP – Digital Light Processing – and is based on the DMD technology (Digital Micromirror Devices) developed by Texas Instruments, where moving micromirrors are the image-forming elements. As components of a consistently digital technology, these systems are used in application fields which far exceed projectors. Here, it is possible to fully utilize the competencies in the field of high-performance optics developed by Carl Zeiss over many years and to implement them in innovative technologies, permitting entirely new applications in fields like biotechnology, printing technology, microlithography and rapid prototyping. The above article describes a very interesting and promising example – use in traffic control systems and similar display systems.

Fig. 3:
The position of the reflector on the DMD chip determines whether the light beam will be transmitted through the projector lens to the display or absorbed.

Chinese Terracotta Army: Not Gray, but Br

Susanne Krejsa

For around 2200 years they had remained intact: the magnificent colors of the famous terracotta warriors in Lintong, China, near the provincial capital of Xi'an. But now, the warriors lose their color as soon as they catch a glimpse of the light of the outside world. The question of why this is happening, and how it can be prevented, is the subject of a joint research project being undertaken by German and Chinese scientists and restorers.

Almost 30 years ago the terracotta army was discovered quite by chance; it soon became famous the world over and is lauded as the "eighth wonder of the world". It forms part of the tomb construction of the First Chinese Emperor *Qin Shihuang* (259 – 210 BC), which was included on UNESCO's list of world heritage sites in 1987. Even at the time the excavation started in 1974, the remains of colorful decorative painting were observed. This painting consists of a layer of East Asian lacquer (Chinese: Qi, Japanese: Urushi), which is used as an undercoat and a brilliant dark brown color. A colorful layer of mineral pigments (predominantly valuable ones), such as azurite, malachite and cinnabar, along with antimonate, ocher, bone white and lead white, was applied on top. Chinese blue (han blue, $BaCuSi_4O_{10}$) and Chinese violet (han purple, $BaCuSi_2O_6$) were also used. These are barium copper silicates, the method of whose manufacture was only known in China. The detection of these unusual pigments on the terracotta army is currently the earliest example of their use that can be precisely dated.

A stable painting technique

A thoroughly stable painting technique was used for the terracotta army. It had to be the best, long-lasting and luxurious, and therefore a technique was used that had already been tried and tested. East Asian lacquer is resistant to pretty much anything, except for UV light and excessive dryness over a long period. Painting an entire army with this highly expensive and hard-to-obtain material is testament to the Emperor's high demands. The pigment layer applied on top was bound using a watery binding agent, which today can no longer be identified. 2200 years of storage in moist earth – the underground corridors of the graves (which were originally filled with air) are likely to have collapsed relatively quickly after completion – resulted in constituents of the binding agent breaking down and water being deposited. As they were completely surrounded by earth, however, the colored layers retained their original form. Today, when the earth is removed, the pressure disappears and the lacquer layer is able to move and become deformed. The water evaporates, reducing the volume, and the lacquer cracks.

Drying out has to be prevented

After 12 years of German-Chinese research it was possible to resolve the problem of the flaking lacquer layers in principle. The speed of the excavation was reduced so that preservation measures could actually be performed in the grave itself. The colored figures are cleaned of the moist earth in small sections and immediately sprayed with water. The cleaning process has to be performed with extreme care and therefore takes considerable time. Then the figures are covered with moist compresses

ightly Colored

Fig. 1:
Colored warriors in grave 2.

Photograph:
Mr *Zhou Tie*, Museum
of the Terracotta Army,
Lintong

2a

2b

Figs 2a to 2c:
Head of a warrior from grave 2. For reasons that are not yet clear the warrior has a green face.

Photographs:
2a: Mr *Zhou Tie*, Museum of the Terracotta Army, Lintong.
Other figures:
Bavarian State Office for the Preservation of Historical Monuments, Munich (*Catharina Blänsdorf*).

Figs 3a and 3b:
Fragments of a figure immediately after excavation (3a), and after cleaning and drying of the colored layer without preservation.

Figs 4a and 4b:
The microscopic photographs show cracked lacquer before (**4b**) and after the preservation treatment (**4a**). After successful preservation the lacquer is flat and sticks to the terracotta, but the cracks remain visible.

Fig. 5:
In a cross-section under the microscope the use of unusual pigments (in this case han purple, cinnabar and azurite, for example) in the painting of the figures can be clearly detected.

made from soaked cotton wool. This results in the water that is present in the lacquer layer being exchanged for the non-volatile PEG 200 (polyethyleneglycol, a substance based on the antifreezing agent ethylene glycol), with an adhesive being added to fix the lacquer layer to the terracotta. Fine cleaning of the figures is then performed in the museum laboratory using microscopes, and individual parts are reinforced. In the case of the warrior with the green face (Figure 2c), the treatment of the head alone took three months.

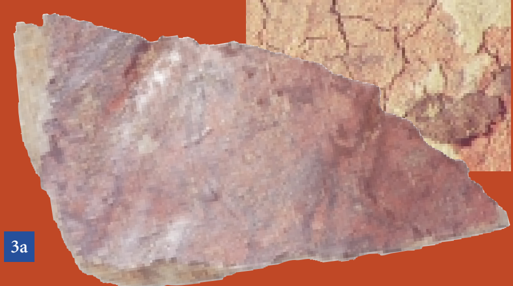
A newer method involves the incorporation of a synthetic material based on an acrylic ester (HEMA, 2-hydroxyethylmethacrylate, similar to plexiglass PMMA, polymethylmethacrylate). This is applied as a monomer, i. e. in the form of small individual molecules, and is subsequently hardened into a polymer. The low-viscosity liquid, which can be mixed with water, can penetrate the lacquer and simultaneously forms a bond with the terracotta surface. The overall procedure is complex and costly, as the polymerization requires an electron-beam system. Nevertheless, the results achieved with this procedure, which so far has been performed on individual fragments only, are very good.

However, there is still a long way to go before all of the problems have been solved. Current tests are focusing on improving the procedure so that it can be adapted to best effect to the various tasks and the climatic situation on site. New excavations in the tomb construction are also throwing up new preservation problems all the time.

Lost expressiveness of the eyes

The painting, which was originally radiant, emphasizes the finely crafted details of the uniforms, physiques, hair, moustaches, hands, feet and faces, to which the Chinese artists had devoted so much attention. Under the microscope you can see how the polychromy was built up: on top of the dark brown Qi lacquer is a thick pigment layer. The skin sections often also contain two pink-colored layers, usually in different shades, to create a slightly translucent effect. Slight shading was used to emphasize the expression of the faces and give them a true-to-life look. The eyebrows, moustache and hairline were painted using fine black strokes. The artists also took advantage of the differences in glossiness between the Qi lacquer and matte paint layers: the finely modeled hair, in shiny black lacquer, formed a vivid contrast to the colorful, material-like, matte hair bands. The pupils, also in black lacquer, sparkled. On top of the clothes, with their radiant and contrast-rich colors, is the armor, which has been lacquered like the original leather armor. All of this gives the observer the impression that the figures are practically able to breathe and move.

4a



3a

4b

3b

5


2c

Details

The Terracotta Army of the Chinese Emperor

The site of the find consists of three graves. The arrangement of the figures could provide clues as to the military tactics that succeeded in destroying all opposing States and uniting 40 million people under the Chinese Empire. Here the warriors were used to guard the route of the procession, which leads to the Emperor's grave 1.5 km away.

Grave no. 1 covers around 14000 m² and contains the main army: 7000 warriors, horses and chariots in a straight-line formation, facing the enemy East. In front are three rows of lightly armed warriors, who form the advance guard, with 38 teams of warriors, horses and chariots behind them

Grave no. 2 is around 6000 m² in size and contains four small units in an L formation. This comprises kneeling and standing archers, chariots and cavalry.

Grave no. 3 is the smallest, covering 520 m², but is also the most important: it probably forms the army's command center – the warriors in this grave, who are only equipped with blunt (i.e. ritual) weapons, are sentries or a guard of honor for the Emperor.

Many more finds are expected

With a great deal of time and effort, it has so far been possible to preserve the decoration on around 20 figures. In many other cases, however, it has been irretrievably lost or at best only partially retained. Around 1500 figures have already been excavated, and other graves from the area of the tomb construction are being discovered and opened every year. The "problem" with the terracotta army and other finds from the tomb construction lies in the techniques and material combinations used, which are unusual even for China, and in the incredibly high number of finds. However, it is already becoming apparent that this tomb construction will not remain an isolated case. The terracotta army comprises four of more than 100 known additional graves, of which only a small proportion have been excavated. The region around Xi'an will keep archaeologists and restorers busy for generations: around 100 emperors are buried there in huge tomb constructions, beneath earth pyramids or in rock chambers.

The Chinese-German project "Research and testing of preservation methods for cultural assets of the province of Shaanxi" has been financed using funds from the BMBF (German Federal Ministry for Education and Research) since 1988. It is due to run until at least the end of 2006.

A **Stemi® 2000 C** stereomicroscope, an **Axiolab®** transmitted light microscope and an **Axiophot®** reflected light microscope camera from Carl Zeiss have provided valuable assistance in preserving the terracotta army, including the earth constructions, and in investigating and identifying materials such as pigments, fabric and wood.

