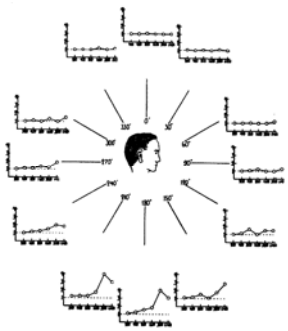
ALVAR WILSKA (1911-1987) – INTRODUCTION OF AN EXCEPTIONALLY MULTITALENTED FINNISH PHYSIOLOGY PROFESSOR, INVENTOR, SCIENTIST, AND A PHYSICIST AHEAD OF HIS TIME

Self portrait

In the year 1944 was Alvar Wilska appointed to the post of Professor of Physiology at the University of Helsinki. After the war in the 1950's, Alvar Wilska was one the best-known researchers in Finland, and a real science celebrity of that time. At the 1960's, on the other side of the world in Arizona, United States, his electron microscopy laboratory was considered to be one of the top laboratories in the world. After his death, in the 1990´s, he was listed among the most important nation builders of Finland. However, until now his work was practically forgotten. Who was Alvar Wilska?

Alvar Wilska was born in Eastern Finland in the rural municipality of Parikkala. He was the first-born in a family of thirteen children, and a gifted child. He showed interest towards the nature and technology from an early age, and at the age of fifteen he built his first telescope to observe mountains of the Moon. At the age of sixteen Wilska became the youngest high-school graduate in Finland. As a nature lover, he first chose botany as his scientific field, but later decided to continue his studies in the medical school at the University of Helsinki. Instead of a hospital career Alvar Wilska wanted to focus on research. At the Institute of Physiology he finished his doctoral thesis – Untersuchungen über das Richtungshören (Studies on directional hearing) in 1938. The original German text was rediscovered in 2006 and once the ingenuity of this research had really been understood was an English translation produced in cooperation between the Aalto University, Finland, and Philips Research Laboratories in Eindhoven, the Netherlands, under the inspiring leadership of Prof. Matti Karjalainen. (http://www.acoustics.hut.fi/publications/WilskaThesis/). Wilska performed his experiments by placing subjects in a spatial sound field, where source directions where adjusted by re-orienting the subject in three dimensions, and keeping the source fixed. He also performed sound field analyses and listening experiments by making use of a self-built dummy head which was based on a male cadaver. It consisted of a realistic reproduction of head, pinnae and ear canals, and contained self-constructed condenser microphones placed at the positions of the ear drums.



At his early academic years Alvar Wilska did not focus on any particular research theme and his "leaps" from one topic to another caused controversy inside the academia. Despite this criticism, he expressed himself: "My wise colleagues often fault me for directing my energy to far too many scientific projects and urge me to focus. However, I truly think that it is most important to harvest knowledge widely to be able to see the associations that are most worthwhile". From the 1930´s to 1950´s the flood of ideas from Wilska had materialised, as later was proven, into cutting-edge research instruments in electrophysiology and several inventions destined for everyday use.

By the end of 1930s, the development of electrophysiological methods for studies on electrically excitable tissues had enabled monitoring of population activity (i.e., fused electrical activity of a large number of cells) as well as the detection of electrical impulses (action potentials) of single cells that had been dissected free of neighbouring cells - a very laborious technique applied at that time to the optic nerve by later Nobel Laureate Haldan Keffer Hartline. However, what was not possible was the detection of impulses generated by single nerve cells from within intact vertebrate tissue. At the Institute of Physiology, University of Helsinki, Alvar Wilska developed a novel method particularly for this purpose. The key element in Wilska's method was the microelectrode that consisted of a sharpened metal wire and a glass capillary that was collapsed on it to provide electrical insulation up to its very microscopic tip. Wilska understood that when such an electrode is small enough, its tip picks up extracellular potential deflections that are generated by action potentials of only one cell. Not only did Alvar Wilska develop the novel microelectrodes ("Wilska-electrode") but he also verified the applicability of the method in muscle and retina in a series of papers published in late 1930s. The possibility of detecting single cell activity from intact tissue was a methodological breakthrough, and the novel method was soon adopted by many researchers. Alvar Wilska's Finnish contemporary at the Institute of Physiology, Ragnar Granit, used such electrodes in his retinal studies for which he received Nobel Prize in 1967, together with Haldan Keffer Hartline. Alvar Wilska collaborated with Hartline in United States during the WWII. It is appreciable that in 1930's Institute of Physiology in remote Finnish capital could offer possibilities for cutting edge research for two outstanding scientists, Wilska and Granit, at the same time.

