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Preface

This year's booklet is the fourth in the series of chronicles produced by the Finnish Academies of Technology, FACTE, and is dedicated to Vilho Väisälä (1889 – 1969) for his achievements as scientist, inventor, entrepreneur and industrialist.

The immediate reason for featuring Vilho Väisälä in 2006 is the 70 years' anniversary of the Vaisala company founded by Vilho Väisälä (V.Väisälä Ltd).

Vilho Väisälä had an exceptionally wide-ranging career in many fields of science and technology. His intensive work around the clock, especially in radiosonde technology, led to valuable inventions and innovations whose influence extended all over the world. He was also a Finnish pioneer in internationalisation.

We thank the author, Academician, Professor Olli Lehto for his exhaustive work, which is a worthy tribute to Vilho Väisälä, a great contributor in developing Finland into a high technology country.

Asko Saarela
President of the Finnish
Academies of Technology

Pekka Ketonen
President & CEO
Vaisala Oyj

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VILHO VÄISÄLÄ 1889–1969
Scientist, inventor and entrepreneur

In March 1931, Dr. Vilho Väisälä, a departmental head at the Finnish Meteorological Institute (FMI), saw a Russian weather sounding device that had fallen from the sky and been found in the Karelian Isthmus just inside Finland's border with the Soviet Union. The device exploited radio technology, which was just then being introduced in meteorology. In Väisälä's opinion, a fine idea had been so poorly implemented that he decided to do it better. This was easier said than done, but after five years of toil, Vilho Väisälä completed a radiosonde which he pronounced as the best in the world. To manufacture and market it, he founded a high tech company in 1936 which has grown into the world's leading supplier of meteorological radiosondes, known as the Vaisala Group.

In 1963, Vilho Väisälä donated about a fifth of Vaisala's shares to the Finnish Academy of Science and Letters. The donation was to form the "Vilho, Yrjö and Kalle Väisälä Foundation" to promote the study of mathematics and the natural sciences. Yrjö and Kalle Väisälä were the beloved brothers of Vilho; Yrjö had become a world-famous geodesist and astronomer and Kalle a professor of mathematics. Due to the success of the Vaisala company, the Väisälä Foundation has become Finland's largest private supporter of scientific research in the fields represented by the brothers.

Family and childhood

Vilho Väisälä was born on 28 September 1889 in the Northern Karelian village of Utra, which is nowadays part of the City of Joensuu. The rise of the peasant family to the intelligentsia had begun at the end of the 1700s at which time Vilho's great grandfather, Josua Väisänen had been sent to school. Since the schools in Finland at that time were conducted in the Swedish language, Josua was given the new surname of Weisell. As Finnish national consciousness strengthened, Josua's descendants gave the name a Finnish form, Väisälä, at the beginning of the 1900s.

Although Josua Weisell's theological studies at the Åbo Akademi were uncompleted, his son, Vilho's grandfather, was ordained as a priest. Of his seven children, the Weisell name was continued only through his son Johannes Weisell. He, too, fell sick of a serious disease as a small child, as a result of which his leg was permanently paralysed. As a child he could only move by crawling, while later he learnt to move with difficulty by means of crutches. After matriculating from the Kuopio Lyceum, he did not continue his studies but took a job as an office clerk at the Utra sawmill.

Johannes Weisell married Emma Jääskelä from Ostrobothnia who, on her mother's side, was descended from the well-known and educated Cannelin family. They conceived eight children, of whom one died in infancy, but the others lived until their old age. Five were boys, two were girls and all matriculated from the upper secondary school. The three youngest – Vilho (1889–1969), Yrjö (1891–1971) and Kalle (1893–1968) – became professors.

It is said that the disabled father never complained about his hard lot in life. For some reason, God had ordained this fate for him. Although his infirmity prevented him from participating in many everyday chores, he was so active in his intellectual pursuits that his thirst for knowledge and tireless work permeated the atmosphere of the house. Especially important was the father's technical inventiveness, coupled with a tendency for mathematical theories. It was just this trait that later characterised his son, Vilho.

When Vilho was still a schoolboy, the Weisell family life began to shatter. The English-owned Utra sawmill and its forests were sold and the new owner closed the mill down. When the handicapped Johannes Weisell lost his job it was a severe blow for the family, and the situation soon became even harsher when Johannes suddenly died of a heart attack in 1904.

The family's plight was extreme, for there was little in the way of public social security. The only near relatives who earned an income were the two oldest children and Johannes' two unmarried sisters, and even they did not earn much. Despite all, care was taken to ensure that the studies of the five children still at school were not interrupted. All had to have the opportunity for an academic education. The family's personal bonds were strong and warm, with each member extending a helping hand to the best of his/her ability. Those difficult years knitted an already close family even more tightly together.

With the severance pay granted by the English company to its long-term employee, the widow bought a small house in Joensuu. No longer was she dependent on the employee apartment at Utra, and the education of Vilho, Yrjö and Kalle was eased.

Vilho Väisälä attended the Joensuu Classical Lyceum and matriculated from there in 1908. He was fortunate in the sense that his home town of Joensuu was one of the few places in Finland with a Finnish-language school leading to the university. At that time, the Joensuu Lyceum was an elite institute of learning; many of its teachers had doctoral degrees, and only about fifteen pupils matriculated every year.

The teaching syllabus was strongly oriented towards languages. The teaching of Swedish right from the first class was not exceptional, and nor was the strong position

VILHO VÄISÄLÄ IN HIS WHITE CAP, DENOTING THE ADMISSION TO THE UNIVERSITY.

of the Russian language in a country which had become a duchy in the Russian Empire. In the eight-class school, Latin was read from the third class, German and Greek from the fifth class and French from the sixth class. Greek and French were optional, but in the three final classes, it was possible to study as many as six foreign languages. Vilho took full advantage of this possibility.

