THE RANTEC YEARS
Dr. SEYMOUR B. COHN (1960 to 1967)

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ABSTRACT

Dr. Cohn's research efforts have resulted in major contributions to the microwave community. The broad scope of his work includes design concepts for numerous types of filters, couplers, multiplexers, and even test equipment used to more accurately measure the devices he designed. His papers on these subjects are always outstanding because they provide detailed practical information easily used by design engineers, i.e., well defined concepts and methods. This paper describes a small part of his activities as Vice President and Technical Director during the Rantec period (1960-1967) as reported by this engineer and friend. His equally successful family life is also mentioned.

BACKGROUND INFORMATION

Joining Rantec represented a significant departure from Seymour's previous tasks at Stanford Research Institute. He was no longer working in a dedicated research laboratory per se, but now as Vice President and Technical Director of a small commercial company with limited sales and a very small (if any) research budget. Total 1960 sales were $1,431,724.

During the first years he supported and completed several government sponsored study programs, however almost all other research activity by necessity had to be directed toward specific Rantec customer requirements. Even in this relatively austere financial environment, Seymour continued to develop new devices and write papers describing them, furthering his contribution to the microwave community.

I had the good fortune to work under his direction during those years and found him to be a very unique, inspiring, and most remarkable person. He was very creative in developing a practical component concept while accurately predicting its theoretical and actual performance. He was equally adept at working on the microwave test bench.

FAMILY LIFE

For many years technical papers in our field have given reference to Dr. Cohn's research papers so that his education and professional background have become well known. However it is not likely that many people using Dr. Cohn's contributions are aware of his personal life.

Seymour and his wife Florence live in Westwood, near the UCLA campus in Los Angeles. The location near the campus was very convenient for Florence where she was a member of the UCLA study-skills counseling staff before retiring two years ago.

Seymour and Florence have three sons Bill, Ric and Peter. Bill the eldest (37) is married and they have a 2 year old baby boy. He is a successful accountant and works in West Los Angeles. Ric, (35) is a commercial photographer, and owns a studio in New York City where he specializes in still life photography for commercial advertisements. The youngest son Peter (31) has followed a computer programing career. He works for a business software company in Torrance, California.

TECHNICAL PAPERS

Several of Dr. Cohn's papers that were published during the 1960-67 period, while he was at Rantec, are summarized in the references. Other of his writings are in reports on sponsored research projects not found in the reference summary.

Seymour developed many innovative components during his stay at Rantec, but some specific devices come to mind that you must agree are truly outstanding contributions.

<u>Re-Entrant Cross Section Hybrid Coupler</u>

One of his papers (42) describes this TEM coupler in detail and the patent bears his name. During the development phase it was affectionately nicknamed the "shotgun" because the re-entrant cross-section resembles a double-barreled shotgun. Where tight coupling is needed, such as 2 or 3-db, the mechanical tolerances required are easily held and considerable misalignment is permissible. Increased spacing between the coupled lines also makes it attractive for higher power operation. As described in the paper, it can also be used as the tightly coupled sections of a multi-section coupler, thus providing wide bandwidth performance. The "shotgun" is indeed a significant contribution to the coupler family.

Majestic-T Hybrid Coupler

A particular customer requirement led Dr. Cohn to give his attention to the development of a remarkable waveguide hybrid (46) that Rantec's sales department named the majestic-T (because of some similarities to the then existing magic-T hybrid). The magic-T is a 4-port device whereas the new hybrid has only 3 external ports. The 4th port of the new hybrid is an internal thin resistive sheet symmetrically mounted perpendicular to the E-plane in the junction region. The result is improved performance over very broad bandwidths.

Dielectric Resonators

The importance of dielectric resonators was certainly recognized by the 1960s. With dielectric constants of 80-100 and unloaded Qs of 6,000-10,000 available, it was apparent that a very small filter (coaxial input/output) could have an inherent small signal performance equal to that of a very large waveguide filter.

