

A PHILOSOPHY OF GRADUATE EDUCATION AND RESEARCH FOR ENGINEERS*

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The title of this paper implies that research is a necessary component of all graduate education, and until a few years ago most of us would have insisted that this was so. Many of us thought this way because we failed to realize that there are different kinds of engineers. I don't mean that there are chemical engineers, mechanical engineers, and so on, but that in general, engineers want and need education for different reasons. For too long we have followed along in the footsteps of our associates in the pure sciences without regard to the special problems that are inherent in professional work.

We haven't time here today to discuss all of the problems involved in graduate education for engineers, but let me attempt to give you some of my philosophy by looking at the types of engineers who want to come to university for advanced learning. Let us consider candidates for a Master's degree, and for convenience, let us subdivide the group into three categories.

1. *The Research-Oriented Engineer* who has no particular interest in production but wants to do research whether it is basic or applied.

2. *The Engineer* who is interested in *Design and Production*; I will call this man the *true professional engineer*.

3. *Students from Other Countries* — who have widely different needs because they have widely different backgrounds; this is a group we have often ignored in the past, but we do so now at our peril.

These subdivisions are an oversimplification of the situation but, on the assumption that they are acceptable, let us look at the kind of programs that are needed to serve these people in the university.

For the *Research-Oriented person* — the important thing is a research thesis with only those courses that are absolutely necessary to enlarge his background and help him tackle his research and area of specialization.

For the *Professional Engineer* we may find that course work only, or a combination of course work and a design project, best meets the need. The assumption is made that most of the people in this group will go to or have returned from industry.

For *People from Other Countries* we need special courses and special people to teach those courses. At the present time, we tend to give students from the lesser developed countries the same kind of training we give Canadian students. This is poor pedagogy, and as a result we fail to help these students on the only basis that has any real significance, i.e. *as individuals*. We could teach courses which would be just as demanding, but which would be somewhat different from those we teach now. More importantly, perhaps, with this particular group of people, we could choose thesis topics with the student's welfare in mind. The topic should be of interest to him and the knowledge of some use when he returns home. Perhaps the only people who can teach these courses are those who know the social and economic situation to which the student will return.

FACILITIES AND FACULTY NEEDED

We can discuss graduate programs at great length, but these programs are only possible if we have the right facilities and the right kind of people to teach. We all know that good research can be done almost anywhere, but most of us realize that if you do good research in a building where the ceiling is falling down, you can do *better* research in a building which is modern and properly equipped. It may be a sad commentary on

our profession but it is only recently that people in engineering have been properly housed, and even today we are not properly equipped for much of the research we should like to carry on. Although I have been watching very closely over the past five years, I regret that I can see no sign yet that engineering research is properly funded.

However, let us assume that we have decent buildings and the research equipment necessary to carry out the programs that we have devised. We then come to the most important item, *the teacher*. In the early days of graduate work it was common to put a student in one room, a professor in another, and you had a graduate program. While many of us would like to think that this is the way to do graduate research, I'm afraid that our thoughts are too much influenced by nostalgia, and not enough by reality. Engineering is interdisciplinary in nature — it always has been, and is becoming more so each year. For this reason, we should avoid turning out individuals who are carbon copies of their professors. Students should be exposed to a wide variety of first class people, whether they are studying at the Master's level or the Ph.D. level.

Let us consider the Doctor of Philosophy Degree. In a recent booklet *The Association of Graduate Schools* set out a few very important principles with respect to graduate education. The booklet is concerned primarily with the Doctor of Philosophy degree, and therefore is concerned with research as a necessary part of graduate education. Here is what the Association has to say on, "*Excellence of the Professors*".

"Of highest importance in the establishment of a sound program leading to a Ph.D. degree is quality of the graduate faculty pro-

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