IEEE Oral History – General Topics
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Objectives of an oral-history interview about a person's career.

- *Family background.*

  I was born in Germany into a very scientific family. Both of my grandfathers were chemists—one very famous. My mother's father is credited with co-developing the Fischer Tropsch process of chemical reactions (https://en.wikipedia.org/wiki/Fischer%E2%80%93Tropsch_process). My other grandfather also specialized in organic chemistry. Both were friends. My father had a PhD in physics and started, together with a friend from the university, an electrical engineering company later to be known as Rohde & Schwarz in Munich, Germany.

- *Childhood influences.*

  From 1940 until 1945 there was World War II, as we all know a very difficult and emotional time. I was sitting in the basement very often, with a steel helmet on my head, wondering if the next bomb would kill me (although I did not fully understand what that meant).

  School up to the age of 10 was uneventful and I ended up in a boarding school closely located to Munich with high emphasis on science. It was challenging. It was there my father gave me a scientific book with the translated title, *How Does this Work*? I was most impressed with the mathematics needed to calculate the working/performance of a ski jump. This was also my first encounter with RF engineering. One of my friends at school built a transmitter, tube based, for a remotely controlled model airplane. I absorbed every item of the schematic and even today I remember the circuit diagram.

- *As a youngster, when and why were you attracted to science, technology, and engineering?*

  The transition was kind of seamless in the classes for what we call *Abitur*—an examination that students in Germany are required to pass in order to be eligible to attend a university. The academic level of the *Abitur* is comparable to the International Baccalaureate, the GCE Advanced Level, and the Advanced Placement tests. Indeed, the study requirements for the International Baccalaureate differ little from the German exam requirements. Both chemistry and physics were topics, but with two chemists in the family and essentially a radio engineer as a father, there was little choice. My father operated a radio amateur station from home, the car, and the boat, so we were always connected to the world. This helped my English and my knowledge of geography. Latin in school was always a problem.

- *Engineering education; mentors.*

  Well, my very versatile father—also very good at skiing and driving a pleasure boat, besides his electrical engineering activities—was a tough taskmaster, and therefore a very good mentor. Munich held too many distractions, so I changed from the Technical University to the much smaller Technical University in Darmstadt, which had a very rigorous teaching schedule. In my field of interest, professors Zinke and Brunswick dominated in the subject of RF technology, while in Munich Professors Meinke and Gundlach were their "competition."

I hated technical mechanics but learned mathematically which way to pull off the toilet paper from the roll efficiently. It has haunted me ever since.

Mistakes are a part of learning, of course. During the university days my major mistake was to write a textbook about microwave transistors (*Transistoren bei hochsten frequenzen*, Berlin, 1965). That experience, at the age of 25, provided both impetus as well as impediments. Given the intervening decades, the details are no longer important.

- *Ambitions and dreams.*

I am not sure I had major ambitions, other than to fully understand radio communication, including antennas and all parts of transmission and reception. Early on, this drive imparted a burning desire to work with RF and microwave communication systems. The university did not allocate then (and even today) enough time to prepare students with adequate theoretical and practical information. I wanted to contribute something useful to this field, but I was not quite sure what that would be. Nevertheless, I constantly explored the various fields of science and technology in an effort to broaden my understanding of complex technical problems.

- *Career choices, especially motivation for career choices.*

My father was not known to spend money freely, so I had to get a job to be semi-independent. You never really disconnect from your parents and that is a good thing.

My father lived to be 80 years old, so I never became an early rich heir. Both things were good. Too much inherited money can be a temptation and you never grow to your full potential. Very few deal well with this situation. Self-earned money feels much better.

Prior to escaping a dominant father, everybody asked "are you the son of the famous Rohde" (I really hated that question not because I did not respect my father but rather I wanted to have my own identity), I was in charge of the Ulm based Military Radio Division of the then AEG Telefunken company. My/our pet project was to design, build, and sell a fully automated Manpack in competition with the Hughes Aircraft PRC 104. I think we did a good job and I still have some of the now about 50-year-old radios. The project encompassed all the technologies I always wanted to combine.

- *How things looked to the engineering community at the time.*

In those days some of the modern mathematics was missing, there were no microprocessors, and versatile integrated circuits had not yet been invented. Most of the interest came from the USA but I was not high enough in the ranks to be allowed to go there. At that time, know-how was not shared as freely as it is today, for an example through IEEE conferences and workshops. Still, I wanted to contribute to worldwide radio technology. So, the solution was to publish innovative things. History demonstrates that technology improves the standard of living, the quality of life, and stimulates coordination and engagement. I wanted to be a part of that. When the opportunity came to move to the USA, I took it.

