

Some Remarks about the Technical Background of Kern & Co Aarau

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SUMMARY

In 1819 Jakob Kern founded in Aarau a mechanical workshop. In 1988 his descendents sold the majority of the shares of KERN & Co Ltd to the main competitor WILD-LEITZ in Heerbrugg. 169 years of ups and downs, of enthusiasm and despair, periods of bold ideas and of endless hesitation – the history of KERN between 1819 and 1988 looks like a cord teared to peaces and again knotted together. In spite of weak periods on the good parts pearls and jewels are threaded.

In 1885 the company's name *J. Kern à Aarau* was changed to *Kern & Cie, Aarau*. A limited company was founded in 1914. In 1857 KERN had 42 employees, in 1874 there were 148, just as much as in 1918, after World War I. The maximum number was reached in 1963 with some 1300 employees. By the end of 1921 the factory had to be shut down and 30% of the shares had to be written off, an action which had to be repeated in 1932 with an amount of 50%.

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1819 – 1900: EXCELLENT WORKMANSHIP

Jakob Kern (1790 – 1867) was born in Berlingen, Canton of Thurgau. After death of his father, the family moved to the canton of Glarus, where his mother also died soon after. The local priest recommended the intelligent orphan to his friend Johann Rudolf Meyer (1739 – 1813), a wealthy silk manufacturer from Aarau. In 1799, Kern found a new home in Aarau. After his school time he made an apprenticeship at the compass maker Esser. His years of travel lead him to the famous instrument makers Baumann in Stuttgart and to Reichenbach and Fraunhofer in Munich. After his return to Aarau Meyer helped him start with his own workshop. His compasses and surveying instruments are distinguished by excellent workmanship and high precision.

During the 19th century, the technical properties of surveying instruments proceeded slowly and in small steps. The manufacturers traced no research and development activities. Most of the improvements were due to engineers in applied geodetic and surveying practice. A good example is the history of the topographic slide rule. Topographic mapping required a large quantity of points which were determined by the stadia method. The problem was to calculate the horizontal distance and the difference in altitude out of the readings on the vertical staff. Provisional types of slide rules had been designed e.g. for mapping Switzerland 1:100'000 by Dufour about 1830. The conclusive design of the topographic slide rule was presented to KERN by Prof. Johannes Wild (1814 – 1894, not to be confounded with Heinrich Wild) in the sixties of the 19th century. KERN produced a large number approximately until 1935, i.e., until self reducing tacheometers became common. The theories of the stadia method and of the slide rule were published by Prof. Johann Jakob Stambach (1843 – 1918).

1900 – 1935: PROMISING DECISIONS AND HELPLESSNESS

The progress in optics and machine tools at the turn of 19th to 20th century offered significant changes in instrument design. The computation of optical systems was based on mathematical theories. Especially photographic lenses demonstrated new possibilities. Better lathes, better threads, better grinding machines, better raw material had significant influence on design and manufacturing. Topographic mapping with plane tables or tacheometers was common practice, but the first steps in photogrammetry had already been made.

During these exciting years, Heinrich Wild was a surveyor with the Swiss Federal Topographic office. He was convinced that by adopting optical systems more efficient instruments could be possible. A test model to read the circles of theodolites made by Wanschaff in Berlin did not satisfy. KERN was also invited to participate but finally declined. KERN should have been alerted but remained inactive. In the twenties of the 20th century Wild began to produce theodolites in his own company. After 1930 the KERN instruments were obsolete. It was im-

possible for KERN to renew design and production by own means. Besides geodesy, Wild decided to go for photogrammetry which proved to be the dominating method in the future of topography. Surprisingly KERN was active in this field at the same time. Based on a patent of the Spanish engineer and colonel Ordovàs KERN built a prototype of a photogrammetric restitution instrument in 1929. The coming years of world wide economic crisis stopped further activities.

During World War I, KERN had difficulties to get telescopes for surveying instruments. After 1920 Walther Zschokke (1870 - 1951), formerly head of the calculating department for optics of C.P. GOERTZ, Berlin – Friedenau, was in charge to build up a department for optical systems. In order to use the new workshops to capacity he suggested to develop and manufacture photographic lenses. Zschokke left KERN after a few years.