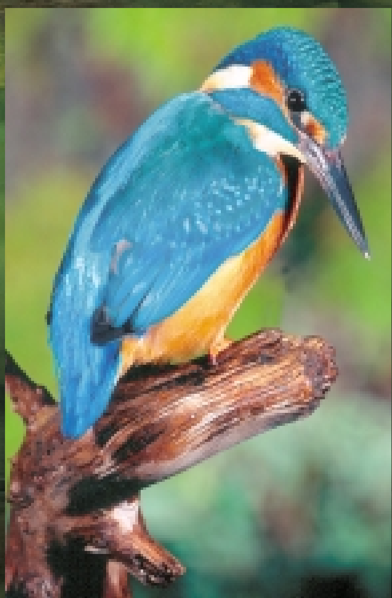
Dr. Susanne Krejsa
susanne.krejsa@chello.at

Catharina Blänsdorf, Bavarian State Office for the Preservation of Historical Monuments
Catharina.Blaensdorf@blfd.bayern.de

www.bmy.com.cn/index_eng.htm

Alcedinidae – Kingfishers

Alcedinidae are a family of birds comprising approx. 90 species in 15 genera which can be found all over the world, many of them in tropical and subtropical areas. Usually plumaged in bright colors, the birds range in size from 10 to 50 cm. Besides their brilliant coloring, they also have three other features in common: a long, strong bill, a large head and short legs which altogether give them a stout appearance. Kingfishers nest in tree or ground cavities where they bring up their nidicolous young. Depending on the region where they live, kingfishers are resident or partially migratory. Most species hunt on land for insects and small vertebrates, while some have become plunge-diving fish hunters. This means that the habitat of these species must be located near water – ponds and streams with dense vegetation on their banks.

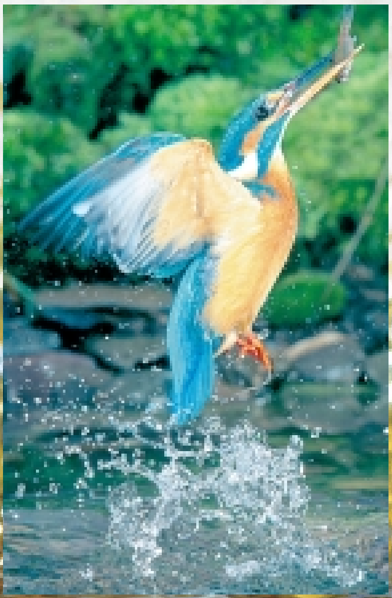


Worldwide distribution

The members of the *Alcedinidae* family distributed worldwide include the giant kingfisher *Megaceryle maxima* in Africa which measures 41 cm. It hovers in mid-air with vibrating wings like a kestrel and mainly feeds on freshwater shrimps. In Asia, the white-throated kingfisher *Halycon smyrnensis* attains a size of 28 cm. Its diet consists of insects, shrimps, fish, frogs, small reptiles, fledgelings and rodents. Australia is the home of two outstanding kingfisher species: the kookaburra *Dacelo gigas* with a size of 46 cm and the red-backed kingfisher *Halcyon pyrrhopygia* measuring 23 cm .

Central European species

The only indigenous species in Central Europe is the common kingfisher *Alcedo atthis*. It lives here as a resident, vagrant or migratory bird and is a solitary animal. *Alcedo atthis* measures approx. 17 to 19 cm and is a fish hunter. It flies at high speed over short distances, in a straight line close above the water surface. Its plumage on the back and head is a striking, metallic greenish blue which changes in hue from blue to turquoise depending on the incidence of light. The bird's breast is of an orange chestnut color with a white spot on the throat, its feet a bright red. The common kingfisher’s area of distribution comprises North Africa and Eurasia, except the northern regions. It nests and breeds in cavities which it digs in steep, clayey banks of clear watercourses or in sand and gravel pits. It is even found near lakes and on the sea coast. Its territory may cover as much as three or four kilometers of a watercourse. The nesting cavities are dug horizon-



tally into vertical banks, the tunnel leading to the nest chamber being 60 to 90 cm long. The female and the male take turns in hatching up to seven white eggs, which takes about 20 days. The nestlings remain in the nest for 23 to 27 days and are mainly fed with small fish and water insects. A kingfisher family with six or seven nestlings may eat as much as 100 fish per day.

Hunting behavior

Watching a kingfisher hunt is a breathtaking sight. A flash of brilliant greenish-blue, it dashes along the river close above the water surface. Or it is perched on overhanging branches at shallow places in wait for potential prey. Having spied suitable prey, it dives perpendicularly into the water with folded wings. With the fish caught in its bill, it beats its wings under water to return to the surface. After surfacing, the bird returns to its perch with its prey and attentively watches the surroundings, the fish still in its bill. Then it kills its prey by hitting its head against the branch or post on which it is sitting. Finally, the bird eats the fish head first, because of the gills, or it takes its prey to its family in the nesting cavity.

A Life with the Kingfisher

Fig .1:
Helmut Heintges in action with his Hasselblad camera and Carl Zeiss 250 mm Sonnar T* f/5.6 lens.

Born as one of ten children, *Helmut Heintges* spent his childhood in a small village in the Eifel region of Germany. In his nature-loving family, he learnt to be an attentive nature watcher from an early age. A box camera permitted *Helmut Heintges* to take his first steps as a photographer, and he took more or less successful shots of roe deer and stags while helping his father with the forest work during school holidays. This was the beginning of a part-time career as a nature photographer. Living near a river, he made the early acquaintance of kingfishers, and the brilliantly colored bird has never since lost its fascination for *Helmut Heintges*.

After years in forestry, he switched to a job in industry in the Cologne area. He was lucky enough to find a riverside property in the nearby Siegkreis district. Again, the shy kingfishers were constant guests on the watercourse.

Helmut Heintges now began to expand his hobby of nature photography on a professional basis. He created three small ponds in his garden and stocked them with fish. And the kingfishers were not long in making their appearance. As a next step, a hide was built to permit the kingfishers to be photographed secretly, without disturbing the birds. Two steep banks with artificial nesting cavities were added shortly afterwards to complete what was practically a typical kingfisher biotope.

As he gradually completed the biotope, *Helmut Heintges* also upgraded his photographic equipment step by step. A complex system of different cameras, light barriers and flash units is now installed around the biotope. What the enthusiastic nature photographer could not obtain through specialized dealers he simply built himself. In spite of one or the other setback, he persistently worked on achieving his great goal: shooting unique pictures of the kingfisher.

Brilliant, fascinating shots are the result of several years of kingfisher photography. In 1992, the first egg lay in the nest. Between 1992 and 2000, kingfishers hatched as often as eight times and reared a total of 52 young.

Fig. 2:
Small pond, observation hut and diving basin with perching branch for kingfisher photography in *Helmut Heintges*' garden.

Fig. 3:
Artificial bank with entry holes of the nesting cavities.

The Kingfisher in Art

Whether in watercolors, color drawings, colored etchings or oil paintings – the kingfisher's plumage shining in metallic blue and turquoise, its orange-chestnut head and breast with the white spot on the throat and its spectacular hunting behavior seem to have such great attraction for artists all over the world that they have made *Alcedo atthis* a frequent motif of their pictures and sculptures. Apart from art, the kingfisher also holds a firm place in superstition. It is often considered a bearer of luck and augmenter of money, and also seems to be of importance as a weather prophet. In bridal pictures, the kingfisher symbolizes faithful love of the spouse. There is the popular belief that the female of the birds which live in couples carries its aged male on its wings, feeds it and looks after it until it dies.

Perched for minutes on a branch near the water before diving for its prey or after a successful hunt, the bird makes an excellent subject for artists. Virtually all pictures of the kingfisher show it sitting on a branch. It is only in rare cases that the bird is captured diving into or surfacing from water, or flying with prey in its bill.

Philatelists from all countries probably possess the world's largest collection of kingfisher portrayals comprising more than one hundred different stamps and stamp series. Even stamps from Macau, Mongolia, the Solomon Islands and the Vatican have been devoted to the kingfisher.

The kingfisher is an attractive, colorful decoration on designer pottery. Bronze sculptures show the kingfisher in different postures. Crystal glass sculptures are ideal to give a vivid impression of the kingfisher's radiant, glittering plumage.

The kingfisher appears not only as a motif in text-related illustrations, but also in the illuminations of magnificent bibles such as the Wenzel Bible. Even the first German still life painter *Georg Flegel* (1566 – 1638) created a painting showing fruit, a kingfisher and a mouse.

Fig. 1:
Painting of a kingfisher by *Vincent van Gogh* (1853-1890), one of the most famous painters today, created in the period between 1886 and 1888 in Paris.

Fig 2:
The kingfisher has been a model not only for glass and metal artists, but also for china manufacturers. It is also a very popular motif on stamps all over the world.

www.zeiss.de
www.bird-stamps.org
www.swarovski.com

Images like Music

When you buy a record or a CD, you usually base your choice on the piece of music, composer or artist in question. But before you even hear a note, the sleeve gives you an initial impression of the content. Does its design perhaps influence whether or not you decide to buy it? *Kornelius Müller*, marketing manager for cinematic and photographic lenses at Carl Zeiss, spoke to photographer *Susesch Bayat*, who specializes in portraits of artists for record and CD covers. With more than 1000 CD booklets, posters and records to his name, he is one of the most active photographers in his industry.

Mr Bayat*, you are well known as a photographer for classical record covers. You come from a Persian-Russian family, but have been living and working in Germany for a number of decades. How did you get into the field of classical music?*

In 1960, after studying architecture in Frankfurt/Main, I went to the Academy for Film, Photography and Advertising in Berlin, where I studied these subjects for two and a half years. Initially I spent a few years working as a cameraman. It was only around 1970 that I took up photography professionally, concentrating to begin with on female portraits, first in black and white, but later in color too.

So you weren't involved with records to begin with?

No. My actual breakthrough as a photographer came at the end of the 1970s with several calendars, for companies including Contax, Carl Zeiss and Mercedes-Benz. People from various industries approached me, including *Meler Markovic* from Polygram International, Deutsche Grammophon. At the time he was their international director for advertising and marketing. Polygram didn't have a photographer in Berlin, and for me this was an incredibly fortunate and decisive moment that resulted in decades of collaboration, not only in Berlin but also on the international stage.

Were you then faced with something new?

I certainly was! The interesting thing was that I had never photographed men before. *Markovic* noticed that after seeing my pictures: "You've only taken pictures of women. Never men?" But I was convinced that I'd be able to do that just as well. My female photography had created the basis that enabled me to place sensitive people in front of the camera and create meaningful images.

And – were you successful?