- *How things looked from the trenches (how things were experienced by the people involved and at the time, as contrasted with the top-down, after-the-fact history).*

German companies at the time were rigid (somewhat better now) with long-held traditions, and sometimes innovation was looked at with suspicion. I remember introducing

non-high-reliability transistors in the Manpack used in huge numbers in taxi two-way radios with practically zero failures, but still not "qualified." It was a challenge to do it, but it worked well. Unconventional things were suspicious. Trial-and-error was not an accepted way to operate, but it was often less costly. In my German days I always relied on team building, shared responsibilities, and modern tools to address complex problems.

These tools can be used effectively to develop architectural top-down approaches. Simple solutions are often superior to complex ones. We must look at each task individually with optimization in mind.

- *Greatest successes, frustrations and disappointments; competitors or rivals.*

These questions kind of go together.

In about 1980, being in charge of the Radio Division of RCA, we as a team developed the basic implementation of what today is called the software defined radio (SDR) and proof of concept. This US Department of Defense (DOD) sponsored effort has had an enormous impact on humanity in general. Modern affordable A/D converters and algorithms for signal processing have enabled many advanced signal-handling capabilities for applications ranging from communication systems to medical monitors (such as cost-effective monitoring of vital signs). All of this was the result of a dedicated and successful team. Much later in the year 2017, I was honored to be recognized with the Wireless Innovation award for contributions in the field of SDR

(https://www.businesswire.com/news/home/20171116006330/en/Wireless-Innovation-Forum-Announces-2017-Wireless-Innovation).

In 1985, I bought the company Compact Software, https://en.wikipedia.org/wiki/Compact_Software.

The first really useful CAD provider kind of collapsed after its employees on the west coast abandoned it. Founded by Less Besser, it was a very powerful linear circuit simulator, but got stuck in linear circuit analysis. SPICE was nonlinear but not applicable for microwave circuits. (https://en.wikipedia.org/wiki/SPICE.)

Robert Pucel of Raytheon made me aware of the Italian professor, Vittorio Rizzoli, who developed the first useful and efficient piece-wise linear harmonic balance method, which became the framework for the new Super compact non-linear SPICE type program, the first in the world that accurately and without any mathematical compromise predicted correctly the noise performance of oscillators, mixers, and frequency doublers. This part, and the introduction of the "noisy" large signal noise contribution, was done well by my team.

As others tried to mimic our approach and used mathematical shortcuts, their programs became faster. This resulted in my frequently used statement: "Yes; they come faster to the wrong answer." For a while, speed was more important than accuracy.

At that time a CAD program needed to have a 2-D, or better 3-D, simulator and I was unable to find a team which such knowledge. The bitter consequence was that I had to merge with Ansoft. They lacked a circuit simulator but probably still today have the best 3-D simulator. Ansoft later was bought by Ansys, a very successful CAD company. This was a good decision, as Ansys could make best use of the Circuit simulator to offer complete CAD solutions for RF circuits. At this point I stepped away from software activities but continued

to monitor the accuracy and convergence of commercially available CAD tools (ADS, Ansys, AWR) and to provide input and feedback from time to time.

- *People who made a great impression, personally or on the field.*

Obviously, besides my "dominant" father, the two groups of professors mentioned previously had a major impact on my life, and I think then I developed an ambition to be as educated as they were. At the same time the tube division of AEG Telefunken published every year a fascinating mini handbook of tube applications and so did Siemens about modern semiconductors, now Infineon. I probably kept all their little books. During these times I actually had the opportunity to exchange some ideas about physics with Prof. Heisenberg, known mostly for his uncertainty principle (also known as *Heisenberg's uncertainty principle*) while being on a sailboat with my father and him. During the sailing I asked Prof. Heisenberg: As the tubes have a cathode as a heater and the plate kind of pulls the electrons out of the heater, could I not use a radioactive isotope that provides ample electrons, a beta radiating element. Prof. Heisenberg said, yes but how do you control the amount of electron flow which the negative voltage in a tube circuit does. Understandably, he was correct, and my awareness at the age about 12 (I don't recollect the exact date) undoubtedly was not well thought out. He just smiled! At that time, I pondered if I would ever comprehend his scientific work.

More recently, my contributions on "Metamaterial Inspired Mobius Resonator loop, RF-MEMS, Opto-Electronics and Casimir force of interactions" are a consequence of past conversation with Prof. Heisenberg and other leading scientists.

- *Importance of professional societies; importance of IEEE.*

My father was the person who brought the IEEE and its concepts to Germany. Many others followed him in this position as the IEEE manager for Germany. They all were well known in the EE and microwave field. In Germany, it took a while (and to a degree still does) to understand the principles of the IEEE. Most companies still think in terms of trade secrets while the IEEE thinks as an open forum. That explains the dominance of the academics in Germany; much less industry activities. I think the practicing engineer needs equal recognition as some of the professors.