Since modern survey began in early 19th century, distance measurement remained the main problem for about 150 years. Distance measurement in cadastral survey with tapes or rods was time consuming and inconvenient. In triangulation it was a matter of extreme accuracy and of extreme costs. The most common methods in early cadastral survey was tacheometry, i.e. measurement of polar coordinates of each point either directly mapped on the plane table or measured numerically then transformed into the national grid by means of coordinates. Many surveyors had good ideas. The manufacturers had only to wait until the next inventor knocked at the door. Several owners of surveying offices or government officials were consultants for KERN, among them Brönnimann, Leemann, Werffeli and especially Alfred Aregger. Rudolf Bosshardt proposed a telescope with two images, one of both was horizontally shifted by optical wedges. Since the amount of shift was proportional to the distance it could be read on a horizontal staff set up at the end of the distance. KERN was not interested in this proposal, so Bosshardt asked ZEISS. Its double image tacheometer (called *Bosshardt-Zeiss*) was very successful. Some few years later KERN changed mind and copied the principle of measurement, however, violated the German patent.

1935 – 1950: KERN & Co AND HEINRICH WILD

Heinrich Wild (1877 – 1951) studied surveying at the Winterthur College of technology for a few semesters. In 1899 he joined the Swiss Federal Office for Topography in Bern. His experience with the instruments was very unpleasant especially carrying out triangulations on the peaks of the Alps. Getting theodolites ready for measurements was a continuous waste of time, so he began to study technical improvements. The reading of the circles was to be improved by new optical systems. Both sides of the circles should be read simultaneously by superposing their images in one single microscope. A plus was the automatically calculated mean value of the readings of both sides.

At this time Wild was involved in the supply of telemeters by ZEISS for the Swiss Army. This contact might have been the reason to invite Wild to build up a new section for geodetic instruments in Jena. Wild joined ZEISS in 1908. His first design was a level with two fundamental improvements (1) internal focussing lens for better stability of the line of sight and for protection against dust, (2) coincidence prisms for exact setting of the bubble. His main con-

cern was still a new theodolite. In 1921 Wild left ZEISS without waiting for the coming out of the TH1 and founded in Heerbrugg together with the financier Jakob Schmidheiny and the geologist and surveying specialist Robert Helbling his own company “*Heinrich Wild, Werkstätte für Feinmechanik und Optik*” (later WILD HEERBRUGG then from WILD-LEITZ to LEICA). The instruments designed by Wild completely changed the field work in geodesy and surveying.

The threatened position of KERN in the market of survey instruments was saved by a lucky coincidence. Heinrich Wild left his company in Heerbrugg in the early thirties as a result of disagreements with his partners about costs and insufficient turnover. He knew about the problems in Aarau. In 1935 he got into conversations with KERN. The cooperation between Wild and the governing board of KERN eventually prevented KERN to disappear. In order to establish the technical cooperation KERN engaged Rudolf Haller (1913 – 2007). Haller was pure luck for KERN and for Wild as well. Best talented in mechanics he was ideal to transform Wild’s designs into parts to make as easy as possible.

At the FIG congress of 1938 in Rome KERN and Wild decided to exhibit a series of three new theodolites designed by Wild and manufactured by KERN. Wild’s main idea was to improve the accuracy of the circles by improving the dividing principle of the dividing machines, i.e. to eliminate the imperfections of the bearing of the machine. The division of the circles was generated by a worm gear. Imperfect grinding of the cog wheel’s axis causes wobbling in the bearing. Wobbling means that the axis does not only turn but also shifts laterally. A laterally shifted axis causes an imperfect position of the circle to be divided relatively to the engraving tool. Wild’s solution were the so-called *double circles*, i.e. instead of one single circle division two concentric ones were used. If dividing *double circles* the machine traces simultaneously step by step a line each on opposite sides of both circles. As a result the wobbling (i.e. shift of the axis) was eliminated in the same manner as eccentricities of circles in theodolites are eliminated.

For the first theodolites to be exhibited in Rome, KERN, modified an existing dividing machine. Its conical axis was preserved despite its poor mechanical properties. The best proof for Wild’s idea was the accuracy of the circle division made with an imperfect machine. Better axes needed new machines. The first new machine was ready for circle production in 1948. KERN was probably the only company who constructed and manufactured its dividing machines in-house.