Having received a good grounding, Vilho continued his language studies as an adult, too. While engaging in international business he found it was necessary to augment the languages he had acquired at school by English, Spanish and Italian, and as his studies moved into full gear, also Japanese. His exceptionally diverse language skills were supplemented by Esperanto.

A common school-time passion among all three of the younger children – Vilho, Yrjö and Kalle – was mathematics, in which they gained extra-curricular knowledge through self-study. Vilho claimed later that he had exhibited Bohemian tendencies at school. "I wasn't interested in anything very seriously – mostly only the female students and sport. I played the violin a little, too." Nevertheless, there was quite a lot of pressure on him to take up mathematics. "My brother Yrjö made me study it, so I got a kind of feel for it." Despite his words, Vilho was always the best or second-best in his class at the upper levels.

Meteorologist by accident

After matriculating, Vilho Väisälä left for Helsinki in autumn 1908 and began his studies at the university. He chose mathematics as his major, and targeted a high grade in physics and astronomy, too. The university's teaching language was still mainly Swedish, even though Finnish-language undergraduates were already in the majority and were rapidly enlarging their relative share. Swedish comprehension caused no difficulties for Vilho, and he wasted no breath on language questions, even though he was strongly pro-Finnish.

Although Vilho and later his brothers Yrjö and Kalle had problems funding their studies, they eventually cleared this hurdle quite well. Their support for each other afforded them a sense of security, while, as top grade students, they received grants from the university and were creditworthy – meaning they could borrow from the students' union and the bank, if necessary. As the most liberal of the brothers in his use of money, Vilho fell into debt in his student days quite considerably, but paid off his loans as quickly as possible upon obtaining gainful employment.

Ernst Lindelöf, Professor of Mathematics, was quick to notice the talented Vilho Väisälä and, when Vilho had completed his Master's degree with excellent grades, urged him to continue his studies to the doctoral level. As the subject for his dissertation, he set a question concerning elliptic functions. As Väisälä had already written a highly-graded master's thesis in this area, Lindelöf believed that a meritorious dissertation would quickly be created.

This was not to be, however. Vilho had fallen in love and wanted to get married with his young fiancée, Aino Blomqvist. Marriage presumed a workplace and such was found at the Meteorological Institute located near Vilho's student flat. He was employed there for magnetic work in the spring of 1912. In its desire to emphasise its autonomy, Finland had a little earlier committed itself to playing a role in the preparation of a global atlas of magnetic fields – even though the country could only just scrape up enough qualified labour for the job. After a quick course at the Pavlovsk Meteorological Observatory near St. Petersburg, and backed up by his very promising studies in mathematics, physics and astronomy, Vilho Väisälä was given the task of managing one survey team.

Väisälä fared well in the magnetic surveys that took place in Eastern Finland over the whole summer, and was ready in the autumn to mathematically transform the re-

THE MAIN BUILDING OF THE ILMALA METEOROLOGICAL OBSERVATORY AT PASILA, HELSINKI. THIS WAS WHERE VILHO VÄISÄLÄ WORKED FROM 1912 TO 1948 AND WHERE HIS FAMILY RESIDED FROM 1912 TO 1926.

sults into their final form. The head of the Meteorological Institute offered him an official residence at the newly completed Meteorological Observatory at Pasila on the northern fringes of Helsinki where, whenever his work on magnetic fields permitted, he could also participate in making meteorological observations. The just-married Väisälä accepted the offer and thus took his first step towards a career in meteorology.

The magnetic surveys continued during the following summers, too, and kept Vilho away from home for long periods. His wife, Aino, did not like it – especially after the arrival of their first-born. Nor was Vilho's pay anything to boast about, and he determined to switch his field of employment. One realistic possibility was to become a teacher in mathematics and natural sciences at grammar school and, in order to qualify, he registered himself at the Finnish Normal Lyceum and began to visit classes as a student-teacher in the autumn of 1915. But fate intervened. In spring 1916 the head of the Pasila observatory transferred to another position and Vilho Väisälä was appointed as his successor.

The appointment signalled Väisälä's final coupling with meteorology, a field into which, in his own words, he got into by pure accident. The completion of his mathematical dissertation had remained on the back-burner, but in 1917 Vilho Väisälä at last succeeded in bringing it

to a close. In claiming later that his dissertation had no other benefit than to help him attain his Ph.D. degree, Väisälä was guilty of exaggeration. Throughout his life mathematics remained a tool that he constantly resorted to in studying meteorology and designing measurement devices.

Right from the outset, the Pasila meteorological observatory focused especially on taking measurements in the upper atmosphere. Self-recording thermometers, barometers and hygrometers were lifted into the air by means of kites. When the First World War broke out in 1914, the Russians forbade kite observations, but in 1918 the Pasila station experienced a brief resurgence in the period in which German military authorities, who needed weather observations, held political sway in Finland. The appropriations awarded to the station grew considerably, kite observations were restarted and the practice was started of also sending measurement devices into the atmosphere with hydrogen-filled rubber balloons, which could reach greater heights than kites.

When peace was restored to the world, Vilho Väisälä made study trips to Germany and Norway and began to develop his observatory. He made conscientious efforts to enhance his meteorological expertise and also engaged in theoretical research. In the early 1920s, he arranged an extensive experiment, reporting its observation results in

VILHO VÄISÄLÄ IN TAMPERE ON INTERNATIONAL WEATHER OBSERVATION DAY IN 1934, AT WHICH TIME HIS RADIOSONDE WAS NOT YET READY. Tampere was chosen as the launch site to ensure that all the self-recording devices launched would fall on their native soil, instead of the sea.

the publication "Über die Wirkung der Windschwankungen auf die Pilotbeobachtungen" appearing in 1925. In this work Väisälä defined a concept that is today known as the Brunt-Väisälä frequency. It relates to all phenomena, from the geosphere to the entire universe, and therefore is relevant not only to the study of meteorology but also to many other university courses. During his lifetime Väisälä never knew what an enduring scientific reputation he would gain through the frequency concept he defined.