While IEEE IEEE's tagline, "Advancing Technology for Humanity," should established it resolutions, unfortunately there is substantial portion of population does not have access to some of the basic stuffs (clean water, electricity, internet, mobile phone, and others) that many of us take for granted. In my opinion, admission to these basic things to improve the quality of life is being considered as a "Human Right". I hope the above award for will help in motivating next generation engineers and young professionals towards developing the technology that will improve the quality of life in the underserved regions of the world.

I have learnt humanitarian challenges and ability to apply engineering capability to explore the low cost solution for improving the quality of life in the underserved regions of the world. I am helping IEEE local community by sharing technical knowhow in the field of emergencies medical needs such as low cost ventilator and other things. During natural disaster, I offered help to establish emergency communications system by supporting HAM radios activities in Region 10 and Blind community in Germany. It is important to share "I like solving problems in my field of expertise where others have failed". Most people lack

the drive or staying power to see things through, this complements my thirst for serving humanity. And, the gratification resulting from this is inestimable.

- *Personal life, other interests, hobbies.*

  My personal life is fairly uneventful, low-key so to speak, and my family and I enjoy our sailboats when on Marco Island, Florida, and my ham radio station, call sign N1UL. I used to like skiing and tennis, but at my age it's too strenuous, so sailing and photography are the other hobbies. And, of course, I enjoy serving as a faculty member at some universities to help students get their PhD in tough topics.

- *Advice; What might you say to young people about the opportunities and rewards of choosing engineering, as a career?*

  To begin with, it's always good to have a very broad education, today to combine economics and engineering. RF engineering has become less popular as it is more math-based and now includes semiconductor physics. The IT part and software engineering, including the activities in the above mentioned SDR challenge, have become more active.

<u>If you have an affiliation with IEEE, questions about IEEE might include the following:</u>

- *What has IEEE, in particular, IEEE publications, IEEE conferences and meetings, IEEE standards, and so on, meant for you personally at different stages in your career?*

  There is no question that in my activities the membership and an active role in the IEEE are a must. I am involved in all the relevant IEEE Transactions such as MTT (*Microwave Theory and Techniques*), CAS (*Circuits and Systems*), AP (*Antenna & Propagation*), UFFC (*Ultrasonic Ferroelectric Frequency Control)*, ED (*Electronic Device*), *Robotics*, and *Photonics* to name a few. These publications and conferences are a huge advantage as we seek interaction and exchange with others and support of newcomers to the fields.

  Ultimately it is the exposure during the conferences, and your own publications that help you very much in your career. There are some old boys' club arrangements, however, that are difficult to avoid.

- *In your own experience, how has IEEE, including any Technical Society you have belonged to, served your field of technology over the years?*

  This can be addressed in one sentence: many good things would never have happened without the worldwide activities of the IEEE. The IEEE mission, "Advancing technology for humanity", is to leverage engineering expertise and know-how to promote global development, both economic and scientific.

- *IEEE is much concerned with attracting young people to careers in engineering and to IEEE. In your view, what might IEEE do better? What is IEEE doing well? What else should IEEE do? For example, IEEE is much concerned with attracting young people to careers in engineering and to IEEE.*

  This is a little tough to address. While being part of all technical activities and holding several committee's chair positions, I have always avoided any other position of power

beyond organizing student design contests, workshops, and reviewing papers in committees or groups like MTT-17 or MTT-22, which stay clear of the old boys' club phenomenon. The IEEE must present itself better as an open and unbiased organization and must consider a term-limit to controlling committees so younger people can better participate.

In some of the decision-making process there are too many old timers controlling things. But this is real life and not the IEEE's fault. Everywhere you go there are complications, some unjustified, some necessary. The current trend for the IEEE becoming more international with new chapters, especially in India, is very encouraging. I was pleased to advance this effort in parts of India as my father did about 70 years ago with the German chapter.

It is worth mentioning that I support IEEE activities at my company and academic University. To name a few, Dr. Ajay Poddar, Chief Scientist at Synergy Microwave, NJ, and Prof. Rudolph Matthias at BTU Cottbus, Germany, are both are very active in IEEE Technical and MGA activities, volunteering services for the benefit of next generation engineers. I have done extensive overseas travel and delivered 500 plus talks in 20 years with Dr. Poddar, Dr. Shiban Koul (IIT Delhi), Dr. Madhukar Pitke (Bhabha Atomic Research Centre, Bombay, India), Mr. Muralidharan Raghavan (Director, Tata Power, Bombay), and many others.

Viewed from the perspective of many years, the technical activities of the IEEE are very important and commendable.