All three types of theodolites exhibited in Rome had double circles and readings on opposite sides. They covered all surveying work from simple cadastral survey to first order triangulation. The smallest type DKM1 had a height of the tilting axis of only 100 mm. It turned out to be a very precise instrument which, weight was only some 2 kg (case included). That’s why it was indispensable for expeditions from pole to pole. The medium type DKM2 was much less successful. Its version DK2 had been designed for cadastral survey and should be a counterpart to the T1 of WILD Heerbrugg. The DK2 had a confusing circle reading system which prevented any breakthrough on the market. The precision type DKM3 had a telescope of a new type. The apochromatic correction and the brightness of the image were achieved by a

combination of mirrors and lenses. Its introduction in geodetic practice was delayed by World War II. Meanwhile Haller designed a new system of the vertical circle which helped to introduce the astronomical version DKM3-A. It was a success worldwide. All new theodolites had a very precise new centring system which needed a special tripod.

Wild's main concern was still photogrammetry. His patent of a photogrammetric stereo restitution instrument was issued in 1946. The idea was to replace the delicate mechanical spatial rods which represent the projection rays between photo and model by an electro-optical system and to replace the mechanical gearing for moving the measuring mark by an electronic system controlled by a joy stick. In 1951, some years after Heinrich Wild's death KERN decided to build a prototype. Haller was in charge of this project.

1940 – 1965: IMPORTANT INTERMEZZO

In the forties of the last century KERN made a new attempt to open the market of photographic and movie lenses. To do so mathematicians and physicists were engaged who developed the world famous Switar lenses for the Paillard-Bolex movie cameras. Among them was the Switar 1:0.9 (!) by Hans Schlumpf for 8 mm – movie cameras. In the Forties, anti reflex coating of the lenses was introduced by Walter Lotmar. The great success of the lenses was dangerous, as the company's commercial results depended to a large extent on one single customer.

The commercial dependence on one single customer ended by a scandal. The governing board realized the dangerous situation. KERN did what any company in commercial and organizational difficulties does and charged a consulting company to solve the problems in 1958. In a first step the member of the management who was the advocate of closing down the unprofitable department of surveying instruments was dismissed. The second step was a new organization of the company. In contradiction to many other cases it was a full a success. The company's structure was organized in four departments, among them the new department for Research & Development. 50 years later, its subdivision into mathematics, optics, physics, electronics, chemistry, geodesy, photogrammetry still looks modern.

In 1963 the decision to continue surveying instruments was a success as the super 8 movie film was missed by Paillard-Bolex. The turnover of movie lenses collapsed within a few months.

1950 – 1965: DISCREPANCIES EVERYWHERE

The following paragraphs may illustrate the interaction between management and staff of Research & Development.

The project of the photogrammetric stereo restitution instrument based on Wild's patent required help of companies specialized in electronics. The system which replaced the mechanical rods was designed by SIP in Geneva (Société Genevoise d'Instruments de Physique). KERN had good cooperation with SIP for many years, because the optical systems for their measuring and tooling machines were designed and manufactured in Aarau. The order of the system to control the floating mark in the stereo image by a joy stick was placed with CONTRAVES in Zurich. Good relations went back to the EOTS (Electro-optical tracking system) of CONTRAVES. EOTS was designed for tracking missiles by intersection from two instrument stations. The most critical part was a giant theodolite made by KERN which photographed continuously the readings of both circles on movie film.

The project's code name was *universal joint*. Two specialists assembled the parts in a locked room. They had not been informed about the purpose of what they do and were strictly forbidden to talk to anybody about their work. Nevertheless one of them made secretly some photographs of the fully assembled plotter. Other pictures do not exist.

