The Scientific Career of Frederik Hendrik Kreuger

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Research is a gamble. But the only risk greater than doing research is *not* doing it.

F. H. Kreuger

FREDERIK Hendrik Kreuger's first encounter with the outside world was in Amsterdam, on May 14, 1928. After attending high school the young Kreuger went to Delft to study Electrical Engineering at the TECHNISCHE HOGESCHOOL. In 1954 after having obtained his diploma, the young engineer took off for Sweden. He could not foresee at that time that he would return to the HV laboratory at the University at different stages in his career.

At the HV laboratories of ASEA in Västerås and in Ludvika, Kreuger took his first steps in the field. His very first publication [1] dates from the year that he was a research engineer in Sweden. In this Dutch paper he describes the use of an anti-corona lacquer for HV machines. So, from the very start, partial discharges were to Kreuger a major issue. In this first paper we can already recognize Kreuger's clear writing style: to the point, and no unnecessary details and formulas. Readability has always been very important for him and many years later when he was a professor he demanded from his students to write clear reports. An often recurring situation is the following. Kreuger (looking at the student's report): "This figure is unreadable!" Student (getting a bit nervous): "But there is a description along the figure axes ... ". Kreuger: "You mean these stains? But how can you do that to the poor reader, these small letters! You must have done that with a computer, so unclear. When I was young we learned to make technical drawings by hand!"

After a short stay in Rugby, England in the HV laboratory of British Thomson Houston, Kreuger returned to the Netherlands in 1956. At the N. V. Nederlandse Kabelfabrieken (NKF) in Delft he took a position as a research engineer in the HV research laboratory. Here his research on partial discharges began to flourish and the basis for his well-known book on detection of partial discharges was laid.

Having met his old professor Heyn again, it was decided that a PhD thesis would be written on the work Kreuger had done on detection and location of partial discharges in cables. At the CIGRE International Conference on Large High Tension Electric Systems in 1958 he was for the first time present on the international stage with his paper *Detection de décharges internes*. This was the start of a long succession of contributions especially in study committee 15 (Insulating Materials) and 21 (Cables). It must be stated that SC21 always has been Kreuger's favorite. One of the reasons probably is his denial of the importance of 'materials'. At the opening of a HV laboratory in Sweden many years later he would state that "Materials do not exist". Kreuger has never been short of direct, bold statements, and this is a good example. What he means is that we should not focus on the (insulating) material, but on the complete technical construction with all its interfaces and flaws.

In 1961 Kreuger graduated from the Technische Hogeschool Delft on *Detection and location of discharges – in particular in plastic-insulated HV cables*. Based on his PhD thesis, his pioneering book on *Discharge detection in HV equipment* [7] appeared in 1964. Even a Japanese translation appeared.

Kreuger made his way up at NKF and in 1969 he became head of the HIGH VOLTAGE RESEARCH LABORATORY and in 1976 NKF Kabel promoted him to technical director. Among other things, this meant that he had to be skilled in management tactics. Kreuger made a detailed study on this topic and published yet another book: *Management and Mismanagement in Research* [21]. One of the one-liners in this book is particularly interesting in times of declining research budgets:

"The cost of research is the price of staying in business."

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Figure 1.

View of some of the test facilities in the HV laboratory at Delft University.

On the international forum Kreuger displayed his management skills by chairing the CIGRE working group *Discharges in Cables* for many years (1963–1974).

In 1985 Kreuger returned to the HV laboratory at the University, this time as a professor, and now for good. The first research project that was initiated was a PhD study on *Computer aided recognition of partial discharges.* Pioneering work was done on the use of computers for statistical analysis of partial discharge data. In 1991 the PhD thesis of Edward Gulski appeared and this subject is now one of the pillars of the high voltage group.

At the same time Kreuger was still involved with NKF and very active when a new type of belted cable was developed. It was found that the application of a swelling tape in three-phase belted cables increased the voltage life considerably and unexpectedly. To study the physics behind this phenomenon Kreuger's second PhD student started a study on the aging process in voids in polymers. Ultra-wide band measurements, both optical and electrical, were introduced and in 1993 Peter Morshuis successfully defended his PhD thesis on that topic.

In making a scientific biography of professor Kreuger one should not forget his non-scientific side. Music, and in particular Hungarian and gypsy music are inextricably connected to Kreuger. Never will we forget the open day at the University when he and his SIPERKOV ensemble sat down in a large Faraday cage. In the darkened high voltage laboratory they played the stars from heaven while (artificial) lightning struck the cage over and over again.

Early in 1993 yet another PhD student graduated, in this case on a topic with no interference from discharges. Jing Tao had studied the fundamentals of surface charging of spacers for GIS. Some of the results of this project can be found in the book Kreuger was to write later on Industrial High DC Voltage.

At the end of the 80's alarming sounds started to reach Kreuger's ears: the number of new power engineers lagged way behind the number needed in industry. With a couple of other concerned captains of industry, he initiated the VAN STAVEREN STICHTING with the objective to promote power engineering at middle and high schools. Exhibitions were organized, special editions of popular magazines appeared and gradually the number of power engineers increased [28, 34]. There is no doubt that Kreuger's efforts have contributed greatly to this increase.

In 1991 two new PhD students started on 'Non-energy dc' and on 'Recognition of partial discharges in HV equipment'. The dc project has now become one of the major research projects and resulted in a better understanding of aging processes and partial discharges in dc apparatus. Another result of the work of Udo Fromm is the production of a partial discharge detector with diagnostic software especially developed for dc. Andrej Krivda has made an extensive study of pattern recognition methods and their suitability for classification of partial discharges.

The work of Kreuger's last PhD student, Marc Jeroense, is the proof of his growing enthusiasm for dc. In the Netherlands, the submarine cable links to Scandinavia are a topic of growing interest and led Kreuger to start a project on HVDC cables. The culmination of Kreuger's enthusiasm can be found in his recently published book *Industrial High DC Voltage* [90].

Before concluding this biography it only remains to say that on behalf of my colleagues of the HV Laboratory I wish professor Kreuger a long, healthy and active retirement. During all of his professional career, professor Kreuger has been involved in research. Therefore I would like to end with his statement:

"Research is a gamble. But the only risk greater than doing research is *not* doing it."

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