The immediate consequence of Väisälä's meteorological research was that he was appointed as a docent (senior lecturer) in meteorology at the University of Helsinki in 1926. He himself regarded the academic teaching vocation that he received through this appointment as extremely important. Through his lectures as a docent, he could improve his self-study by teaching others. "As a docent, I was totally free to do what I wanted. I always lectured on just those subjects that I myself wanted to study."

In addition to his theoretical work, Väisälä began to study the advantages and disadvantages of aerological measurement devices made in various countries. As an expert, he set to work himself to try and improve them, and, almost without noticing it, he became an innovator. The first stage of designing equipment usually con-

sisted of mathematical calculations put down by pen on paper. When this theoretical know-how was combined with Väisälä's in-built technical brilliance and his practical experience acquired in the field, good results were inevitable.

Building a radiosonde

The most challenging problem of atmospheric research in the 1920s was how to retrieve the results of observations made at high altitudes. Although measurement devices could be brought back by using kites, they could not be sent up as high as was necessary. Hydrogen balloons did not have this drawback, but at high altitudes they ultimately burst and the fallen equipment often disappeared or was found too late. The advance of radio technology threw up completely new possibilities to transmit the measurements taken by balloon-hoisted instruments back to the ground by radio. Research and development was carried out in many places, especially in France, Germany and the Soviet Union.

As already mentioned, fate once again intervened in Väisälä's meteorological career when a fallen Russian radiosonde was found in Finland in 1931. Upon acquainting himself with the instrument, Väisälä noted that a superb idea had been poorly implemented and decided to build a better one. This was the most important decision of his career and one which came to have incredibly far-reaching consequences.

From Väisälä's perspective, the Russian radiosonde had chosen an opportune moment for its unexpected appearance. At the beginning of 1931 the head of the Finnish Meteorological Institute (FMI) had retired. The selection of a new director was a long process and during that period Väisälä had fairly free hands to decide what to do at the Pasila meteorological observatory. This was necessary, for his decision to build the "world's best radiosonde" kept him occupied for years in this ambitious endeavour.

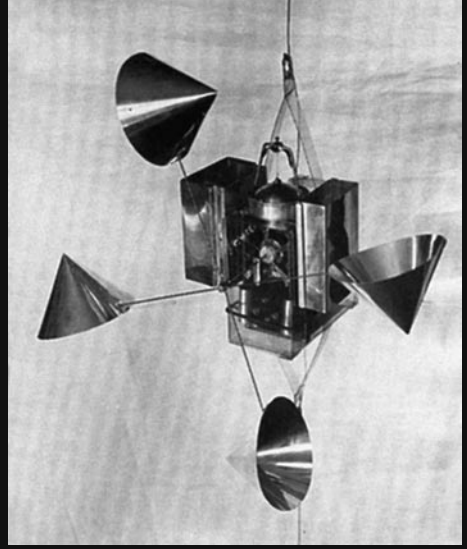
When he set about building his sonde, Väisälä's intention was not merely to improve the Russian device, but to redesign everything right from scratch. The decision affected not only the measurement devices, but the whole sounding system, which should be capable of transmitting the temperature, air pressure and moisture measurements back to earth as easily recognisable radio signals. The years 1931–1936 were the most industrious of his life. In 1926 the Väisäläs had moved into a new apartment building whose current address is Mannerheimintie 66. There Vilho returned after the close of his normal workday in Pasila, but he went back to his workplace in the evening to build his sounding device. He worked long days, often into the small hours of the morning. From 1934, the Ministry of Education supported his project by offering a three-year grant which Väisälä used to hire a post-graduate student, Mauri Tommila, to assist him. He turned out to be very competent and, in Väisälä's words, he carried "the burden and heat of the day, and often also of the night, in the laboratory."

The chief candidates for the new director of the Finnish Meteorological Institute were the departmental heads of FMI – Vilho Väisälä and Jaakko Keränen. They were extremely well-matched. Expert opinions were divided and when the Finnish government voted on the matter the vote was tied. Väisälä was finally proposed to President Svinhufvud for the director's post because Prime Minister Kivimäki had voted for him. However, the President chose Keränen.

In the same year 1934 when the Ministry of Education began to support Väisälä's project, the new head of FMI, Jaakko Keränen, forbade Väisälä from continuing the development of the radiosonde. He feared that Väisälä's pet project was interfering too much with the normal operations of the Pasila station and he did not share Väisälä's faith in the future of the self-made radiosonde. Väisälä took no notice of the order. The development of the instrument was so far along the way to a successful outcome that the work could not be dropped and, after all, he had the high-level support of the Ministry of Education. Jaakko Keränen and Vilho Väisälä had known each other for a long time and had had much co-operation.

Keränen did not renew his ban, and the development of the radiosonde was continued.

By 1934 Väisälä had calculated the theoretical grounds for the operation of his radiosonde, but many technical difficulties remained. Although the experiments went on endlessly and scores of failed test pieces were abandoned, Väisälä did not despair. On the contrary, in early 1935 he described his instrument in the scientific publication "Eine neue Radiosonde", and at the end of the same year he announced to the International Meteorological Organisation that his radiosonde was ready for sale, published a price list of different items and even the delivery schedules, even though a delivery-sure, marketable radiosonde did not yet exist. At last the tension broke. "The device had reached a stage of development that it was sure to work." Väisälä considered the date of completion of the RS 11 radiosonde to be April, 1936. In his own words: "When I developed the radiosonde, it wasn't just an individual invention, but a whole series of inventions. It was necessary to overcome an almost countless number of small and large difficulties, and an enormous amount of time was spent on conducting scientific measurements, experiments and calculations. Now I have completed the most perfect radiosonde system in the world." The special features of Väisälä's radiosonde were its economical price and light weight which eased its lifting into the air.