My customers were happy with the pictures, which meant that my cover photography then took off very quickly. In the 1980s the economy was booming, and during this period, when I moved into the field as a photographer, classical music was also experiencing an unprecedented golden age. There was so much to do, and I was constantly on the move – one day London, the next New York, then Munich and Copenhagen. I was often in the Berlin Philharmonic Hall in Berlin with *Herbert von Karajan*.

Your photographs of artists are not normally taken in the studio?

Unless special photo-shoots had been arranged with the music companies, I often had very little time available. Sometimes you only officially have ten minutes – only rarely do you get one or two hours. I simply tried, during the orchestra's rehearsals, to find a favorable and beautiful subject. I have often set up a temporary studio inside the orchestra areas or inside the hall. The music companies appreciated my flexibility and speed. Artists are often rather difficult people and normally have little time. This means that the photographer has to be able to develop and implement ideas quickly.

So the special skills of a photographer who takes pictures for classical record covers include the ability to create a suitable location for your work whatever the premises?

That's right. Wherever musicians perform, I'm always very quick to spot a suitable backdrop for photos.

Figs 1a to 1c: *Leonard Bernstein* (born 1918 in Lawrence/Mass., died 1990 in New York/ USA) during recordings with the Vienna Philharmonic Orchestra in Vienna.

Figs 2a and 2b:
Herbert von Karajan, conductor (born 1908 in Salzburg, died 1989 in Anif near Salzburg/ Austria).

Figs 3a and 3b:
For record and CD covers several photographs are presented to the artist for selection. Solo violinist *Gidon Kremer* (born 1947 in Riga/Latvia) opted for this portrait for the design of the CD cover "5 Mozart violin concertos".

Even without a studio. To do this, you need to be able to empathize with the artists. I take the time to listen to the rehearsals. The musicians know from their record companies that I can take photographs. And that's why they give me time.

Have there ever been any particularly "difficult cases"?

I'd rather give you a positive example. I obviously couldn't ask *Herbert von Karajan* to come to the studio. But he was very well aware that you need time to take good pictures. He spent half an hour posing with *Anne-Sophie Mutter*, or on his own, and then with other artists. Half an hour, twenty minutes – that was enough time to take a professional picture. *Karajan* was also disciplined, very disciplined, even after two or three days of demanding rehearsal work – one of the most disciplined conductors I have known. He was brilliant, he really was very good! I'm very grateful for the time I spent with him, grateful that I'm one of the few people who has been able to take photographs of him. Another conductor who was an exception was *Leonard Bernstein*, of course, but his charisma was quite different from *Karajan*'s.

When you photograph musicians, you obviously have to understand a great deal about how they think and what they do?

Of course! If you are making a double piano recording, for instance with *Alexander Rabinovich* and *Martha Argerich* and a work by *Rachmaninov*, then the dramaturgy of the cover image also has to be right. You can't photograph in a Romantic style. It needs to look a bit more progressive, harder. That doesn't mean that I have to like *Rachmaninov*, but I need to capture the atmosphere of this music in my picture.

How important is the photo on the cover of a record or CD to whether or not a person decides to buy it?

It's very important! *Karajan* once said: "You can't see the notes." He recognized how important the cover was. In addition to the quality of the music, he also placed a great deal of importance on the image and the overall marketing. He was aware that it is not only the artist's name that sells a record, but also the external design. The sales figures of his records today, more than ten years after his death, show that *Karajan* was right.

Before we see a picture on the cover of a record, countless photo-

graphs are produced, showing the artist with various expressions. Here* Gidon Kremer *seems quite friendly. In the version on the cover, however, he looks much more serious. This pattern can also be seen in other examples of your work. You usually offer your customer a wide range of different images, but often a stern facial expression is the one they go for. Why is that?

I have no influence at all over the designer. He makes a preliminary selection, which includes a number of different facial expressions, and sometimes will certainly also include a friendly one. These images are presented to the artist.

So it's the musician who makes the decision?

That's right. The musician has "the right to his or her own image". And the record contracts dictate that he or she can decide which image will be released. In my personal opinion, image selection should be left to the designer and the photographer, as they know a lot more about the subject. But nothing can be done about it, that's just the way the law is. Mr *Kremer* picked a more serious photo. And it's not such a bad choice.

Whether friendly or serious, from a technical point of view the images are all of the same standard. And that brings us to the technology: What technology, and in particular what camera technology, do you use for record cover photography?

I started out with a 35 mm camera, but for 20 years now I have been working only with a 6 x 6 medium-format Rollei.

Which lenses do you use?

All of the lenses are from Carl Zeiss. I usually use the **Sonnar® 4/150**, **Makro-Planar® 4/120** and **Planar 2.8/80** on the Rolleiflex 6008. But I also use a **Sonnar® 5.6/250** and a **Distagon® 4/40** and **4/50**.

What are the advantages of these lenses over those of other manufacturers?

With Zeiss lenses I can work with a fully opened aperture. They offer a performance that is exceptionally consistent and a particularly high brilliance that I haven't found anywhere else. I often take photographs in very low light. With Zeiss lenses, even under these conditions I can still focus very precisely. Sometimes, if it's raining outside, I photograph indoors against a window. I put the camera on a tripod, take the 80, open the aperture fully and expose for a thir-

tieth of a second. I can rely on the image being of print quality. That really is unusual on the market.

But besides the technology, sensitivity to light is also important. You have to deal with so many kinds of light – artificial light, neon light, daylight, sunlight, flash, soft and hard light – because in most cases you're not able to photograph in a studio.

When these images are reproduced on a CD sleeve they are relatively small. Are your photos ever used in larger formats as well?

The largest images were shown at a Polygram exhibition in New York in a format that was around 1.2 m x 1.2 m. Today lots of new possibilities are available, thanks to computerization and large-format ink-jet printing. Most of the images I have photographed using Carl Zeiss lenses and a Rollei could also be enlarged to 10 m x 10 m and more. It is the high quality of the originals that makes this possible.

Do you also take photographs with Contax cameras?

Yes, I also have a **Contax G**. But once you have worked with a Rollei, that is with a medium-format camera, and with these excellent Zeiss lenses, the results are so outstanding that you stick with them! Zeiss lenses are a real work of art – in terms of design, handling, focusing and quality. But also in terms of weight. It's obvious that you are holding something of real quality. The lenses look good, too. And the quality of the manufacturing is outstanding – all that precision engineering inside! Unfortunately, this is something that many people are completely unaware of.

That's interesting! For you the relative heaviness of these lenses is a sign of good quality! We are often faced with demands for the lenses – or the products in general – to be made lighter.

Absolutely not! If you want light equipment, you shouldn't be photographing using 6 x 6. Nowadays, in the age of digitization, you need to pay particular attention to quality. When major feature films are made today, the action is shot using Arriflex cameras and Zeiss lenses. I've been working with these cameras for many years. Quality-minded camera operators and film producers shoot using these cameras on 35 mm film, rather than using digital. The quality offered today by a 35 mm film or a wider format cannot be matched by digital imaging technology. The time may come when it can. I'm slowly having to get used to the idea that one day I, too, will have to take digital photographs. But when that day comes I'll use a Rollei with Zeiss lenses.

The fact that you insist on using Zeiss lenses, whether analog or digital, must say something about the quality of the product.

Yes, absolutely.

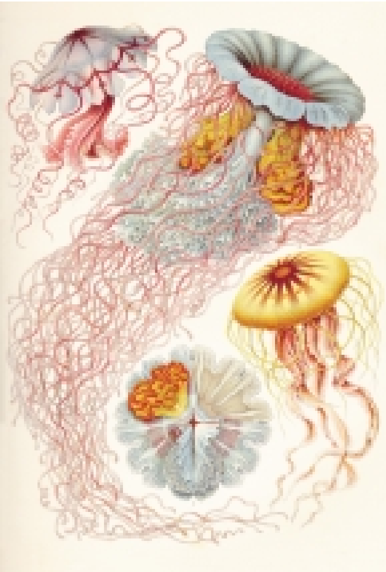
Mr* Bayat*, thank you very much for the interesting interview.

Kornelius Müller, Camera Lens Marketing Department, Carl Zeiss
ko.mueller@zeiss.de
www.zeiss.de/photo

Susesch Bayat
info@vellard.de
www.bayat.trixdata.de

Fig. 4:
For the production of a CD of works by *Antonin Dvořák* and *Richard Strauss* the Berlin Philharmonic Orchestra was joined in the Berlin Philharmonic Hall by: (from left to right) cellist *Mischa Maisky* (born 1948 in Riga/Latvia), violist *Tabea Zimmermann* (born in Lahr, Black Forest/Germany) and conductor *Zubin Mehta* (born 1936 in Bombay/India).

Figs 5a to 5c:
Photographs of mezzo-soprano and Wagner singer *Waltraud Meier* (born 1956 in Würzburg/Germany) for a new CD production.



Discomedusae, *Ernst Haeckel*, Art Forms in Nature, 1899 – 1904.

Buchenwald I, *Gustav Klimt*, Staatl. Kunstsammlung, Dresden.

"The House with the Ocean View", installation by *Marina Abramovic*. A **Diascope®** spotting scope by Carl Zeiss was available for viewing details.

Nature – The Greatest Artist of Them All

Art comes in many forms. Who is not struck with admiration by the images nature has created? We can find aesthetic beauty and skilful craftsmanship in almost all pictures based on or taken from nature without understanding the origins of the work or the details of how it came about. Abstract microscopic and macroscopic images and representations of nature and the environment provide fascinating aspects of and insights into the diverse manifestations of life. Such works, created as if by an artist's hand, are among the many wonders that nature, in her astonishing profligacy, offers. In this way art opens the eye to nature by revealing new perspectives, and arouses thoughts and emotions that suggest new ways of looking at it, new ways of seeing.

**Seek the light
and you will discover the universe.**

William Turner

Exhibition "Ecologies" by *Mark Dion*, Chicago, with a stereomicroscope by Carl Zeiss included in the laboratory equipment.