According to the philosophy of absolute secret nobody dared to ask a photogrammetric specialist's opinion. However the management of KERN had some doubts about the prospects of the instrument. In 1955 an expert was named. Everybody knew that he was WILD Heerbrugg minded. His assessment was negative, too universal, too precise, too big, too risky, too expensive, too much avant-gardism, no chance. In his eyes the market required a simple and cheap equipment. Finally he recommended a young photogrammetrist who had already two patents for this kind of instruments. The young photogrammetrist – Henk Yzerman - was engaged within some few days. The extremely complex and costly prototype was literally forgotten, forgotten in no time together with all technical experience. Due to the movie lenses, money was no problem. In photogrammetry KERN stood again at the beginning. The cheap equipment PG1 suggested by the expert was a flop. The following plotter PG2 had a mechanical restitution system based on splitting the rotation of the spatial rod in the projection centre of both photographs in two components. One component moved the frame of the aerial photographs in one direction, the other component moved the optical viewing system. The result was an instrument of a sturdy and flat construction. For mapping in small scales the PG2 was very successful. Some 700 instruments were produced. Both PG2 and PG1 were presented at the ISP congress in London in 1960. The name "PG" was derived from German „Photogrammetrisches Gerät“.

In addition to the restitution instruments KERN presented at the ISP congress in London an unexpected instrument. The purpose of the PLP (Parallel Light Printer) was to equalize the density of dark and bright parts in aerial photographs. The bright parts on the ground give areas in plain black just drowning important details. On the contrary in the shadow of valleys were distinguishable only some faint black traces. Existing instruments which reduced the

overall contrast and improved the contrast in detail were based on television techniques, but the equalizing effect was poor. The approach of KERN was different. The aerial photographs were put in contact with the not exposed films and then laid flat on top of the PLP. The film was exposed by a light flux of parallel rays which passed through the aerial photograph and whose intensity was continuously controlled by an electronic system. The light flux was geometrically defined by a diaphragm which moved line by line over the package of photograph and film. The results were excellent. Unfortunately Henk Yzerman had some disagreements with the management. He left Kern and with him the theoretical background. Again the management named an expert whose report was very scientific so that the management named another expert to condense it. Meantime some further tests were carried out especially in medical applications. Equalized x-ray's of fractures enhanced fine structures which were not visible without processing by the PLP. Doctors involved in the tests were enthusiastic. In addition to photogrammetry also medical applications were within reach. Since the photogrammetric applications on a large scale looked unsure to the management and since it was decided that no medical equipment should be produced, the first series of 25 PLP was scrapped. Within some weeks the PLP was forgotten. Just as the first restitution instrument some 10 years ago.

1965 – 1988: NO COMMON BASIS FOR DISCUSSIONS

Distance measurement was the main concern in cadastral survey. In the fifties of the last century all big firms in surveying instruments knew about the possibilities of electronics but had great respect for developments without consultants. About 1965 the cooperation with the consultant to KERN was cancelled because a recently engaged young electronic engineer promised that there were no problems which could not be solved. At the FIG congress 1971 in Wiesbaden KERN presented the electronic distance meter DM 1000. Unlike to all competitors it had no motor-driven parts. Two years later KERN presented the DM 500 at the ACSM spring convention in Washington DC. Fully developed in-house it remained for years the smallest distance meter on the market. For the KERN management a unexpected success, for all competitors a nuisance. The staff had never been encouraged or supported or even got the order to improve or to minimise or to any other step forward. The management was obviously surprised but also suspicious that a breakthrough like the DM 500 was reality. Besides the DM 1000 KERN had a license of the NRDC (National Research and Development Council) to build a distance measurement instrument which in principle was developed by the NPL (National Physical Laboratory) in Teddington (England). The Mekometer ME 3000 was extremely precise. $\frac{1}{10}$ mm for distances of 100 m were obtained. It was indispensable for dam deformation measurements and in nuclear research plants.

The optical theodolites except the DKM1 and the DKM3 were outdated. The new excellent DKM2-A was the only type which did not provoke discussions. It was presented 1968 at the ISP congress in Lausanne. Theodolites with scale microscopes, e.g. the K1-S, were blocked until 1974, when a member of the management retired. The electronic theodolite E2 based on a moiré pattern for circle reading was first shown at the FIG congress 1977 in Stockholm. After a redesign due to unforeseen substitution of discontinued electronic parts it came out by 1980. It proved to be as accurate as the DKM3. The not very reliable ME 3000 was replaced

by the Mekometer ME 5000 which had longer range and even higher accuracy. The SICORD Software was developed for free stationing with electronic theodolites and for setting out points by given coordinates. SICORD was based on the 1982 in-house developed **Data Interface DIF41** for the HP41 calculator. A step towards a surveying office in a suit case was made with the **ELFIE (Electronic field book)** software presented at the FIG congress 1986 in Toronto. Its purpose was a survey completely calculated and graphically displayed right in the field (coordinates, boundaries, surfaces, contour lines, lists of coordinates etc.). It should be compatible with INFOCAM. A new series of theodolites strictly on modular basis to fulfil different requirements should replace the E2 with modules to read the circles, to measure inclination components, motor modules to drive automatic theodolites, a module to measure distances, electronic firmware and software. The E10 was ready in 1988.