VÄISÄLÄ'S RS 11 RADIOSONDE, COMPLETED IN 1936, BECAME THE FOUNDATION OF HIS BUSINESS THAT WAS INTERNATIONAL FROM THE OUTSET.
The structure of four "cups" at the ends of thin shafts rotates the coupling. There is a thermometer on the left and a barometer on the right, both in radiation-protected chambers, and a moisture gauge on top. The transmitter and batteries are situated in the back part of the device.

Own business

Väisälä commenced the manufacture of his radiosonde immediately the system fulfilled the standards of accuracy and reliability he had set. The transition from product development to production happened so smoothly that the first instruments for sale were made by habit in the workshop of the Pasila observatory. When orders began to accumulate, Väisälä realised he would have to move the production away from Pasila. Together with a couple of his assistants he commenced production in the rented basement of his apartment building in Mannerheimintie street. It is reminiscent of the launch of Hewlett-Packard in a Californian garage.

Väisälä decided to do his own marketing without any intermediary sales organisation. He became an entrepreneur who founded the firm of "V.Väisälä" in 1936, although it was officially registered only in 1941. He remained the president right up to his death in 1969. And this was his secondary occupation in the sense that, despite the growth of his company, he did not relinquish his permanent public sector posts – he was a departmental head of FMI until 1948 and a professor of meteorology at the University of Helsinki from 1948–1956. As he himself

said repeatedly: "I'm more of a scientist than a businessman." In the first article of its articles of association, the company's line of business was defined as "to carry out the manufacture of scientific and technical devices and to financially support scientific research."

Väisälä gained his first order just when he had announced that his radiosonde was ready. The customer was Professor Carl Gustav Rossby from the Massachusetts Institute of Technology who was planning a research expedition to Cuba and ordered 20 radiosondes from Väisälä. Prior to the outbreak of the Second World War, the Meteorological Institutes of Sweden, Denmark and Norway switched over to the Väisälä radiosondes, and England and Poland also became customer countries. FMI became interested to the extent that at the end of 1936 soundings were made with the new equipment. Director Keränen had not yet really warmed to the idea, however. In March 1937 he gave an interview to the Helsingin Sanomat daily newspaper in which one heading was: "Radiosondes still unreliable".

By 1936 about 15 different radiosondes had been developed in various countries and market competition was tough. Nevertheless, sales of the Väisälä equipment got off to a good start. Initially the number of company personnel remained small, with four persons permanently employed in 1939. The Soviet Union's attack on Finland

in November 1939 stifled what had been an encouraging start to exports, but this was soon replaced by a new customer when the Finnish defence forces showed interest in the Väisälä radiosonde. Väisälä's official post in FMI and his job as an entrepreneur became increasingly intertwined.

Although Vilho Väisälä had not taken up arms in Finland's civil war of 1918, it did not denote a passive attitude towards national defence in independent Finland. From the early years of the 1920s he had co-operated with the air force in studying the upper atmosphere with the help of aircraft. In these contacts he was not just the receiving party, but also made suggestions on how to develop the military weather service. The new FMI director Keränen also strove to promote co-operation between his institute and the defence forces, but the scarcity of funds hindered the fulfilment of his plans.

During the period of peace that followed the "Winter War" between the Soviet Union and Finland (1939–40), the University of Helsinki marked its 300th anniversary. In honour of the event, which was celebrated more modestly than had been envisaged, the Finnish President granted the title of honorary professor to six meritorious representatives of the sciences and arts. One of them was Vilho Väisälä.

In contrast to the Winter War, when to a large extent a weather service had to be organised for the Finnish defence forces without any proper planning, there was a greater state of readiness when the "Continuation War" broke out in 1941. As FMI was subordinated to the weather bureau at the army headquarters in Mikkeli, Väisälä became a civil servant under the defence forces.

The Väisälä radiosonde was used by the Finnish defence forces to make weather observations in many localities right from the outset of the Continuation War. There was great demand for radiosondes and entrepreneur Väisälä quickly became fully employed in his small workshop. In addition, Väisälä taught meteorology courses on aerology and observation methods for the air force. But the other branches of the armed forces also required a weather service. The success of the field artillery, which played a key role in Finland's great defensive battles of 1944, can be partly attributed to the improved weather service produced for the artillery by the Väisälä radiosondes.

The war did not shake the optimistic Väisälä's faith in the future. While hostilities were still continuing he made a number of organisational changes with a view to expanding activities. At the beginning of 1944 he founded Mittari Oy (Mittari Ltd) as a production company and a

THE VAISALA COMPANY'S FIRST WOODEN FACTORY WAS COMPLETED AT PASILA IN 1946.

little later V. Väisälä Oy (V. Väisälä Ltd) for commercial activities. Indeed, exports again got off to a good start after the war. Delivery volumes began to grow so fast that a factory building became essential. So it was that Mittari's wooden factory building was completed near the Pasila observatory in 1946. The move from the basement workshop in Mannerheimintie street meant the near quadrupling of production space, which made substantial personnel increases possible.

The Second World War had raised the prestige of meteorology when it was noticed what a decisive influence the weather could have on military operations. The best example was the Normandy landings. In order to improve weather forecasting and the conditions for flying, much effort was put into meteorological research and observations, and this trend continued after the war, too.

Vilho Väisälä had been right in his assessments of the growth in demand for radiosondes. However, he was soon to discover that business would be affected by the strategic importance of the radiosondes; in particular, the most powerful of the world's nations were aiming at self-sufficiency in this field. It became clear to Väisälä that the export of his products to the technologically most advanced countries would in many cases be impossible. An exception was Scandinavia where the market for the Väisälä radiosonde expanded dramatically imme-

diately after the war. In 1944 an interim agreement had already been made on the manufacture under licence of the Väisälä radiosonde in Sweden and in 1947 this was continued by an oral agreement for some years. A reason for co-operation with Sweden was also the difficulty in importing the necessary raw materials and components to Finland.