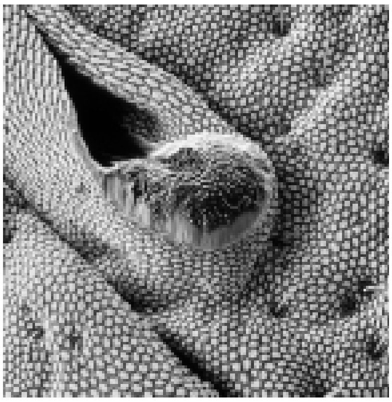
Mankind has always struggled to understand the workings of nature. Nature has been a constant theme in art through the ages. For centuries, nay millennia, men have made pictures reflecting the varied natural forms of life around them. The scenes depicted and their emotional power reflect the times in which they were created and the prevailing circumstances of their creators. The way we view and interpret them is influenced by the time that has elapsed between them and us and the social environment in which we live now.

Art through the centuries

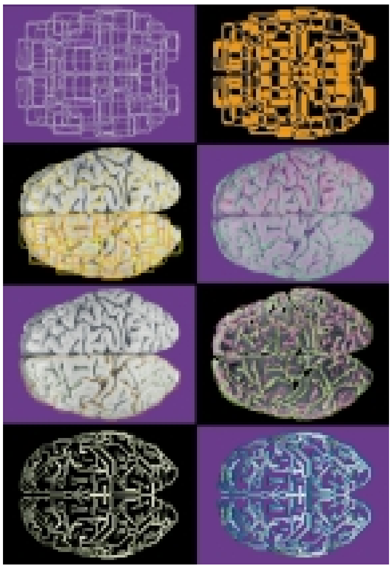
Images and sculptured forms taken from and originating in nature have a timeless appeal. The cave paintings of *Lascaux* in the Massif Central dating to the Paleolithic era fill us with wonder and fascination. When we consider the paintings of the aboriginal peoples of Australia and their closeness to other worlds, it is a spine-tingling experience. The sculptures of *Michelangelo* and the paintings and drawings of *Leonardo da Vinci* fill us with amazement. But motifs from nature appear not only in drawings, watercolors, paintings and sculptures. They find their place, too, in sacred and secular architecture: ornamental foliage on Greek columns, highly wrought animals representing fabulous creatures in Roman and Gothic churches, abstract foliage designs on public buildings and offices and residential apartments in art nouveau style. Even images taken from light or electron microscopes become strangely beautiful through quite random artistic effects, depending on the optical technology used. Incidents from the daily lives of human beings are transformed into total works of art by a combination of human creativity and nature's genius. Nature itself, in its landscapes, plants, animals and apparently lifeless materials, may present images of intrinsic beauty and overwhelming power depending on the point of view and psychological makeup of the viewer. Today artists are increasingly inspired by the environmental sciences, biology, medicine and optics. A number of well known artists use microscopes and other optical instruments in their work.

The farther we penetrate the unknown, the vaster and more marvelous it is.

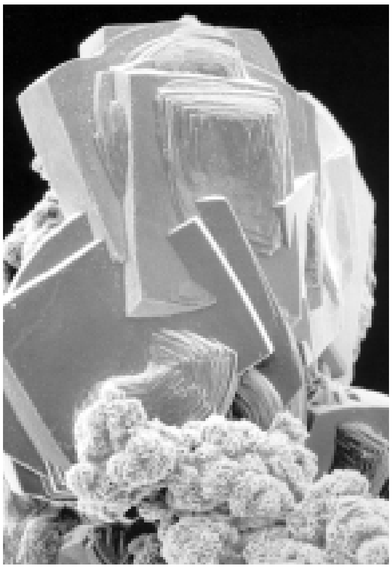
Charles Lindbergh



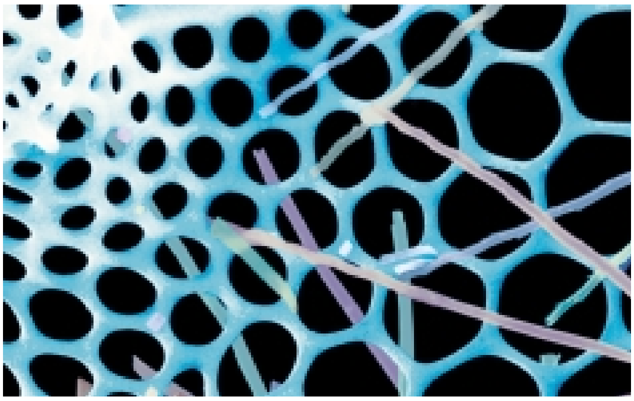
Lacewing – Skin of an African insect, *France Bourély*, scanning electron microscope image, magnified approx. 10,000 times. From the book "Hidden Beauty: Microworlds Revealed" by *France Bourély*.



Circuit Collage, 2000, *Heidi Cartwright*, digital photographs. Prince of Wales Medical Research Institute, Randwick, Australia.



Riff in Lilliput – formation of zeolite crystals, *France Bourély*, scanning electron microscope image, magnified approx. 10,000 times. From the book "Hidden Beauty: Microworlds Revealed" by *France Bourély*.



Microplankton, 2001, *Dee Breger*, scanning electron microscope image. Magnification approx. 4500 times, post-section digital staining. Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, USA.

Total works of art from human hand and nature

Mark Dion is an installation artist who works primarily with natural subjects. In a recent exhibition at the Smart Museum of Art at the University of Chicago entitled "Ecologies" *Dion* presented a project he called "Roundup", using a little laboratory for entomological research and a **Stemi® 2000** stereomicroscope.

The performance artist *Marina Abramovic* spent 12 days without speaking or eating in three rooms of her installation "The House with the Ocean View". The public was invited to watch the scene as long as it wanted and focus on details of the work with a Zeiss **Diascope®**.

Microscopic art

The pharmacist and biologist *France Bourély* creates breathtakingly beautiful microscopic images of the microcosm. Using a **LEO** electron microscope, she arranges details from nature in artistic settings.

In the 19th century *Ernst Haeckel* from the university town of Jena created richly illustrated and artistically arranged images of the specimens examined under the microscope in the course of his natural history studies and excursions.

And keen scientists today frequently enter the picturesque results of their research work in photographic competitions that award prizes for the best pictures according to artistic criteria and exhibit the results. In October 2002 the Rochester Institute of Technology mounted an exhibition entitled "Images From Science". Many of these pictures from the world of science were taken with Carl Zeiss microscopes.

www.mpiz-koeln.mpg.de
www.medphoto.wellcome.ac.uk
www.ldeo.columbia.edu/micro
www.lsc.org/antarctica
www.rit.edu/~photo/
www.gerstenberg-verlag.de
www.leo.de

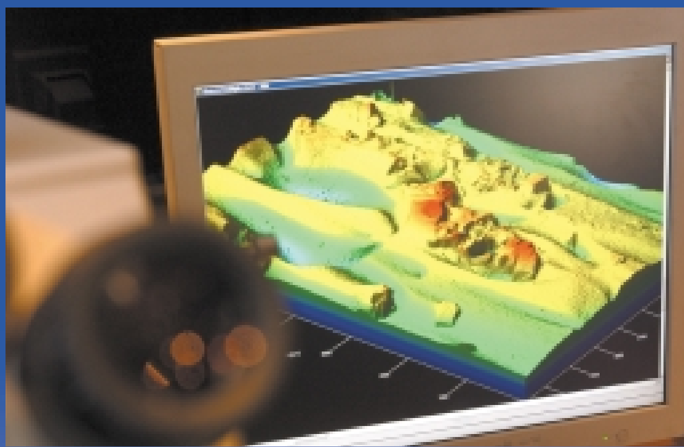
Rolling Materials Microscopy

Starting out early in December 2002, an eye-catching truck labeled "Materials microscopy on the move" toured all across Europe. Its cargo was state-of-the-art microscope systems from Carl Zeiss. On the road for more than half a year, the truck visited leading customers and users from the fields of materials analysis and the materials sciences, presented the latest innovations in the field of materials microscopy and demonstrated new solutions to specific application problems.

Jena was the 61st stop on the 17,000 km tour of the truck through altogether 16 countries. The show truck, which is 16 m long and weighs 36 tons, started its tour in the UK, then moved southward to Italy and France, continued its journey up north through Scandinavia and returned to Germany via Eastern Europe. It not only used country roads, but crossed the Baltic Sea and the Channel by ferry. By the middle of April, the Zeiss specialists from Germany and the sales organizations in the visited countries had presented the latest Zeiss innovations in the field of materials microscopy to more than 1,500 users and demonstrated new solutions to specific application problems. The innovative instrument systems, from the **Stemi DV 4** stereomicroscope to the **LSM 5 PASCAL** laser scanning microscope, fully equipped for materials testing and quality inspection, were functioning correctly without any defects right up to the very last day of the tour. Not something that can be taken for granted with such sensitive instruments on such a long and exhausting tour.

From September to December 2003 the Mat Mobile is on tour all across the U.S.A.

[*www.zeiss.de/mat*]



Music for Health

In November 2002 *Dr. Dieter Kurz*, President and CEO of Carl Zeiss, presented two surgical microscopes to *Karlheinz Böhm*'s "People for People" Ethiopian aid foundation with a symbolic check. Carl Zeiss sent the surgical microscopes to two hospitals built by "People for People" in order to achieve a marked improvement in the surgical possibilities offered by these facilities. They are now being used for vascular surgery and for the treatment of special eye diseases that could otherwise lead to blindness.

In seven regions in Ethiopia, the "People for People" foundation is implementing a large number of initiatives: agricultural and agro-ecological projects, the construction of wells, girls' hostels and schools, and the expansion of the country's healthcare system. It is also involved in training programs and educational measures aimed at improving the position of women in society. 585 staff are in action for about 1.7 million Ethiopians, with 300 helpers supporting the activities of "People for People" in an honorary capacity.

