Some thoughts on the present and future status of electromagnetics research in U.S. universities

Thomas B.A. Senior

Electromagnetics finds applications to radar, scattering, communication systems, antenna design, microwave devices, remote sensing, etc., and an in-depth knowledge of the subject is necessary to expand the state-of-the-art in all of these areas. For development work as well as research per se, a continuing supply of trained people is important now and in the future, and the need is unlikely to diminish. Because of the nature of the subject, graduate training is almost certainly required, and whilst an M.S. degree is adequate for the majority of the development work, we must continue to educate a few of the more original and insightful thinkers to the Ph.D. level. Hopefully, the latter will be the source of the new ideas and concepts on which the vitality of the field depends, and will also become the leaders and the teachers of the future.

Compared with a decade or so ago, the number of university students and, hence, newly-qualified engineers in this area has diminished. Coupled with this, the number of new concepts and techniques that have appeared has also decreased, particularly in the U.S., and whereas the U.S. was formerly the unquestioned leader in electromagnetics, I do not think it true any longer. Indeed, many of the new ideas that have surfaced in the last decade have originated abroad.

There are several reasons for this, and the forces that are now at work may well make the situation worse as the years go by. To appreciate this, it is necessary to examine how the present situation has come about.

Electromagnetics as we now know it is a product of WW II and the development of radar. Many of those responsible for the development, and who may well have been associated with the MIT Radiation Laboratory, joined the faculties of major universities in the years immediately following the war. Under their leadership, the field blossomed, becoming an integral part of the electrical engineering discipline. Thanks to the ready availability of 'no-strings' federal research support, a handful
of large research-oriented universities established major research programs in the electromagnetics area. Each group was large enough to provide the freedom and intellectual interaction from which significant developments generally arise and it is largely true that most of the ideas and concepts which we are now using are products of the late 50's and early 60's. The same mechanism was also at work in a number of industrial organizations, such as in the aircraft industry, and in a few government laboratories.

The late 60's and very early 70's saw a dramatic change, most particularly in the universities. The student body reaction against the Viet Nam war and also against the work and job-oriented mentality perceived in society as a whole led to a decrease in the number of students entering engineering, and a precipitous drop in the number interested in electromagnetics—a subject which, by its nature, is applications-oriented and entails an immediate commitment to 'difficult' mathematics and somewhat abstract theory. At the same time, the fact that some of the work in electromagnetics was classified because of its actual or potential applications led to the abandonment of such work in many major universities, or to its inclusion in those research activities which were sloughed off to a separate research organization divorced from the educational process. Last but not least, the reduction of federal support per se and the strictures imposed by the Mansfield amendment effectively stifled the more innovative research and decreased most university groups involved in electromagnetics to less than the critical size necessary for other than the most routine development-type research. As a result, many universities virtually ceased all significant research activity in electromagnetics, with the corresponding faculty moving over to other areas or simply dropping 'sponsored' research entirely.

The coming together of these several factors has had some unfortunate consequences as regards the area of electromagnetics at present, and bodes ill for the future.

The last 10 years have seen few new developments to compare with those of the 50's and 60's. Most university groups have now neither the size nor the resources needed to foster new developments, and the
situation is getting worse. The key people who initiated electromagnetic research in universities after WW II are now reaching, or have reached, retirement age, eliminating the leadership which was so vital in the past. These retirements are also coming at a time when there is a dearth of talented younger people available to step in; and worse still, when there is a virtual hiring freeze at most universities (either because of a shortage of endowment or state funds, or because of demographic decreases in the student population) so that the positions are not being filled, or being allocated to some other discipline more in vogue with the students.

For the last several years, the output of engineers trained in electromagnetics has not kept pace with the demand. The resulting backlog of unfilled positions has led to salary levels for newly qualified B.S. and M.S. graduates, such that only the most single-minded students are willing to go on to a doctorate. In many Ph.D. courses, certainly in the electromagnetics area, U.S. citizens and/or permanent U.S. residents are almost non-existent, and the few talented ones that do graduate are offered salaries in industry which far exceed what universities can offer them as assistant professors. For the next few years at least it is therefore going to be very difficult for universities to maintain even the competence in electromagnetics possessed at the moment.

Electromagnetics has now evolved into a mature discipline and the difficulties which I perceive are, perhaps, not atypical of a newly-matured subject. As the rate of new discoveries decreases, so do the availability of financial support and the desire of students to enter the area. Each feeds on the other to accelerate the decline, and at a time when almost all engineers are in short supply, the mere availability of jobs provides no braking action. Were it not for the students from abroad, many universities would no longer be able to offer any graduate courses in fields, even now, and certainly none beyond the M.S. level.

Quite frankly I am pessimistic about the future of electromagnetics as a discipline in U.S. universities. No one university, and no government or industrial laboratory, has a group of sufficient size to offer hope for revitalizing the field. Those people who are still active in research and who are endeavoring to expand our knowledge are decreasing in number
and are an aging population. And as universities enter a decade of contraction rather than of growth, faculty who retire will not be replaced. It is, perhaps, the misfortune of electromagnetics that its leaders figure disproportionately in those EE faculty retiring in this period.