As the Western markets were slow, Väisälä began to focus his export efforts on the developing countries. Marketing was forwarded by the good reputation and economical price of the radiosonde, but there were also problems. Finland was a poorly-known, far-off country, and if something was known about Finland it did not necessarily help exports. The radiosondes were largely disposable items – they were generally lost along with the balloon – and therefore buyers needed assurance of their continuing, uninterrupted supply. Although the best solution in many cases seemed to be the establishment of local production, Väisälä was wary of this and avoided it right up to the 1960s.

Vilho Väisälä's work in developing foreign trade was amateurish in the sense that he had no sales organisation, but preferred to rely on his network of professional colleagues for foreign contacts. Nonetheless, the fact that business grew rapidly from such a haphazard basis and in difficult circumstance tells much about the quality of the equipment and Väisälä's personal abilities and charisma. He himself had designed the devices he sold, and was expert in every aspect of their operation. It bolstered his image that he was an inventor who swore by the name of science.

The growing manufacturing operation had hardly got into full gear in the Mittari company's new production hall when a great change occurred in Vilho Väisälä's life. He left FMI after 36 years of service when he was appointed as professor of meteorology at the University of Helsinki in 1948.

Professor of meteorology

Meteorology was in a weak position at the University of Helsinki, even though the meteorological department had been established in 1921 and meteorology had become an independent subject two years later. There was no permanent post in meteorology and the department operated in cramped quarters in the physics institute building. Professor Oscar Johansson's position was individual, so that meteorology could lose its chair when Johansson retired. This was due to happen in 1945 or, if he was granted a three-year extension, at the latest in 1948 when he would be 70 years old.

While the war was still going on, the physics professors had taken action to boost the position of meteorology and had proposed the creation of two new personal professorships. The candidates they proposed were Professor Vilho Väisälä and the head of the marine research department, Professor Erik Palmén, both of whom were university docents. The war provided an extra justification for the proposal. "Since the practical import of meteorology has greatly increased in recent times, it is essential to upgrade meteorological teaching at the University which is also responsible for areas of practical life such

as the scientific education of meteorologists operating in the service of air traffic or in military tasks." The mathematics-natural sciences faculty decided to propose to the University Council that Erik Palmén and Vilho Väisälä be nominated as personal professors.

The war prevented establishment of the posts, however, and when peace was restored, meteorology had lost its importance for the defence forces. However, the Finnish government wanted to promote science, even in the difficult post-war period. The budget for 1947 contained appropriations to found the Academy of Finland and four new personal professorships for the University of Helsinki. In the inter-faculty competition for these posts, meteorology received one, but Palmén was appointed, not Väisälä. At this point, fate again stepped in. Palmén, who was on a study leave, had not yet taken up his post when he was appointed as a member of the newly established Academy of Finland. Thus the meteorology professorship was awarded to Vilho Väisälä.

Väisälä had developed the modest Pasila meteorological observatory into a significant research and observation centre. By the time he was appointed professor of meteorology, the company he had founded from nothing was progressing well and had built a new factory. As a novice professor, he was for the third time in the position of pioneer, for he inherited a department of meteorology

that was in a miserable state. It had the use of only three rooms in the institute of physics, no permanent staff at all and a negligible annual grant. Practical experiments were carried out, as Väisälä well knew, in the Pasila observatory since it was not possible in the small premises of the department. The scarcity of resources was partly the fault of Professor Johansson who had run the department since 1921 and had not bothered to fight for funds.

With his usual energy, Väisälä set about putting the department into better shape. During his ten-year tenure, 1948–58, meteorology gained a notably stronger position at the University of Helsinki. This process took place exceptionally, for the department of meteorology was maintained largely by donations made by the Väisälä company. This made it possible to hire a research assistant, an office clerk and a laboratory assistant, acquire the majority of the equipment needed for teaching and build up a meteorological library.

The University of Helsinki's department of meteorology was integrated with the Väisälä company, for the research assistant did a lot of the company's work and the operations of the department were directed mainly at instrument meteorology. The university was so clearly the recipient party that the legal and ethical aspects of Väisälä's actions were not questioned. As the development of the Väisälä radiosonde had been done partly

with funds from FMI, Professor Väisälä now paid back his "debt" to the government. In money matters he was both generous and precise; an exact record was kept at Mittari Ltd of the considerable donations made to the university.

Väisälä's department began to arouse favourable attention and success brought friends and influence. Väisälä's word began to carry weight. Public funds began to be received for the purchase of equipment and various other purposes, while the meagre department funding increased more than tenfold.

It was also important to impose some method on what had been rather random teaching practices. The lecturers, Professor Väisälä and the meteorology and geophysics docents held a meeting every year in March where they planned the following year's curriculum. The docents normally abided by Väisälä's wishes and lectured on some specialities related to the courses, but occasionally took advantage of the docent's teaching freedoms and reported on their researches. Väisälä himself preferred to lecture on subjects related to meteorological measurement instruments and observation methods, but also delved into theoretical questions, dynamic meteorology and thermo-dynamics, all subjects with which he was familiar. He was regarded as a good teacher who got his message across.

Through his professorship, Vilho Väisälä gradually fell into a new daily schedule. During his initial years as a professor, he lectured in the afternoons, but then changed his routine. Early bird as he was, he appeared in the department bright and early, held his lecture from 8 to 10 on those days when they were scheduled, and otherwise buried himself in his scientific work. It was theoretical research related to the upper atmosphere and radiosondes. Before his lunch break he took care of sundry administrative matters and often had time to drop into the laboratory to discuss the work of the research assistant. At these times he would willingly chat about events in his childhood and schooling in Joensuu. Väisälä went home for lunch and, if there was no special reason, would not return to the university. The afternoon's work continued in his own factory where there was much to do.

