Microwave Industry Outlook—Who Will Develop the Wireless Communication Products of the 21st Century?

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Invited Paper

***Abstract*—The growing demand for wireless professionals is not matched by the preparation of RF and microwave engineers. A joint action of industry and academia, possibly coordinated by the IEEE, is needed to prevent serious engineering manpower shortage in the future.**

***Index Terms*—Continuing education, distance learning, engineering education, research and development.**

DURING the past 25 years, we have witnessed a remarkable change both in the college and on-the-job education of RF/microwave (RF/MW) engineers. During the Cold War era, education for microwave engineers was well focused in a great number of universities, thanks to the large amount of research money provided by the defense agencies. In addition, young graduates hired by companies were given extensive in-house training, generally mentored by senior engineers. The first 6–12 months' assignments frequently involved job rotation through essential departments to give young engineers a well-rounded practical background. Product development and product life cycles were relatively lengthy. Most of the engineers became highly specialized and were continuously educated in their fields of specialty.

In contrast, today's new graduates are expected to "contribute to the bottom line" immediately, usually without the guidance of mentors. Product lifetimes and "development-to-market" cycles are critically short. Since the wireless communication industry now focuses on high-volume short-lifetime products, low-cost and short design-to-market cycles are often more important than performance. Engineers must become "generalists," knowing a wide range of technologies. In addition, projects are now usually handled by product teams made up by the staff of research and development (R&D), marketing, production, Q.A., and sales departments. To operate effectively in this environment, engineers also need to develop verbal and written communications, as well as people skills—something they were generally not exposed to in college.

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To make matters worse, more than a decade ago when lucrative research funds from government and defense industry dried up, many universities quickly dropped their microwave engineering curricula. A number of professors in the field switched to teaching other types of courses where research money was more readily available and challenging new areas were opening up. As a result, engineering students receive very little analog RF/MW education and quite frequently from someone not in touch with the needs of the industry. Therefore, students are frequently attracted to other areas where mentors are more visible; leaving an even deeper hole in the pool of available qualified engineers for the wireless industry. (As far as I know, there is no university in the U.S. that offers a complete microwave engineering program today.) At the same time, we read surveys and predictions about the needs of the wireless industry, as well as the very likely increase of military hardware development during the next decades. If these predictions are correct, we will run out of properly trained engineers quite soon.

Since the universities are not prepared to provide the necessary preparation for real-life wireless engineering challenges, the task falls on a handful of continuing education groups. Unfortunately, continuing education is always controlled by economic cycles. For example, a relatively small percentage of working engineers were allowed to take short courses during the recession of 2001 because spending has been carefully watched by the accountants. In such economic slowdowns, the "two Ts" (i.e., travel and training) generally feel the pinch first. The tragic events of September 11, 2001 of course made things even worse, because companies put severe limitations on both domestic and international travel.

Business fluctuation aside, we can see an interesting trend when comparing the profiles of continuing education course participants during the past decades. (Since my company is completely focused on the RF/MW industry, I used data based on our attendance records during this period.) The plot in Fig. 1 shows that, in the 1990s, post-college training was emphasized after being on the job for some time. In contrast, recent data indicates that more than two-thirds of the training takes place shortly after graduation. The second chart (Fig. 2) again shows a noticeable increase in the attendance of the B.S. degree holders, indicating that the present four-year college programs are not providing enough to be useful in industry.

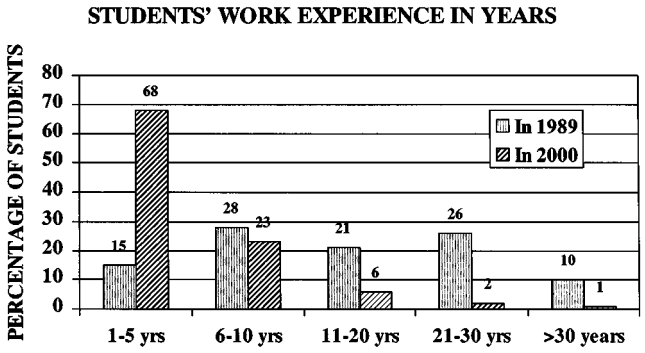

Fig. 1. In 1989, 75% of continuing education students had 6–30 years working experience, while in the comparable group of recent students, 68% had less than five years experience.