Developing technology of science was one of Wilska's missions: "I feel that my mission is to develop methods so that scientists may make a good use of them when striving for their goals".

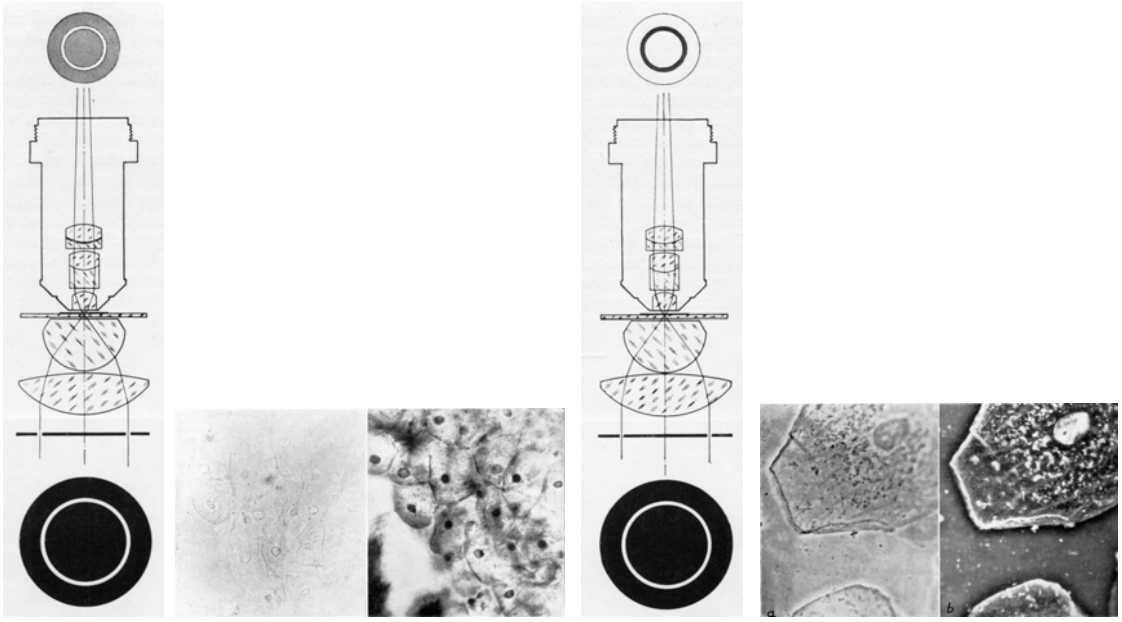
Materials and methods of manufacturing metal microelectrodes have changed since the days of Alvar Wilska, but the basic concept of his microelectrode technique is still widely used in what is nowadays called unit activity recording.

During the Second World War Wilska became the Professor of Physiology at the University of Helsinki and worked as the Head of the Wihuri Research Institute (Salus Hospital). During the war, he served his country as a scientist. He developed a useful tool for war surgery, the "stereoscopic X-ray fluoroscope", an X-ray instrument enabling the surgeon to locate shrapnel and other foreign bodies accurately for removal, and made inventions to ease the hardships of everyday life, and invented inexpensive methods for the air and anti-tank defence.

Alvar Wilska was also a passionate promoter of many public health issues. Modern public health work in Finland for prevention of chronic diseases and promotion of health started in a practical way in the 1970's with the passage of the public health and tobacco laws, and starting national health projects. In this respect the writings and activities of Alvar Wilska were amazing and so much ahead of their time. In the 1940's and the 1950's, before moving to the USA in 1959, professor Wilska wrote pioneering articles about the need for science based public health work, about the role of cholesterol in coronary heart disease, about the role of sugar in dental caries, about the harms caused by alcohol and in a very pioneering way about the great damage to health caused by smoking: "We are approaching and witnessing a turning point in a tragedy of mankind, which in the same time will be a big event in the history of medicine." Alvar Wilska did not only write and speak. He also introduced many public health activities, he tried to establish an

antismoking association, argued with dairy industry about the need to reduce dairy fat, and condemned obesity as unhealthy. Later, he was proven to be right – but too early!