From movie star to development aid worker

It all started with a bet. In a German TV show, the movie star *Karlheinz Böhm*, well-known for his roles in Austrian, French and US film productions, betted that not even every third viewer would donate one German mark, one French franc or seven Austrian shillings to the inhabitants of the North African Sahel zone that was suffering from a severe drought and famine at the time. Needless to say, he lost his bet. In October 1981, with donations totaling 1.4 million German marks, he flew to Ethiopia and saved 1500 of the seminomads fleeing from the Babil/Eastern Ethiopia region from almost certain death by famine.

Experiencing the dire plight of the refugees changed the movie star for life. On November 13, 1981 the son of prominent parents – his father is the famous conductor *Karl Böhm* and his mother the singer *Thea Linhard* – set up the foundation "People for People" which he has since expanded doggedly and tenaciously into one of the largest denominationally and politically independent aid organizations. For several months a year, he lives in the extremely simple conditions in Ethiopia, and he spends the rest of the time traveling round Europe giving lectures. "My motivation is the little word "anger," explains *Böhm*, "Anger at the unfair and inhuman discrepancy between rich and poor."

To date, "People for People" has collected over EUR 200 million, 100% of which it has invested in concrete projects, in water supplies, in the forestation of the country, in the construction of roads, bridges, orphanages, schools and agrotechnical training centers, in basic medical care and education in a large region with a widely scattered population of almost two million inhabitants. The

nomads have become farmers, are learning to read and write and, with the appropriate guidance and support, are finding new perspectives for a better and more self-reliant life.

Music from all over the world at Carl Zeiss

For connoisseurs of jazz music, the Carl Zeiss Hall in Oberkochen, the small German town in which the company is based, is one of the most popular ports of call even for internationally established musicians on their travels between New York, London, Berlin and Moscow. In Oberkochen people of all ages gather to let themselves be swept away by the musical delights offered by their stars. In 1990 the two Oberkochen-based firms Carl Zeiss and Leitz/LMT and the local council decided to embark on a project that would revive the town's cultural life. This resulted in a

festival called *"Jazz Lights"* – a week-long feast of music which has attracted guests from all over Germany every year since then. The organizers definitely have a talent for bringing not only such big names as *Chris Barber, Dave Brubeck, Toot Thielemans, The New York Voices* and many others, but also young hopefuls in the jazz scene onto the Oberkochen stage.

Charity concert in Oberkochen

On April 5, 2003, to mark the 75th birthday of *Karlheinz Böhm*, a charity concert for "People for People" was organized in the Carl Zeiss Hall as part of the *"Jazz Lights"* International Jazz Festival. The 13th Jazz Lights came to a close with a real highlight – a concert with *Miriam Makeba*, also known affectionately as *Mama Africa*, in favor of *Karlheinz Böhm*'s initiative. To the enthusiastic applause of the ambassadors of Ethiopia and Austria, *Karlheinz Böhm* received the proceeds of the concert. The rhythms and words of *Miriam Makeba*'s songs definitely had a feel of Africa about them, the continent which anthropology now describes as the cradle of humanity, in other words the continent to which we owe our very existence.

[*www.menschenfuermenschen.org*
www.jazzlights.de]

Ideas for the Future

Around 1880, quite independently of each other, employee suggestion schemes were set up in the USA, Germany and the UK. Along with Krupp and AEG, Carl Zeiss was one of the first companies in Germany to introduce the employee suggestion scheme in 1903.

The classic goals of traditional employee suggestion schemes usually develop from production. This is reflected in ideas to increase production and productivity, simplify procedures and methods and improve quality, ideas on working conditions and organizational forms, ideas to reduce stockouts and ideas to reduce costs by making savings in materials and working hours.

The modern aspect taken on by the employee suggestion scheme more recently is more communicative and motivational in nature. The aim is no longer purely to reduce costs and is much more about motivating employees, day-to-day cooperation and the working atmosphere. This contributes to the creative development of the company as a whole. Priority is also given to each employee's opportunity for personal development. Reputable studies have shown that successful companies are increasingly turning to the creative potential of their employees in the fight to cut costs, as "…employees know best how production can be optimized or processes speeded up".

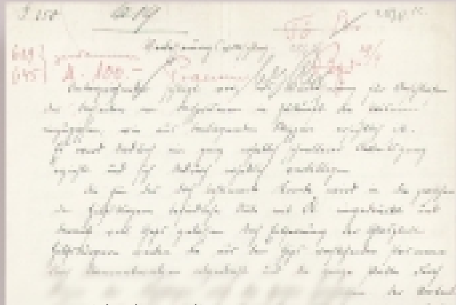
Fig. 1:
The employees who were rewarded for their improvement suggestion in May 2003: (from left to right) *Claus-Peter Walny, Peter Hölscher* and *Jürgen Söll* from the Industrial Measuring Technology business group.

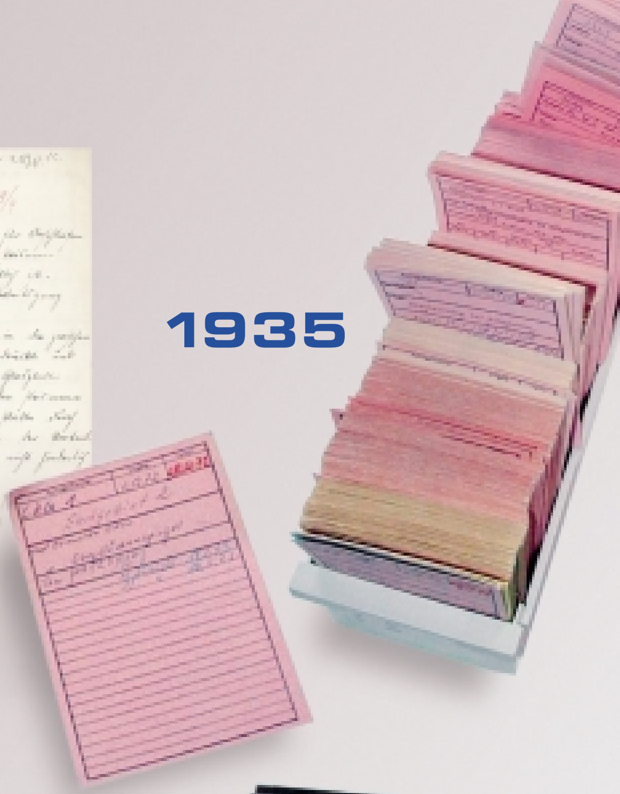
The direct route was the route to success

The workforce at Carl Zeiss first expressed the idea of creating an office within the company to deal with improvement suggestions as early as 1901. The management announced the establishment of the so-called Technical Committee on January 31, 1901. Just three months later, however, the office was "closed down" at the instigation of the foremen, due to reservations about the expertise of the committee members concerned and the impracticality of the procedure. However, the management thought that in itself the idea was a positive one, and declared their intention to try and find a more suitable format. From December 22, 1903 onwards, an entirely new suggestion scheme was introduced. It was now possible to present an improvement suggestion directly to the management, without taking a roundabout route via a committee or the employee's superiors. This measure guaranteed that the decision would be reached carefully and impartially. The person submitting the idea received a fixed payment that was appropriate to his or her suggestion. The hope was that this would not only give the employee inner satisfaction, but also a feeling of external recognition. The bonuses were not (as is usual today) paid together with the employee's salary. He or she received the special payment in person from the management.

In practice, improvement suggestions were submitted via a form using mailboxes in the department for employee suggestions. The suggestions were then managed using an index card system, with key details of the ideas entered on the small index cards. A separately maintained list made a complete overview of all the individual suggestions possible. All status information, such as the name of the person submitting the idea,

1915





1935

the level of the bonus and how the suggestion was developing, was recorded, right down to the smallest detail. This method of data management was commonplace within the employee suggestion scheme until into the 1970s. And even today the status of each suggestion is carefully updated.

Suggestions around the globe

IT tools then made their entry into the employee suggestion scheme. With the arrival of the first computer systems, punch cards were introduced, with microfilming used to archive the forms submitted. All the accumulated data was recorded, saved and processed using the punch cards and microfilms. The computer lists provided an overview of all the suggestions that had been received. For almost the last 40 years the number of suggestions submitted has increased at an incredible rate. Up until 1980 around a hundred improvement suggestions were received every year. By the mid-1990s this annual influx had risen to around 700. The introduction in 1998 of even more effective methods and processes for handling the suggestions has seen their number increase annually by more than 30%.

The main focus of the employee suggestion scheme has also changed in recent years. Whereas traditionally the emphasis lay on the administration of the suggestions, new methods – now firmly established – now enable all employees to present their ideas and suggestions quickly and unbureaucratically. The employee's idea is now placed unreservedly in the foreground. The development of the employee suggestion scheme from the role of suggestion administrator to that of idea coach has begun and will continue steadily. Processing times for the individual suggestions have already been reduced by around 75%. With the online employee suggestion scheme all employees now have the opportunity to present their ideas by a paperless system, and can look up the current status of their suggestions. The assessment of the ideas and the meetings of the committees are also by and large carried out electronically on the system. Today 60% of improvement suggestions are already submitted in this way.

The employee suggestion scheme has now been extended to all Carl Zeiss locations in Germany. And with the introduction of the scheme this year at Carl Zeiss in Hungary and the Minneapolis site in the USA, the employee suggestion scheme at Carl Zeiss is gradually taking on an international character, too. The first suggestions that have been received show that the scheme has met with acceptance at Carl Zeiss worldwide.

Over the years it is not only the quantity of suggestions that has increased. The quality, in particular, should also be underlined. The usefulness of the current employee suggestion scheme has quadrupled over the last five years. Last year, employees' ideas saved the company more than 2 million euros. Employees are being encouraged to take part in the employee suggestion scheme through various promotions, ranging from a lunch invitation and petrol vouchers through to the chance of winning a car.

1960

1982

2003

Computer Tomography for Industry

The computer tomography (CT) we know from medical applications also offers new industrial possibilities that were totally undreamt-of in the past. Carl Zeiss 3D Metrology measures and inspects customers' components and materials using a special industrial tomograph.