The University's long-pending project on a great "Institute building" (which upon completion was christened Porthania) finally got underway in the 1950s. The building was primarily intended for humanities, law and social sciences, but owing to Väisälä's activities, space was found on the uppermost floor for meteorology, too. The department moved there in 1957. Later, its conspicuous landmark was the spherical protective shell of a weather radar located on the roof of Porthania – but this belongs to the period after Väisälä's time.

Vilho Väisälä became a professor at a relatively mature age. When his retirement began to loom, a wave of concern again spread at the University of Helsinki over the future of meteorology, for there was still no permanent post in this field. It is to Väisälä's credit that, before retiring, he arranged sufficient premises for meteorology and the post of ordinary professor.

Väisälä also succeeded in bringing about the second of his grand aims – the establishment of a full chair in meteorology. When this was achieved at the beginning of 1957, the 67-year-old Vilho Väisälä was its first temporary holder "for the time being and for no longer than it takes to refill the post". A new professor was appointed on 6 June, 1958, thus marking the end to Vilho Väisälä's university career. At his factory, however, he was known for the rest of his life as the "Professor" (if he himself was present) or simply as the "Prof".

Vaisala company

Upon becoming professor in 1948, Vilho Väisälä had wished to detach himself as much as possible from practical duties and spend more time on scientific study. Over the years he would often say: "I'm more of a scientist than a businessman." Soon after his appointment, Vilho engaged his lawyer brother, Hannes Väisälä, as the vice president of the company. But hardly had Hannes taken up this new post than he died suddenly in 1949. As Vilho wanted to keep the company management in the family, he recruited Hannes' 29-year-old son, Pentti Väisälä, an engineering graduate, and began to train him to be vice president.

The post-war progress of Väisälä's company is well depicted by the fact that, from 1945 to 1955, the annual sales of his radiosondes increased from 1,000 to over 25,000. When Mittari Ltd's factory premises became insufficient, Väisälä acquired land by the Nurmijärventie road in Vantaa (adjoining Helsinki in the north) and established production facilities there in 1955. As well as moving to Vantaa, the Mittari company gained a new name, Vaisala Oy (Vaisala Ltd) under which all business operations were subordinated in 1958.

As the 1950s wore on, Vilho increasingly transferred responsibility for operational management to Pentti Väisälä. In 1955, Pentti presented a paper outlining his vision of the future. The company was doing well, but in a narrow field. This was a source of risk for two reasons. First, the unstable political situation in the world might break foreign trading relationships on which the company's operations depended, and secondly the huge sums of money being invested in research and development elsewhere might put new methods or equipment on the market that would outperform the devices then being used.

If either of these threats were to eventuate, it could be fatal for the company. In order to guard against the first scenario, Pentti Väisälä proposed the establishment of subsidiaries in those countries that, upon the outbreak of hostilities, would probably be on the other side (Finland could be forced to support the Soviet camp). To counter the second threat, he recommended close monitoring of the situation and the allocation of more resources to R&D.

This strategy paper did not go unheeded, and was used as a basis for development. As a counterweight to Vilho Väisälä's scientific orientation, business factors began to be stressed more and more. Although it signalled greater power for Pentti Väisälä, Vilho Väisälä was still

the undisputed patron in his factory. He remained the alert overseer of operations as president and chairman of the board, he still played a key role in the design of equipment and, due to his personal contacts and expertise, he was an unparalleled customer relationship and marketing man.

The most immediate threat to the company's success was the ageing of its core product, the RS 11 radiosonde. Despite the improvements made to it over the years, it was still essentially the same product as when it was first made in 1936. Since then, technology had advanced tremendously and competitors had introduced enhanced models to the market.

Soon after the war it came to the attention of meteorologists around the world that the measurements made by different weather sounding devices – especially temperature measurements – could differ from each other substantially. In order to investigate the discrepancies, a number of international comparisons were arranged, the first taking place in Switzerland in 1950. The results conflicted to such an extent that the experts could draw no conclusions as to the superiority of the various sounding devices. Väisälä, who was present, was convinced that his sonde was far from the worst. It was only one quarter of the weight of the second lightest sonde, and sold for no more than half the price of any of the others.

It was decided to continue the comparisons and the next test was again held in Switzerland in 1956. Fourteen models were represented, still exhibiting considerable divergences. The Väisälä sonde was prone to a temperature measurement error that was larger than most. Väisälä was aware of this weakness and had already developed a mathematical model to correct it in the 1930s. The situation was unsatisfactory, however, especially as improvements in the balloons had made it possible to reach even higher altitudes, which increased the error.

This second test showed that the sector was in a state of ferment, as a result of which a global organisation known as the Commission for Instruments and Methods of Observation (CIMO) set up an international committee to continue comparisons of the radiosondes. A situation of highly visible global competition arose in which the Vaisala company had to succeed. The renewal of the old sonde had become essential.

Right up to the mid-1950s, the Vaisala company's research activities had been very much dependent on Vilho Väisälä, and the work had been done mainly in the department of meteorology at the University of Helsinki. A significant change occurred in 1957 when, as a result of Pentti Väisälä's strategy paper, a research and development department was established in the Vaisala company. Consisting of a sounding station, a radiosonde labora-

tory, a radio laboratory and a workshop, the department was the scene of vigorous R&D targeted at producing a completely new radiosonde.

Väisälä himself was fully involved in this undertaking. Despite being of rather senior years for a researcher – he was approaching 70 – he once again buried himself in intensive, creative effort. His youthful enthusiasm was still intact, and as a counterbalance to ageing he had acquired vast theoretical and practical expertise. His special contributions were the mathematical models that he calculated as a basis for tests. So many test pieces failed that Väisälä's indomitable self-confidence and good-natured optimism were needed to bolster the faith of the research team.

The project advanced step by step, through trial and error, and finally reached a satisfactory conclusion. In Autumn 1959, the second-generation RS 12 radiosonde was introduced. Although its measurements were still based on the variable capacitance principle, all the measuring instruments had been renewed. The temperature measurement error caused by the sun's radiation had been significantly reduced by a new protective cover. The flight-ready RS 12 weighed 280 grams compared with 800–2200 grams for competing sondes. Väisälä's new device caused a commotion around the world.