A precision plotter PG3 based on the P2 projection principle was presented at the ISP congress Lausanne 1968. The analytical **Digital Stereo Restitution** instrument DSR1 and the automatic plotter GP1 were shown at the ISP congress 1980 in Hamburg. The DSR1 was based on a small PDP computer linked to local processors for local functions, e.g. to control the movements of the frames carrying the aerial photographs. An attempt of orthophoto equipment failed as the head of the group left KERN.

Surveying is mathematically nothing but geometry and physically beside of boundary stones nothing but information. Measurements and computations transform geometry from analogous to digital. To do so information systems were essential for all instrument makers. In the Eighties KERN developed INFOCAM together with an Austrian institute. INFOCAM survived the merger with WILD-LEITZ, but was discontinued in the Nineties. Information systems became a field of activity of companies with world wide presence, e.g. INTERGRAPH. Their systems covered also the needs of surveying.

In 1968 NASA ordered a series of four 16 mm movie lenses with different focal lengths for the APOLLO-missions to the moon in 1969. The first steps of mankind on the moon had been documented on movies using KERN lenses. The management hardly noticed the importance.

Besides of geodesy, photogrammetry, lenses, KERN was active in the field of telescopic sights for military purposes, e.g. the FERO-Z 13 for tanks against air and terrestrial targets, vidicon based telescopes for observations by night for visible and for infrared light as well, photo interpretation equipment based on PG2.

FINALE

The technical success contrasted sharply with continuous hesitations of the management to decide any commercial or organisational problems. Both governing board and management were deeply suspicious about the capacities of the staff and had no confidence in their talents. Looking back too much inability if not incapability was at work on the highest level of the KERN management. Concepts and products were up to the requirements of the market but production was too small, simply because the sales volume was too small. The marketing effort was clearly underestimated.

The last member of the founder's family made the shareholders to feel unsure about the future of the company whence he had little difficulties to buy the missing shares. May 13th 1988 he sold 68% of the shares to the main competitor the WILD-LEITZ group in Heerbrugg. It was a personal defeat for all staff members.

The works in Aarau were closed in 1991.

REFERENCES

- [1] Aeschlimann, Heinz, Erb, Bruno: Doppelkreise für Theodolite, 2007, (manuscript)
- [2] Haas, Franz: J. Kern à Aarau en Suisse (Geschichte der Firma Kern), 2005, (manuscript)
- [3] Preis – Courant von J. Kern 1878: www.history-of-geodesy.ch (catalogues)
- [4] Schweizerische Geodätische Kommission,.: Heinrich Wild 1877 – 1951, Band 31, 1977
- [5] Wild, Heinrich: Die neuere Entwicklung einiger geodätischer Instrumente,.: Vermessung, Grundbuch und Karte, Zürich 1941
- [6] Stadtmuseum Aarau: archives and instrument collection of Kern
- [7] 120 Jahre Kern Aarau 1819 - 1939, Festschrift, Aarau, 1939
- [8] 125 Jahre Kern Aarau, Festschrift, Aarau, 1944
- [9] 150 Jahre Kern, Festschrift zum 150-jährigen Jubiläum, Aarau, 1969

BIOGRAPHICAL NOTES

Born in 1931. In 1956 dipl. ing. of Swiss Federal Institute of Technology Zürich (ETHZ), then for about 3 years survey work for hydro electrical power plants. Since 1960 with Kern. Thesis about dam deformation measurements in 1972. Again with Kern until 1989 as product manager for geodesy and surveying. Finally partner of an engineering company for automatic measuring systems (monitoring systems for land slides, automatic surveying systems for tunnel boring machines).

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