The application of conventional 2D-CT systems of human medicine is focused sharply on the density spectrum of people (bones, muscles, organs). These 2D-CT units operate with quite low X-ray radiation and reduced projection to keep the radiation dose for the patient as low as possible. 2D-CT systems are suitable for technical applications only to a limited extent, as their low resolution and extremely long measuring times of several hours, and sometimes even days, would render them inefficient for this purpose.

New services with new technology

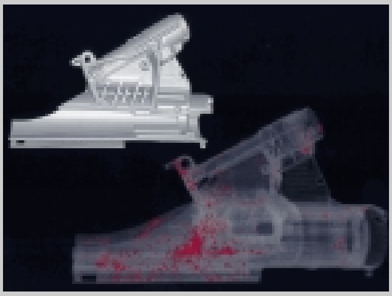
In the Service Center of Carl Zeiss 3D Metrology Services GmbH, a subsidiary of Carl Zeiss IMT in Aalen, contract measurements are performed on behalf of customers using the RayScan X-ray inspection system from *Hans Wälischmiller*. This new technology is based on a 3D-CT system with a 225kV microfocus X-ray source and a surface detector of 1024 x 1024 pixels. This 3D-CT constitutes a multi-purpose system for frequently changing applications and a wide spectrum of testpieces. The RayScan 200 features a measuring range of 500 mm x 500 mm x 1000 mm.

Material	additive wall thickness
Plastics	200 mm – 250 mm
Light metal alloys	approx. 150 mm
Model materials (plaster, wood, resin)	200 mm – 250 mm
Glass, ceramics	on request
Steel	approx. 25 mm

Some materials suitable for CT analyses with a maximum additive wall thickness.

Making the invisible visible

With the RayScan 3D Computer Tomograph it is possible to visualize in a non-destructive manner elements and structures on the inside of components, e.g. material defects or internal workpiece features and geometries that cannot be probed or inspected optically. Using state-of-the-art bevel beam tomography, it only takes one revolution of the testpiece to generate virtual 3D volume data that contains the geometric information at each point of the test object. The main fields of application are the entire field of plastic injection molding, casting production focused on light metal, and the machining of compound materials.



The RayScan X-ray inspection unit is a combined system for radioscopy and bevel beam tomography. Unlike 2D computer tomography, it permits several hundred layers to be captured simultaneously within a few minutes and the observation of radioscopic images. As a consequence, RayScan opens up a great number of analyzing methods. Wall thicknesses, distances, bores, radii or angles of all internal structures can be measured and also compared. Hence it is possible to illustrate the entire surface of the test component (inside and outside) in the form of millions of points and to compare these with CAD data. For a nominal/actual comparison, the results of the computer tomography are matched up to the CAD data for the entire volume. Also, CAD data can be generated from the results of the computer tomography. The 3D-CT data obtained in this manner may be used as a basis for Reverse Engineering and Rapid Prototyping applications.

The cooperation between Carl Zeiss Industrial Metrology and Hans Wälischmiller GmbH includes Sales, Applications and the upgrading development of industrial tomographs.

Fig. 1:
External view of a steering column. X-ray picture obtained with the computer tomograph. A look at the interior of a steering column.

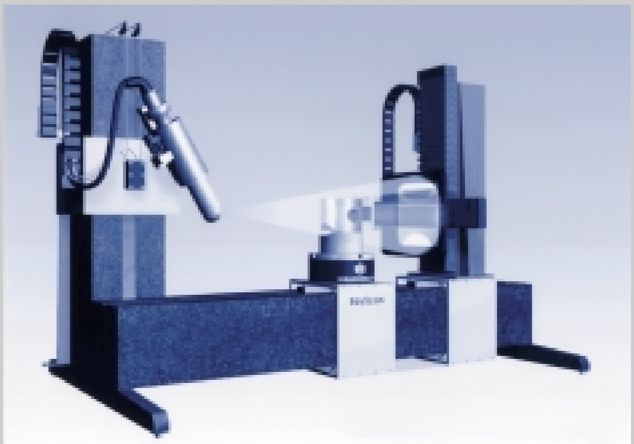


Fig. 2:
In its Service Center, Carl Zeiss 3D Metrology uses the industrial computer tomograph of *Wälischmiller* to measure customers' components.

Siegfried Tomaschko
Carl Zeiss 3D Metrology Services GmbH
www.zeiss3d.de

Hans Wälischmiller GmbH (HWM),
Markdorf/ Bodenseekreis
www.hwm.com

Lenses from the Net

When you go to your eyecare specialist, you expect to get good advice. But who advises him or her? The Web-based lens consultation module NetConsult by Carl Zeiss is aimed at helping eyecare professionals to find and compute the right lens for their patients. NetConsult is an integral component of the NetFral® System for the online processing of all business processes associated with lens consultation and ordering.

What happens online?

From the purely technical viewpoint, **NetConsult** computes the edge and center thickness as well as the weight of the eyeglass lenses for the selected frame. The online connection of the eyecare professional's PC to the Carl Zeiss servers offers the benefit that he or she always has access to current production ranges and to the entire database for several billion lens versions. This means that the latest products available are also immediately included in the consultation program right from day one.

Selection and ordering of eyeglasses by mouse click

In their sales talks and consultations, eyecare professionals and their patients together compare the thickness and weight of selected lenses on the screen. All data such as diameter, edge thickness, center thickness and weight of the lens types are shown in a clear, understandable way. From a comparison of up to six different lens types, the eyecare professional finds the lens for the patient at a glance. Also for **Gradal® Individual** progressive lenses, an approximation technique or an exact production calculation can be used to determine thickness and weight data.

To be able to determine the exact dimensions and shape of the edged lenses for the thickness and weight calculation, not only standard frame shapes (pilot, panto, square, circular/oval), but also special shape data can be read. An additional benefit of online consultation is the certainty that only lenses that are actually available are displayed during the consultation.

After the consultation, the order can be triggered online or placed in the shopping cart for subsequent order placement. On request, the selected lens is then optimized for the frame at Carl Zeiss. In some countries, up to 70 % of all lenses ordered are available from the eyecare professional the next day.

NetConsult offers individuality!

With **NetConsult**, the eyecare professional has the possibility of configuring the patient consultation process in accordance with his or her own ideas. The lenses are offered via product lines or via special applications:

- The product lines are geared toward the Zeiss product lines such as Premium, eXPress, Eco, Special and Campaigns. In addition, the eyecare professionals can also compile their own product lines from the overall portfolio on an individual basis.
- The corresponding products can be found in the applications Workplace, Children's glasses, Sport and Sunglasses (plano power).

Andreas Nix/Christina Scheible,
Ophthalmic Products Division
nix@zeiss.de
www.zeiss.de/opto

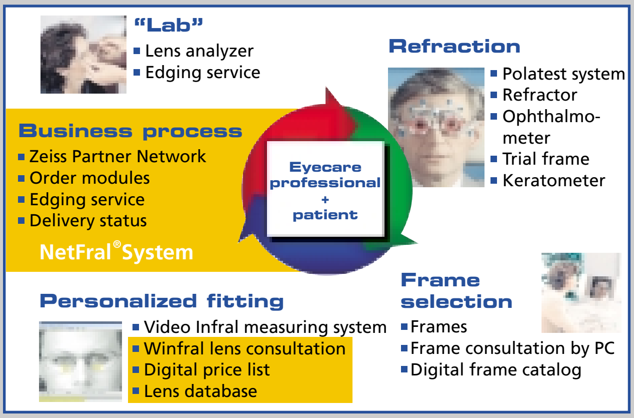


Fig. 1:
Only a mouse click away: online services from Carl Zeiss for eyecare professionals.

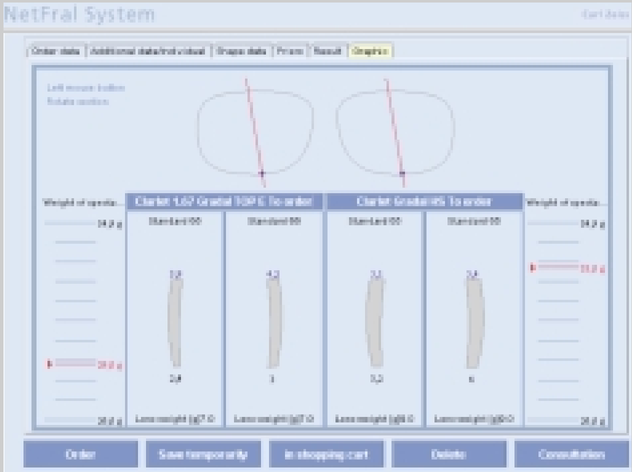
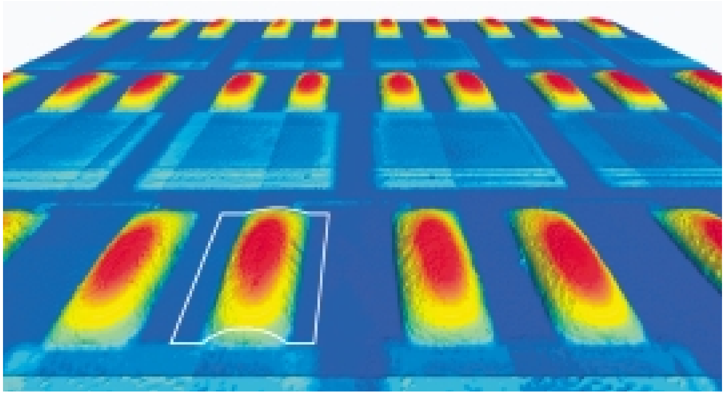


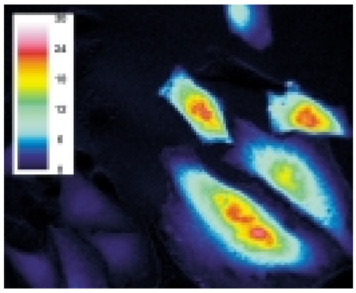
Fig. 2:
Direct comparison of two lens types. The lenses were computed "virtually" for the required frame shape. This screen shot shows a frontal view of the shape and a section through the future lens in the position of the red line. The weight of the eyeglasses can also be directly compared on the lateral scales.