At the same time as a new radiosonde was being developed at Vaisala, other attempts were also being made to improve the sounding system. As it was possible to determine the sonde's altitude from the signals it transmitted, its flight path could also be determined if its direction from some fixed point on the earth's surface was known. The sonde could then be used to supply information on the direction and speed of the wind.

Although an optical theodolite could be used to track the sonde's flight path, its disadvantage was that it was useless when the sonde was behind cloud cover. Knowing how critical wind measurements were, Vilho Väisälä had already pondered, years before development of the new radiosonde, how optical tracking could be replaced by taking bearings from the signals transmitted by the radiosonde.

Believing that he had solved the problem theoretically, Väisälä hurried – as was typical of him – to publish his results. He described his method to the international scientific community at Brussels in 1951, admitting however that the required equipment was still far from perfect. Years of finishing work lay ahead, but, by the 1957–58 International Geophysical Year, development was so far advanced that Väisälä's radiotheodolite passed the hundreds of tests conducted on it. When it was launched in

tandem with the RS 12 radiosonde, the radiotheodolite greatly improved the Väisälä sounding system.

The Vaisala company made a third giant leap forward a little later when it developed a fully automatic radio sounding receiver. This fulfilled a dream that Vilho Väisälä had entertained ever since he began to develop his radiosonde in the 1930s.

Expanding operations

The research and development department established in line with Pentti Väisälä's operating plan grew over the years in both size and importance. In this respect, the strategy outlined for the Vaisala company was successful. The other parts of the program – the expansion of the product range and the establishment of foreign subsidiaries – did not work out as expected. Attempts were made to enter new sounding fields by developing sondes to measure radio-active fallout, or the direction and speed of the wind, or geodetic data based on the ideas of Vilho Väisälä's brother, Yrjö. Owing to low demand for these products, they never became commercially viable and manufacture was discontinued. Other attempts were made to win new markets by developing an electronic microscope and radio telephone. But in these cases the company could not draw on Vilho Väisälä's vast meteorological expertise and contact network. Moreover, the main competitors applied more resources to hardware development than was possible for Vaisala. The products never became profitable and had to be given up.

Vaisala was active in marketing its core product, the radiosonde, and negotiations gradually led to new ex-

ports to developing countries. Vilho Väisälä continued to relate cautiously to Pentti Väisälä's strategy of establishing subsidiaries and manufacture under licence, until it began to seem as if the South American and African markets required a local production unit.

In June 1959, Vaisala's board of directors resolved to found two subsidiaries, Vaisala Sudamericana in Buenos Aires, Argentina, and Vaisala SAF in Johannesburg, South Africa. Both ventures made Finnish industrial history – Vaisala Sudamericana was the first Finnish manufacturer in South America, while Vaisala SAF was the first in Africa.

Neither company redeemed the hopes invested in it. Although Vaisala SAF was relatively successful in the South African market, it could not be used as a platform for the planned conquest of Africa because South Africa's policy of apartheid increasingly isolated it from the rest of Africa. Vaisala Sudamericana was in difficulties right from the outset as Argentina fell into a deep political and economic crisis, and exports could not be commenced to other South American countries. Sudamericana's debt to the parent company swelled so much that, by the mid-1960s, it had notably weakened the financial position of the whole Vaisala company.

In 1963, Pentti Väisälä, the company's vice president, died abruptly at the age of 42. Pentti's unexpected passing was a great shock to Vilho Väisälä and caused him to revise his plans for the future of Vaisala as a family company. Although he remained as chairman of the board and president, the operating management had been taken over by Pentti to such an extent that his departure had to be compensated immediately. The successor chosen by Vilho was not from the family but had worked for the company since 1955. He was a radio engineer called Yrjö Toivola. He had joined Vaisala through his passion for an international environment, new technology and innovation.

Toivola took over the responsibilities and powers that had been held by Pentti Väisälä, while still retaining his position as head of research and development. He reinvigorated research activities and strove, in the spirit of Vilho Väisälä, to encourage a corporate culture that valued innovation. With respect to foreign operations, the company returned to Vilho Väisälä's cautious policy. The Vaisala SAF and Sudamericana manufacturing units were wound down, although final closure did not take place until the 1970s when Vilho Väisälä was no longer present.

The core product was still the Väisälä radiosonde and its ancillary equipment. The general trends in technology were monitored closely, and in 1965 Vaisala launched the fully transistorised RS 13 radiosonde which was the first

of its type in the world. Attempts were made to minimise the risks related to concentrating on a narrow sector by augmenting the product range with equipment for surface weather observation. All product offshoots that were outside the traditional area of expertise were pruned. Steps were taken to automate production by introducing modern methods and equipment, and in this Vaisala was often the first in Finland.

Not all the new products turned out to be successful, but the Vaisala company swiftly reacted to the opportunities presented by technological advances. Vilho Väisälä lived to see his company recover from the trials and tribulations of the early 1960s and settle into a steady growth track again. Yet even better was in store for the company – before the end of the decade, Väisälä's radiosonde would receive the best possible quality recognition.

Throughout the 1960s, CIMO worked hard to define reference sondes. The work was carried out by a six-person Radiosonde and Radiowind Measurements Committee to which Vilho Väisälä was elected in 1965. In its interim report for 1967, the committee stated that there were five potential reference sonde systems for temperature measurements in the world – West German, Finnish, French, Japanese and Soviet. The comparisons between those making it into the "final" were carried out in 1968 and 1969, and the French sonde was dropped due to its

VÄISÄLÄ'S BUSINESS WAS GLOBAL, AND THUS HE TRAVELLED FAR AND WIDE. THIS PHOTO WAS TAKEN AT A CIMO (COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATIONS) CONFERENCE IN TOKYO IN 1965. NEXT TO VÄISÄLÄ ON HIS LEFT IS THE VAISALA COMPANY'S VICE PRESIDENT, YRJÖ TOIVOLA.

deficiencies. The Finnish (read Väisälä) sonde was the latest model – the RS 16.