During Seymour's dielectric resonator experiments, he found that the measurement techniques generally being used to determine dielectric constant and loss tangent were subject to considerable error due to the presence of unavoidable small air gaps between the dielectric surfaces and the metal walls. He and another engineer Ken Kelly, developed two precise measurement techniques (45) that eliminate the effect of air gaps through the use of resonant modes for which $E = 0$ at the dielectric-to-metal interface. A dielectric materials manufacturer recently described several of their measurement techniques (Microwave Journal 10/88) and refer to the Cohn-Kelly method as one of the preferred approaches.

While the above paper (45) describes measurement techniques, Dr. Cohn's second paper (47) describes the use of the high dielectric constant materials in filter designs. A theoretical analysis was made to determine the first three resonances of practical configurations and also a method of computing the coefficient of coupling between resonators. Experiments confirmed the coupling values and the predictions of spurious responses. I had the pleasure of performing some of these experiments for Seymour and went on to build several dielectric resonator filters during this time period using his concepts.

The materials available at that time had excellent electrical characteristics (high Q and dielectric constant) but unfortunately the thermal stability was very poor, i.e., a dielectric resonator, made of those materials, would have made a good thermometer. Because of this temperature sensitivity, the use of dielectric resonators did not become practical until the material thermal problem was solved some fifteen years later.

Automatic Phase/Time-Delay Measurement Systems

As the sophistication of microwave systems increased, the need to control phase response of components became increasingly more important. A specific customer (Raytheon) needed an S-band bandpass linear phase bessel filter having very stringent phase characteristics. Seymour designed and built that filter for them, but they needed proof that it really had the correct phase response. Point by point frequency/phase measurement was the only way to do it at that time. This was a cumbersome time consuming task that we would now consider archaic. After seeing this need, Seymour devised a phase measuring system concept employing many of the components he had already designed. Using these concepts, he and co-engineers George Oltman and Norman Weinhouse developed a series of broadband, precise instruments (40,43) for direct-reading measurements of phase, amplitude and impedance. These achievements of the early 1960's were precursors of modern vector network analyzers.

A similar piece of equipment was developed by this team during the same period to accurately automate measurement of time delay over a swept frequency band. This system is still used in our laboratory today.

CONCLUSIONS

During the development of the test equipment mentioned, an incident occurred that impressed all of us. It may be unusual to mention something like this in the conclusions but it is typical of Seymour's insight and ingenuity. A compact low loss filter passing 0.5 to 9.0 GHz was needed. It required a steep skirt on the low side (-80 dB @ 20 MHz). One would first consider a highpass filter having a cut-off below 500 MHz. However, because of the extremely wide passband, numerous spurious responses in the high-pass circuitry can occur well below 9.0GHz, the upper band edge.

Seymour solved this requirement by designing a very compact bandpass filter employing 50 parallel coupled resonators. The resonators were thin rectangular plates that were broadside coupled. He used half-mil mylar dielectric to provide the spacing between resonators to achieve the coupling necessary for the extreme bandwidth needed. Since the center frequency was in C-band, the resonators were actually quite small. The unloaded Q of such closely spaced resonators was very low but in this case it had little significance since the filter loaded Q was very very low. Thus the filter provided the spurious free selectivity needed in a small package with low insertion loss.

Following Rantec activities, Seymour became a consultant as he is today. During these intervening years he has provided our company with solutions to very difficult filter/multiplexer and coupler/hybrid requirements. There is often a number of ways to design a device that will meet the specification. It is equally true that there is usually a "best way" to accomplish the same task where all factors such as convenient element values, mechanical tolerances, environment and costs are thoroughly considered. Seymour's designs typically are the "best way".

Only several of his publications during this period are covered in this paper but most of them (36 through 49) are included in the references listed. Some of these and numerous other papers are discussed by the other contributors to this special session honoring Dr. Seymour B. Cohn.

These comments provide a small insight into his life and into the unique contributions he continues to give to our microwave community.