Light Microscopy

The **AxioCam® MRc5** microscope camera with a 5-megapixel CCD-sensor produces high-resolution images of microscope specimens with perfect color accuracy in a very short time and at a reasonable cost. To satisfy the need of many users to have a camera they can connect easily to their PCs and laptops, we have equipped the **AxioCam® MRc5** with a fast FireWire data interface. Furthermore, rapid live image speeds permit fast operation and focusing of the sample on the microscope. With the **Axio-Vision®** imaging software the camera is astonishingly easy to operate.



Highly resolved topography of an array of soldered joints with marking of simple scan field size (20.08 x 16.77 x 0.44 mm³).



FRET-encoded image as an example of a test cell line (CHO-K1): positive control with coupled molecules of the fluorescence dyes CFP and YFP. The color encoding showing concentration-dependent FRET intensities was performed with **AxioVision® FRET** using the Youvan method.

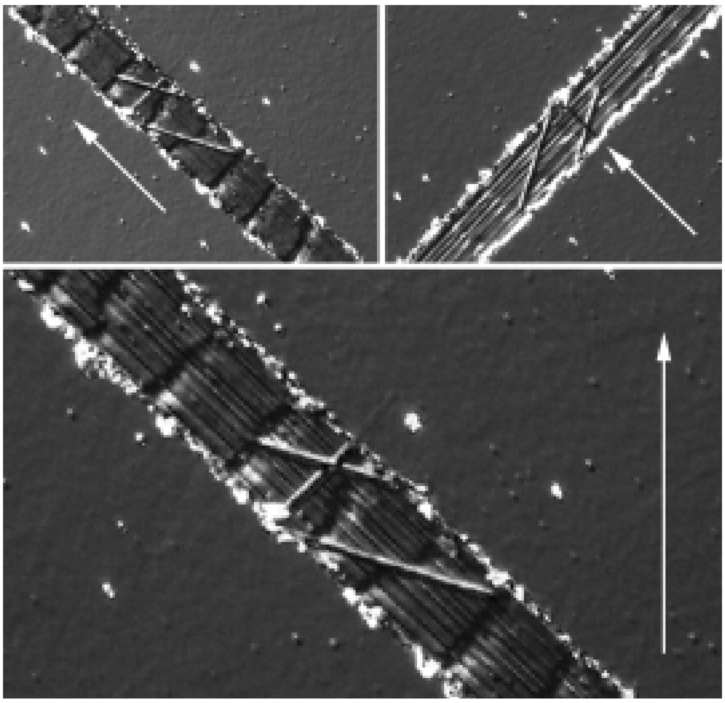
AxioCam® MRc5 digital camera.

The new version of the **LSM 5 PASCAL®** confocal laser scanning microscope for materials research and quality inspection features attractive hardware and software functions. Non-contact 3D materials analysis has now become possible even for large or bulky samples. Fast and precise measurement of height steps in the nanometer range have become possible with the piezotechnology. The new **StitchArt** software permits long profiles and extended topographies extending over hundred times the size of the microscopic scan field to be acquired at a high-resolution. The **LSM 5 PASCAL®** can therefore assemble and measure height profiles over long distances and large-area portions of material surfaces as image stack arrays at a high resolution.

Roughness or waviness analysis, thin sections or steep slope angles, micro or macro, – the **StitchArt** option matches the recording format to your applications and thus broadens the horizon of your microscope. In addition to convenient recording, processing and displaying of XYZ image stacks, XY-profiles can now also be acquired along a straight line or a freehand curve. Complete processing procedures, including filter, fit and balance algorithms, are saved as parameter files and are therefore available any time.

The new **AxioVision® FRET** software offers optimum accuracy in FRET examinations, allowing cell and developmental biologists to determine the processes in cells even more precisely, e.g. the energy transfer portion of two adjacent protein molecules. In addition to the recording of time-lapse series and the creation of FRET-dependent false-color, access to 16-bit images is also possible, considerably increasing the measuring accuracy. Furthermore, measurements in the various techniques can be set to the local regions of interest, i. e. measurements are possible directly in the FRET images. The possibility of automatically recording all the required time-lapse images via a few, logically linked operation windows is a further benefit. **AxioVision® FRET** can also be used for the recording of standard fluorescence images.

The **C-DIC** technique now permits even the finest structures, errors and defects, which generate no or only insufficient contrast in classical brightfield/darkfield, to be displayed in high contrast in the light microscope. The **C-DIC** Differential Interference Contrast technique in circularly polarized light provides the semiconductor and MEMS industry and all branches of materials examination with increased effectiveness for defect detection. Defects are recognized more quickly and the objects are displayed in much better quality. Object structures lying in different azimuths can now be contrasted one after another by adjusting the **C-DIC** prism and not by the stage or object rotation required in the past. This means that object orientation and the full information content are retained.



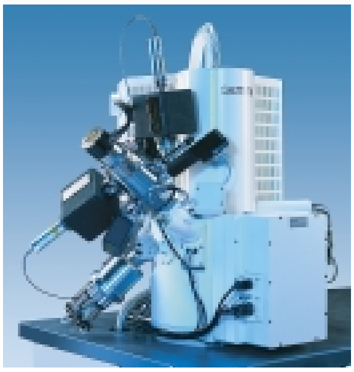
If two structures run vertically to each other, the **C-DIC** technique makes it possible for the first time to image both structures simultaneously without any need for stage rotation.
Top left: linear DIC.
Top right: linear DIC, stage rotated through 90°.
Bottom micrograph: C-DIC, splitting direction as indicated by arrow.

Axioskop® 2 MAT routine microscopes.

The **Axioskop® 2 MAT** routine microscopes for reflected and transmitted light meet the specific demands made by modern materials microscopy. They are available as manual and motorized versions and offer the possibility of recognizing more detail and measuring structures more precisely using the **C-DIC** and **TIC** interference contrast techniques. The motorized microscope models permit the automation of procedures such as digital image recording and image analysis using the **AxioVision®** software, which markedly enhances effectiveness, e. g. in quality inspection. With the **Axioskop® 2 MAT** mot, the reflector turret, z-drive, brightness control and switching mirror are motorized and the nosepiece is coded. With its ideal viewing angle of 20°, the trinocular TV Ergotube permits vertical adjustment of up to 50 mm.

Electron Microscopy

The **LEO 1540XB CrossBeam®** system for use in the semiconductor industry and in nanotechnology is based on the modular **CrossBeam®** design. **LEO CrossBeam®** technology provides a unique combination of the outstanding electron-optical imaging capabilities of **LEO GEMINI®** field emission SEM technology and a focused ion beam (FIB) system. In this configuration, the FIB system is used for targeted materials processing using an extremely focused ion beam which permits material to be removed, modified and deposited. The integration of the ion column control system in the **LEO 32** software makes the system easy to operate. As an all-time first, **CrossBeam®** technology allows the simultaneous visualization of the machining process with maximum resolution. On this basis, the current **LEO CrossBeam®** series is setting new standards in the fields of semiconductor analysis and structuring technology for MEMS and microstructural components.



LEO CrossBeam® 1540XB electron microscope.

EC Epiplan-Neofluar® microscope objectives.

The **EC Epiplan-Neofluar®** objectives for materials microscopy are available as H/DIC models for brightfield and DIC examinations, as HD/DIC models additionally allowing darkfield examinations, and as Pol model (with strain-free optics) for polarization-optical observation. Furthermore, a model with a long working distance is available. The high fidelity of the objectives is particularly beneficial in structure analyses of weakly reflecting objects (glass, coal, ceramics). Where sub-micrometer structures are displayed, the complete image information is retained up to the very edge of the field. A further outstanding feature is the elimination of false light in the range from near UV to near IR. The constant aperture over the entire field results in a homogeneously illuminated object field.

GEMINI® column on the **SUPRA** field emission electron microscope.

The application spectrum of field emission electron microscopes – including for example nanotechnology – is making constantly increasing demands, in particular on the resolving power at low acceleration voltages. The **SUPRA** field emission electron microscopes with the third-generation **GEMINI®** column provide the best resolution values currently available: 1 nm/15 kV, 1.7 nm/1 kV and 4 nm/ 0.1 kV. Further outstanding benefits are high flexibility, a specimen current of 20 nA and a current stability of 0.2 %/h. The new features also include a eucentric specimen stage, the high-efficiency in-lens detector, the extension of the pressure range in the VP mode and enhancements of the VPSE detector. Users have the choice between nine different models: the entry-level model **SUPRA** 25, **SUPRA** 35 and 35VP for general applications, the fully analytical high-resolution FEREMs **SUPRA** 50 and 50VP, and the top-of-the-line systems **SUPRA** 55 and 55VP, **SUPRA** 60 and 60VP offering versatility and ultra-high resolution.

Industrial Metrology

GageMax is a measuring machine for use directly in the production environment which features markedly reduced life cycle costs and higher productivity. Its outstanding features include its small footprint, ease of operation for production staff, and its ability to provide metrology room precision in a manufacturing environment despite poor temperature conditions, dirt and floor vibrations. **GageMax** meets the major demands made on measuring equipment: availability, robustness and a progressive service strategy. Service modules such as teleservice or on-line diagnosis meet the requirements for high accuracy and repeatability. The use of new guideway and drive systems in the enclosed 3D box allows the machine to be used even in very rough ambient conditions. This new guideway technology allows for ambient temperatures of more than 35°C and eliminates the need for purified air. No additional costs are incurred for enclosures, air-conditioning or cleanroom conditions, because all critical components are housed in the compact, protective 3D box. Both the installation and preparation costs on the part of the customer and the current costs are markedly reduced. Thanks to the sturdy and massive basic body of mineral cast, **GageMax** is even more insensitive to typical floor vibrations from machining centers. The temperature-dependent accuracy specifications enable a single product to be offered worldwide for various production sites and for all ambient and temperature conditions. **Gage Max** can be used like an open metrology room in the production environment. As a result, time is saved by reducing part transport and allowing parts to assume the temperature of the metrology room. There are no delay times caused by the late provision of results or delayed process corrections.