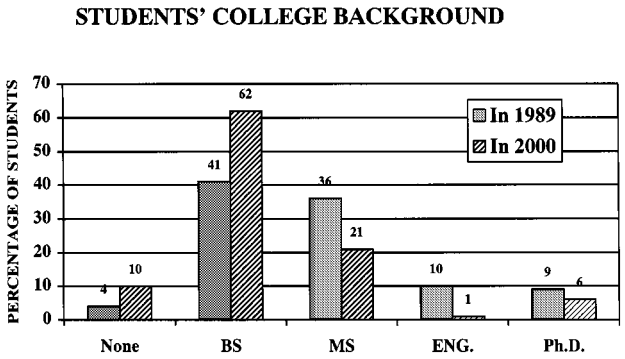

Fig. 2. In the 1989 group, 55% of the continuing education course participants had an M.S. or higher college education compared to 28% in the year 2000. It is also interesting to see that engineer degree holders are disappearing from the scene.

Looking at the current status of advanced research is equally disturbing. Since government research grants have been cut back and long-term industrial research (the Bell Laboratories type) are effectively nonexistent, the question "Who Will Develop the Wireless Communication Products of the 21st Century?" is a difficult one to answer. Looking at Figs. 1 and 2, we can also see that senior engineers with advanced degrees are noticeably absent from continuing education. In today's globally competitive world, most top managers are short-term goal oriented and are not willing to invest in the future. No wonder our industry has not seen significant technical breakthroughs in the past decade.

Computer-based training (CBT) has a promising future, but it takes significant resources to develop products for a relatively small specialized market. Further Internet/Intranet speed and bandwidth improvements will make these forms of presentations more lively and interactive. The ultimate goal of a "virtual classroom" is to bring world-class experts to one's computer screen to answer questions and mediate discussions. The course instructor may be on a beach in Hawaii, while students may be sitting in the comfort of their own living room, maintaining two-way communication.

Based on my experience, most engineers still prefer traditional (instructor-led) courses, conducted by a "practitioner" with presentation skills. Ideally, 3–5-day courses, presented off-site (so managers cannot pull students out of the class), augmented by hands-on computer-aided engineering (CAE) laboratories and real-life measurements, will provide maximum benefits. Interacting with colleagues and learning about problems and solutions from peers working at other companies are the additional bonuses of real-life training.

So, where do we go from here? It seems that both academia and industry must change to handle the educational needs of the future. Universities must provide better fundamental preparation and industry must invest in education. In the absence of an effective intermediary group, however, it is hard to see how this will happen. The IEEE could certainly help, but its Educational Activities Group would need a basic restructuring and a fresh outlook to be effective in such a task.

Last, but not least, practicing engineers must also go through an attitude adjustment. Most engineers these days still expect their employers to fully subsidize continuing education and would not consider paying for it out of their own pockets. The "good old days" when companies routinely paid 100% of education-related expenses, including time off work, may never come back. Just as other professionals have (i.e., doctors, lawyers, etc.), we must also place high priority on being technically updated, even if we have to pay for it.

Les Besser (S'64–M'66–SM'75–F'93–LF'01) is currently the Chairman of Besser Associates, Mountain View, CA. A native of Hungary, he began his engineering career in 1966 in the Microwave Division, Hewlett-Packard, where he developed broad-band microwave components. He received a patent for the first thin-film amplifier circuitry used in the CATV industry. He then concentrated on microwave integrated circuits (MICs), GaAs FET amplifiers, and CATV systems at the Microwave and Optolectronics Group, Fairchild. During this time, he became interested in computer-aided design (CAD) and wrote the SPEEDY program that offered a transistor database with high-frequency device parameters. He later joined Farinon Electric Company, to direct their microcircuit design and development effort. During that period, he authored COMPACT, the first commercially successful microwave circuit optimization routine, soon to become the industry standard. He also founded Compact Software, a pioneer CAD software company (now part of Ansoft) and was active in serving the engineering design needs of the RF/microwave industry during the next ten years. In 1980, his company merged with the Communication Satellite Corporation (COMSAT), where he served as a Senior Vice President. In 1985, he formed Besser Associates, an organization dedicated to continuing education through instructor-led and Internet-based short courses, CD, and videotaped presentations. The company now has over 50 Associates and has provided live training to over 40 000 engineers, managers, and technicians worldwide. He was instrumental in the formation of the RF EXPO Short Course program from 1986 to 1991. From 1988 to 1990, he also served as the Editorial Director of *Microwave Systems News* (MSN) magazine. He has authored or co-authored over 70 technical papers, developed three one-week short courses, and contributed to and co-authored several textbooks. During the past 30 years, he delivered short courses at several major universities, including the University of California at Los Angeles (UCLA), Stanford University, Massachusetts Institute of Technology (MIT), Oxford University, and Cambridge University. He is listed in Marquis' *Who's Who in the World*.

Dr. Besser has been involved in numerous IEEE activities. He was the recipient of the 1983 IEEE Microwave Theory and Techniques Society (IEEE MTT-S) Microwave Applications Award, the 1987 IEEE RFTG CAREER Award, and the prestigious 2000 IEEE Third Centennial Medal.