Prof. Itoh’s Contributions to Electronics

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Although Tatsuo Itoh is perhaps best well known for his work on numeric methods in electromagnetics and metamaterials, his contribution to electronics has been a driver through his entire career. In fact, even before going to university, he dabbled in amateur (ham) radio and even built several vacuum tube receivers. He began his studies at Yokohama National University, Japan, where he focused on electronics and radio science [550] and continued working on electronics by building a ruby laser for his undergraduate thesis. Prof. Itoh stayed on at Yokohama National University for his master’s degree, developing a composite resonator for a helium-neon laser. During his summers, he worked on phototransistors while at NEC Central Research and on commercial optics while at Olympus Camera.

After completing his master’s degree, Prof. Itoh made the decision to pursue a Ph.D. degree in the United States at the University of Illinois at Urbana-Champaign. In addition to his important work at this time on electromagnetic field theory, he worked on many practical problems. This included work on microstrip, waveguide, gratings, resonators, and many other structures. His efforts in these areas continued at Illinois, after he completed his Ph.D. degree, during a stint as a postdoctoral fellow. He later took a position in Menlo Park, California, at the Stanford Research Institute working on C-band amplifiers. Soon after, Prof. Itoh began his academic career at the University of Texas (UT), Austin, where much of his work was related to electronics. During this period, his group worked on couplers, delay...

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lines, millimeter-waveguiding structures, IMPATT (IMPact ionization Avalanche Transit-Time) oscillators, and Gunn diodes [S51]–[S63].

Prof. Itoh moved to the University of California, Los Angeles (UCLA) in 1991. At this point, a significant proportion of his efforts focused on active antennas [S64]–[S67], a field of study that bridges the boundaries between antenna theory and electronics. This research area was well suited to Prof. Itoh’s broad background. Influential research topics in this period included harmonic tuning of power amplifiers using printed antennas, injection-locked oscillator phased arrays, and self-oscillating mixers.

Prof. Itoh pursued research in other areas related to electronics as well. Various retrodirective arrays were demonstrated, which used the phase relationship of self-oscillating mixers to receive and return a directive signal in the same direction. This was originally proposed as a technique for noncontact RF identification cards. Power-combining techniques were an influential topic in the microwave community during the 1990s, and Prof. Itoh contributed to the field by developing a unique slab-based power-combiner technique using image guide and a linear array of dipoles to excite the array. Another student worked on building gallium nitride amplifiers using early devices.

Prof. Itoh also continued to apply his electronics knowledge to optics, through successful collaborations on distributed photodiodes for broadband microwave signal generation. These distributed photodiodes possessed some circuit qualities related to artificial transmission lines, making them inherently broadband. They generated microwave power by mixing two optical frequencies together inside the distributed photodiode structure.

At this time, Prof. Itoh always had more than a dozen graduate students and several postdoctoral fellows in his research group. He maintained active collaborations with a variety of researchers around the world. A photograph of Prof. Itoh from the 1997 IEEE Microwave Theory and Techniques Society International Microwave Symposium (IMS) is shown in Figure S4.

Both of us remember our time in Prof. Itoh’s lab at UCLA as being incredibly dynamic. Days were spent in the laboratory with the other master’s and Ph.D. degree students. This allowed for many fruitful discussions and collaborations. The experienced students taught the less-experienced students how to use computer-aided design tools, do measurements, and fabricate circuits. Commercial electromagnetic solvers were relatively limited. Therefore, we relied on the custom finite-difference time-domain solvers written by the group for full-wave analysis. Each of us worked toward the weekly Wednesday laboratory meeting, during which we presented each week’s results. These meetings began at 6:00 p.m. and typically did not end until after 10:00! While long and arduous, the sessions taught us how to make effective technical arguments and honed our presentation skills. We all gained a good understanding of everyone’s projects, providing us a broad and general understanding of microwaves and electromagnetic theory.

Bill remembers being impressed by Prof. Itoh’s work ethic and energy: “If he wasn’t on travel, Prof. Itoh would always be in his office when I arrived and would generally still be working when I left. He still had energy for racquetball three to four times a week with his Ph.D. degree students, and I looked forward to playing with him, even though I was invariably beaten. These matches were some of my favorite times and were the best opportunity to learn who Prof. Itoh was as a person. I learned that he had practiced gymnastics as a youth, which perhaps accounted for his dexterity on the racquetball court. He believed in going for a run when he had a cold. He was also incredibly proud of the mileage on his car, which he used to commute from Los Angeles to the Bay Area on

Figure S4. Prof. Tatsuo Itoh (far right) with members of his group at the 1997 IMS in Denver, Colorado. From left, Dr. Yongxi Qian, Vesna Radisic, Bill Deal, Kuang-Ping Ma, Al Perkins, and Prof. Itoh.
the weekends. I believe that this was the same car he would use for a monthly commute between Austin and Los Angeles when he was at UT.”

To this day, Prof. Itoh continues to apply his knowledge to solve a variety of problems related to electronics. Significant contributions have been made recently in terahertz signal generation using quantum cascade lasers [S68]–[S69]. As microwave systems have evolved to include silicon integrated circuits, he has contributed to interconnects, transitions, diplexers, and resonators compatible with this integrated circuit technology. He continues to publish on oscillators, resonators, and filters.

For the most part, Prof. Itoh’s work on electronics has the common approach of selecting diverse components and functions, understanding how they operate, and then integrating them together in a way that had not been done before—all with the intention of improving performance or demonstrating a new and novel mode of operation. This work has been well received and resulted in many published papers that continue to be highly cited.

Both of us believe this diverse work on electronics significantly influenced Prof. Itoh’s many students as well as the community. His most fundamental emphasis for each of us was to first understand the unique properties of what we were working on. This meant understanding operation from first principles and then applying this knowledge to building electronic systems. We soon sensed the need for developing a deep understanding of microwave electronics, device physics, circuit design, and antenna theory.

References


and his coworkers have accomplished much. His technical reach has been wide (and continues to broaden), and his insights and approach to problem solving are extremely effective.

Other matters, mentioned by each of the sidebar authors, include the contributions Prof. Itoh has made to enriching the lives of those who have worked with him. Examples include providing student guidance while encouraging independence and his understanding that the teacher’s goal is to learn and grow with the student. In matters of execution, his work ethic and leadership are exemplary.

These short summaries are intended to recognize that Tatsuo Itoh, as all of us, is a work in progress. We offer best wishes to him for the future. Thank you, Dragoman, for providing examples of excellence to us all!