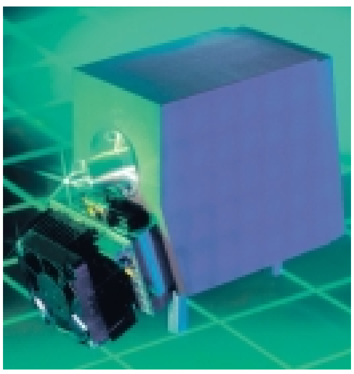
GageMax coordinate measuring machine.

The new **PRO Select** horizontal-arm measuring machine meets the constantly increasing demands for higher accuracy combined with optimum productivity in the measurement of sheet metal components. The high-precision linear guideways of the axes require little maintenance and provide long-term stability. Via interfaces, the centerpiece of the instrument, the X/Z unit, can be combined with various sensor carriers and carts. This strategy allows flexible reactions to the various requirements from the users. The sensor carrier is mounted to the crossarm via a universal adapter. This allows other sensor carriers to be used without any need for mechanical conversion. The maximum permissible error MPEE of the high-end version of **PRO Select** totals 18 µm + L/125 ≤ 50 µm for one measuring arm of Y = 1600 mm and Z = 2500 mm. The spatial acceleration of **PRO Select** is up to 1500 mm/s^2, and the travel speed may be as high as 833 mm/s. The mechanical construction of the instrument with linear guideways and the three-point bearing of the measuring bar make sure that the instrument is extremely easy to service. Time-consuming and therefore expensive service jobs such as adjusting the bearing or realigning the entire measuring bar are a thing of the past. This means that the costs for the machine's life cycle are noticeably reduced and the uptime of the system improved. To ensure that the high speeds entail no safety hazards for the user, a completely new control system has been developed. When the light barrier is crossed, the machine does not suddenly stop, but reduces its speed to a safe level monitored by a computer. This means that measurement is not interrupted, but continued at a slightly slower speed. A simple turn of the key switch – and the machine continues to measure at high speed.

PRO Select horizontal-arm measuring machine.

Spectral Sensor Systems

The **MCS-CCD** spectrometer is the first spectral sensor to be equipped with a UV sensitive CCD array as a receiver. The **MCS-CCD** modules are available in two different versions: UV for the spectral range from 200 to 600 nm and UV-NIR for 200 to 980 nm. With its time-tried, compact and rugged design, the **MCS-CCD** offers all benefits of previous MCS spectral sensors such as thermal stability and shock resistance. The **MCS-CCD** features outstanding photosensitivity, making the module excellently suitable for use wherever weak light signals must be detected. These areas include, for example, fluorescence measurements in microscopy and special layer thickness measurements in the semiconductor industry. The module is completed by CCD control electronics from the company *tec5 AG* providing a full 16 bit resolution. A plug-on temperature control board for cooling the chip is available as an option. The user has the choice between different interface types such as USB 2.0 and PCI. Further options include support software for all common programming languages and the connection to ASPECT PLUS. The **MCS-CCD** sensor is currently available as an OEM module, the laboratory system including software is in preparation.



MCS-CCD spectrometer module.

Camera Lenses

The conditions of use for camera lenses in space differ substantially from those on earth. The lenses must be able to permanently cope with extremely cold temperatures, vacuum and radiation. They must also survive shock and vibration during the rocket launch without being damaged. In addition, the optical and mechanical components are not provided with the usual outgassing surfaces. The lenses require pressure compensation bores for the use under vacuum conditions in space, a special, rigid mount without focusing mechanism, and a fixed stop.
Known as a supplier of high-performance lenses for scientific and technical applications in space since NASA's moon landing missions, Carl Zeiss has been commissioned by the Massachusetts Institute of Technology (MIT) in Cambridge, USA with the manufacture of three lenses of the type **Distagon® T* 1.2/3.5** in a version suitable for the use in space. The lenses will be installed in satellites where they will help to ensure the fast, precise orientation of the satellites on the basis of orientation points in space. The **Distagon® T* 1.2/3.5** lenses will have no problems meeting the extremely critical requirements made on their optical performance with respect to contrast, distortion and brightness distribution.

Distagon® T* 1.2/3.5 lenses.

Sports Optics

The **Varipoint VM/V 3-12 x 56 T*** riflescope is the combination of a red-dot sight with a high-grade riflescope. With its variable power and newly enhanced magnification, the instrument offers what many hunters have long been waiting for.

The **Diavari V 6-24x56 T*** tele riflescope with its large objective diameter is the ideal choice for poor light conditions. It comes with a bullet drop compensator as a standard feature and with other attractive benefits such as a constant reticle size over the entire power range and a wide reticle adjustment range.

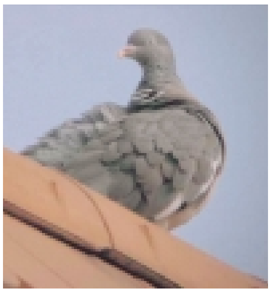
Something special among red-dot sights: the **Z-Point reflex scope** offers innovative features such as Zeiss-patented digital function control and the new optical configuration of the light source which has also been patented. The Z-Point scope is ideal for drive hunting in particular.

The **Quick-Camera-Adapter** connects **Diascope®** spotting scopes with digital still cameras, digital video cameras or SLR cameras, converting the spotting scope into a super tele lens. Its use could not be easier: simply mount the adapter on the tripod, align the camera on the adapter and lock it in position. Just swing out the camera for observation, and swing it back again for shooting photos. The rugged unit can be folded to a compact size. Spotting scopes from other manufacturers can also be mounted.

The Quick Camera Adapter converts **Diascope®** spotting scopes into super tele lenses.
Photos: *Koschate, Wolf Wehran.*

The **Victory** NV 5.6x62 T* night vision scope brings light into the dark: stags on a clearing.
Photo: *Sportive Werbeagentur*, Munich.

The **Victory NV 5.6 x 62 T*** night vision scope replaces the Zeiss **MONO 5.6 x 60 N** and offers significantly enhanced performance. Its features include advanced electronics, redesigned high-performance optics, an integrated additional illuminator and the possibility of mounting flash lights with an integrated IR filter via an adapter. Objects can be clearly identified at distances between 5 m and 500 m, the field of view of 146 m at 1000 m is exceptionally large. Superb ease of use of this high-tech scope is ensured by its ergonomic design and convenient layout of controls.



Ophthalmic Products

VisuCard™ – the new magnifier no bigger than a credit card – opens up many different possibilities to the user: whether as a reading aid for out and about or simply for seeing those tiny things that are part of everyday life, the **VisuCard™** is the ideal helper, as its small size allows it to be taken practically anywhere. Its special feature is a microstructured asphere which ensures outstanding imaging properties right into the peripheral areas. With a refractive power of 6.5 D, the magnifier is a mere 0.8 mm thick: in other words, it is as flat as a credit card. A hard coating protects the surface and ensures that the **VisuCard™** can take a lot of punishment in everyday use. Every magnifier comes standard with its own cover for safe storage and transportation.

VisuCard™ – the new magnifier no bigger than a credit card.

Masthead

Innovation, the Magazine from Carl Zeiss
No. 13, September 2003

Publisher:
Carl Zeiss, Oberkochen,
Corporate Communications,
Marc Cyrus Vogel.

Editors:
Dr. Dieter Brocksch, Carl Zeiss,
73446 Oberkochen, Germany,
Phone: (+73 64) 20 34 08,
Fax (+73 64) 20 33 70,
E-mail: brocksch@zeiss.de

Gudrun Vogel, Carl Zeiss Jena GmbH,
07740 Jena, Germany
Phone: (+36 41) 64 27 70,
Fax (+36 41) 64 29 41,
E-mail: g.vogel@zeiss.de

Authors at Carl Zeiss:
info@zeiss.de
www.zeiss.de

Other authors: If no information is given to the contrary, other authors can be contacted via the editors.

If readers have any inquiries about how the magazine can be obtained or if they wish to change their address (the customer number should be indicated, if applicable), we would kindly ask them to contact the editors.

Article on page 6:
Cranial section from the "Atlas of Anatomical Studies", Leonardo da Vinci, at akg images, Berlin, and "Serratura" (leg amputation) woodcut from the "Feldtbuch der Wundarzeney" by Hans von Gersdorfer at akg images, Berlin.

Article on pages 18 and 19:
1st, 3rd and 4th picture from the left: Picture Alliance/dpa – epa afp kanter, epa efe Jose Huesca, Marco Kohlmeyer

Article on page 29:
Kingfisher, Vincent van Gogh, at Van Gogh Museum Enterprises B.V., Amsterdam

Article on page 38:
Buchenwald I. Gustav Klimt, at Staatliche Kunstsammlung Dresden.

Design: Corporate Design, Carl Zeiss, 73446 Oberkochen, Germany
Layout and setting:
MSW, 73431 Aalen, Germany.
Printed in Germany by
C. Maurer, Druck und Verlag,
73312 Geislingen a. d. Steige.

ISSN 1431-8059

Picture sources: Unless otherwise specified, all photographs were contributed by the authors or originate in the archives of Carl Zeiss.

Articles supplied with the author's name do not necessarily reflect the opinion of the editors.

The Magazine from Carl Zeiss
Innovation

Cover Photo:
The US conductor, composer and pianist *Leonard Bernstein* was one of the greatest musicians of the 20th century and at home in all of the world's famous concert halls. His most well-known composition is the musical West Side Story.

Small Photo on Back Page:
One of the specialist fields of the Berlin-based photographer *Susesch Bayat* is classical music. Portraits of conductors and musicians on over 1000 record and CD covers bear his unmistakable mark. The tool he uses for his work is a medium-format Rolleiflex 6008 camera and lenses by Carl Zeiss.