At its general meeting at Versailles in September 1969, CIMO published the committee's final report. It noted that there were only very minor differences between the temperature measurements of the Finnish, West German, Japanese and Soviet sondes, and that the results were in harmony statistically with the derived values. Thus, any of these four sondes could be used as references. This outstanding acknowledgement of Vilho Väisälä's life work came just as the Vaisala company was producing its 500,000th radiosonde.

Vilho Väisälä himself did not live to experience this glorious moment sealing the success of his radiosonde. In early 1969 he had still been full of vigour and in February–March made a two-month long congress and sales promotion tour of North and South America with his vice president, Yrjö Toivola. During the trip he presented several scientific papers and organised various promotional functions. But in May he fell sick and in August, only one month prior to the Versailles general meeting, passed away.

Legacy

After Vilho Väisälä's passing, his son-in-law Hannu Voipio, MD, was elected as chairman of the board of the Vaisala company, while Yrjö Toivola, who continued Väisälä's scientific corporate culture, was elected as president. As it grew, the company was taken on the main list of the Helsinki Stock Exchange. Its market capitalisation in 1994 was some 800 million Finnish markkas (about EUR 135 million). Since then, the rapid growth of the company has continued, due to its strengthened global market position. In the early 2000s, the net sales are approximately 3 times, and the market capitalisation approximately 3.5 times as great as in 1988.

The company's original operations have retained their importance. Although the radio sounding systems have advanced hand in hand with technological breakthroughs, Vilho Väisälä's influence remains in the capacitance measurement method used in the sensor. As a supplier of upper atmosphere sounding equipment, Vaisala is overwhelmingly the largest in the world with a market share of about two thirds. While Vilho Väisälä still lived, the market share was estimated to be about one fifth at best, even though Vaisala was the world's largest exporter

of sondes then, too. Although the relative percentage of Vaisala's products accounted for by sounding systems has declined slightly, it still makes up one third of net sales. A good one third currently derives from weather observation systems operating on the surface of the earth, and the final portion from other measurement devices and sensors related to the atmosphere. In many of these sectors, too, Vaisala commands a globally leading position.

Production is carried out in Finland and the United States, and over 95% of the products are exported outside Finland to over 100 countries. Nevertheless, Vaisala's domestic orientation is reflected in the fact that more than half of its 1100 employees work in Finland.

The company has travelled a very long distance since the days when Vilho Väisälä and a few assistants manufactured sondes in an apartment building basement. Most of the growth Väisälä did not live to see himself. The most spectacular advances were made after his death and especially during the time of Pekka Ketonen who succeeded Yrjö Toivola as president in 1991. Vilho Väisälä's basic philosophy has been preserved unchanged, however, over the years. The Vaisala Group is still characterised by a focus on high technology and special niche areas in which it aspires to capture global leadership.

Although the primary legacy of entrepreneur Vilho Väisälä is the burgeoning Vaisala Group, he also left

behind a significant and enduring legacy as a scientist. Pentti Väisälä's sudden death in 1963 caused him to think seriously about the future of his company. At 73, he was resigned to the fact that his own life might not last long – after all, he had already suffered one heart attack.

It was only one month after Pentti Väisälä's passing that the Finnish Academy of Science and Letters received a letter from Vilho Väisälä offering to donate 3000 Vaisala shares (representing 22% of the total shares) to the Academy. The donation was conditional on the shares forming a Foundation bearing the name of Vilho, Yrjö and Kalle Väisälä, whose yield would be used to support studies and research in the field of mathematics and the natural sciences. The wish was expressed at the end of the letter that the undersigned would be pleased if, in distributing grants, priority would be given especially to researchers in the scientific branches that were close to him and his brothers. This wish has been followed by allocating awards and grants to researchers in mathematics, physics, astronomy, meteorology and geophysics.

The monetary value of Vilho Väisälä's donation was difficult to define, because the Vaisala company was owned nearly exclusively by him at the time of the donation. At the beginning, the foundation was given a modest accounting value on which a hypothetical interest yield was calculated. It was only this interest sum that

was distributed in the form of grants, and throughout the 1970s, no more than 6000 Finnish markkas were granted annually on this basis. This sum was not great, and due to inflation it actually diminished all the time. The index-adjusted amount distributed in 1971 corresponded to 6000 euros today, but in 1980 when the value was at its lowest it was only 2000 euros.

After the bottom was reached, the foundation began to rise steeply. This was influenced both by the changed treatment of the foundation in the accounting policies of the Finnish Academy of Science and Letters, and the growth and stock exchange listing of the Vaisala company. The value of grants distributed in 1989 grew to 85,000 euros. But in the 1990s the foundation became even more significant. The sum for distribution in 2000 totalled 10 million Finnish markkas and in the following year two million euros. In these two years, the foundation supported university equipment purchases. Since then, the awards and grants distributed annually have stabilised at one million euros.

The grants distributed in the 2000s have been so momentous that the Vilho, Yrjö and Kalle Väisälä Foundation has become Finland's largest private benefactor of scientific research in mathematics, astronomy, physics, meteorology and geophysics.

THE FINNISH ACADEMY OF SCIENCE AND LETTERS ANNUALLY ARRANGES A RECEPTION OF THE VILHO, YRJÖ AND KALLE VÄISÄLÄ FUND (CREATED THROUGH VILHO VÄISÄLÄ'S DONATION), AT THE HOUSE OF THE ESTATES.

All persons depicted here are recipients of awards or grants in 2003, except for the Academy's secretary general and chairman on the far left. The photo illustrates the lasting influence of Vilho Väisälä's work by showing how widely the fund promotes research and post-graduate education in the fields represented by the Väisälä brothers.

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