After the war, Wilska started to study electron microscopes and gradually his work focused on them. The first Finnish electron microscope was completed in his laboratory in 1949. During the following decade he invented and built the Anoptral microscope (article in Nature, 1953) used for observing living biological specimens. At the same time he made plans to make the electron microscope more suitable for biological samples, in that respect reminiscent of the anoptral microscope. To see the living microscopic world with good contrast without staining the cells, Alvar Wilska darkened the objective and condenser lenses with soot from a candle flame. The light was then let through the concentric rings. This microscope, called an Umbral microscope, gave better contrast than a regular microscope without staining the specimen. When AW made a soot ring on the objective lens heavy, objects such as cells were seen even with better contrast on a golden brown background with darker area around the edges. This gave a three-dimensional effect to the observed specimen. Because of its exceptionally good contrast and resolution researchers many times found anoptral microscope more useful than the phase-contrast microscope that was awarded the Nobel-prize in 1953. The theoretical principle of the Anoptral was explained by Dr. Friz Gabler from the Optische Werke C. Reichert Corporation, which also started the manufacture of Anoptral microscopes.



Umbral Anoptral

Instead of letting the light beam come through a ring on sootened objective as in Umbral, in Anoptral the ring was sootened, which gave better contrast against light brown backround. In addition, the object was seen three-dimensionally. In his optical research, Alvar Wilska's primary idea and a dream was to see biological phenomena as is, without manipulation.

Thanks to his highly innovative ideas in optical research, Alvar Wilska received an invitation to work in the United States, where he moved in 1959. For the first time, he had adequate resources at his disposal and results were gained fast. In few years time Wilska´s laboratory at the University of Arizona became one of the top laboratories in the world for the development of modern electron microscopes.

In the early 1930's Ernst Ruska succeeded in constructing the first electron microscope, but his TEM had a lower resolution than that of light microscopes of the time. It was the beginning of development of electron microscopes in which Alvar Wilska participated. Ruska and Wilska had correspondence about the problems in the field.

Now, as a Professor of Physics at the University of Arizona, AW was able to concentrate on the improvement of the instrument. As a medical doctor, Wilska was interested in getting good images of biomedical samples. To achieve this he used low accelerating voltage and did not fix or stain the specimen. This often caused instability and other problems during photographic documentation. He experimented with several permanent magnetic lens systems and succeeded in correcting interference caused by spherical aberration. He reached high contrast without heavy metal casting.

Finally, Wilska succeed in shortening his microscope to 32 cm! the conventional ones being two metres high. His dream was to create an instrument that would be easy to use in less than perfect conditions. For years he did not want to release his microscope for production because he could foresee that the constantly developing auxiliary techniques gave possibilities to improve the instrument further. In 1979 he started working with the Japanese company Akashi, but this collaboration had to be discontinued in a few years. Travelling between Tucson, Tokyo and Helsinki was too much for his health and he had to finish working even in Arizona. AW returned to Finland and kept developing the instrument in his home laboratory in the basement of his house until November 1987, when he finished his last plans. At the later stages of his career, he finally received valuable help from the Technical Research Centre of Finland (VTT), which gave a four-person group for finishing his work. Matti Ryynänen did build an instrument with his colleagues. The team published a paper on it in 1994.

Alvar Wilska was an important figure in the field of electron microscopy. Even today, many of Wilska's innovations have been used in TEMs of many well known companies, and his small TEMs could be valuable instruments in modern biomedical research.

Alvar Wilska passed away at the age of 76, only three weeks after finishing his final plans of a next-generation TEM.

Alvar Wilska's motto: One should never be left clueless.

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1920's
Starts medical studies at the University of Helsinki

1940's
Professor of Physiology, Head of the Wihuri Research Institute (Salus Hospital), wartime inventions for evereyday life, stereoscopic X-ray instrument for surgery, inventions for air and anti-tank defense (for example ingition mechanism for "Molotov's cocktail"). Work on developing microscopes starts

1960-1980's
Ceaseless work on developing electron microscopes in USA and Finland, pursuit of perfection,
retiring from publicity

Death 1987

Birth 1911

1930's
Research on tympanic vibrations, muscle and neurophysiology (Wilska-electrode), thesis: Untersuchnungen über das Richtungshören (Studies on directional hearing)

1950's
Science celebrity and public figure, leading the way for national health work (anti sugar, fat, salt and alcohol) , health innovations, "let's wilska!") , Anoptral microscope – a success!, focusing more and more on electron microscopes, New Orleans 1959 - AW reaches the cutting edge of EM research

Future prospects? TEM on your desk…