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ELECTRONIC DESIGN EDUCATING FOR AN UNCERTAIN FUTURE

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ABSTRACT

The next decade will undoubtedly present challenges to the Electrical Engineering profession, and indeed to society in general, that we at this time, have only begun to appreciate. Indeed, the only thing that is certain is that profound change will occur in the level of electronic technology used throughout the community.

This paper examines the qualities that most probably will be desired in Electrical Engineering graduates, and shows that these are the qualities that are generally attributed to Design Engineers.

The 'ELECTRONIC DESIGN' and 'ELECTRICAL DESIGN' courses at the W.A.I.T. are intended to introduce students to the special problems involved in tackling practical engineering design tasks, where the starting data may be vague, or incomplete, and where many alternative solutions may be equally valid.

Many students find it difficult to adjust to such a loosely structured syllabus, having been drilled thoroughly in problems with unique solutions and well defined solution proceedures.

In order to allow these students time to adapt to these concepts the LECTURE BASED - LABORATORY SUPPORTED style of teaching previously used has, during the last few years, gradually evolved to a LABORATORY BASED - LECTURE/ TUTORIAL SUPPORTED structure.

Students have the opportunity to SELF PACE their learning and are assessed solely on laboratory and assignment performance.

It is hoped that such a course will better equip the student to tackle engineering projects, and, by encouraging him to solve tasks which at first appeared (to him) insoluble, better suit him for a professional career in a rapidly changing technology.

1. INTRODUCTION

The change in the level of electronic technology available over the last several years has occurred on two fronts, that due to a proliferation of sophisticated analog integrated circuits and that due to the development of digital LSI ICs, including the microprocessor.

Simultaneous with the advance of this technology its effective, and actual, cost has been steadily reducing.

Projections by semiconductor manufacturers show that this trend will continue, at least until the early 1980s.

An example of equipment which will soon be appearing in our community is the daisy wheel electric typewriter being produced in the U.S.A. for $US1390, which uses an F8 micro to control the daisy wheel, another to control the linear motor which traverses the printing wheel across the page and a Z80 to accomplish error correction and word processing. Options include floppy disc text storage.

There are few mechanical parts in this typewriter, which is priced comparably with the 'Selectric' types which are currently the 'accepted standard'.

Although many similar applications of advanced technology could be cited this machine is important because it emphasises the shift, both in design and maintenance, from mechanical to electrical devices which will fundamentally affect employment throughout our society.

Although it is at present sufficient to confine the discussion in this paper to the effects of utilization of currently available technology it is inevitable that, at least for the next several years, the complexity of electronic devices will increase.

2. WHAT IS 'THE DIGITAL REVOLUTION'?

Many educators seem to be frantically planning new coursework in Digital Technology as if some magic metamorphosis has occured in electronics during the last several years.

This 'metamorphosis' is usually labelled something akin to 'The Digital Revolution'.

But there is no revolution.

Over the last decade there has been a gradual evolution of Digital Technology.

When this author designed the International Electronic Music Synthesisers in 1972 he was accused of using 'complex digital technology', and 'that newfangled CMOS', which would not be understood by the consumers of that project.

Few current designs do not use digital and analog techniques side by side.

It is essential that digital technology not be compartmentalized but that a balanced overview of all technology be maintained.

It is not enough to change some of our course structures to encompass simple digital theory (which is often taken from texts, and therefore at least two years behind the state of the art anyway), the whole methodology by which we train Electrical/ Electronic/ Communications Engineers must be re- examined.

The very fact that we still compartmentalize into the above categories is dangerous.

What is a 'Communications' major going to do when confronted with a μ255 COMDAC in a telephony link?

Is he going to 'call in' the 'digital blokes' or be capable of coping with the device as part of his responsibilities.

In 1972 an Asynchronous Communications Data Link needed a circuit board full of MSI ICs to implement start, stop, and parity bit generation and detection.

Last year one UART IC and one Programmable Baud Rate Generator IC were required.

Now a device called a 'Programmable Communications Interface' IC contains a USRT, UART, PBRG, and status registers which can be programmed and interrogated by an 8 bit micro. bidirectional data bus.

"But this gadgetry will never appear in commercial equipment"

The PCI only costs $17, a dedicated micro. and software could be in production soon for about the same, so it will be a commercial necessity for manufacturers to use such a (seemingly sophisticated) system approach.

The engineers who are now starting their training will be expected to design, specify, and maintain this equipment.

Unless we, as Australian educators, train them correctly there is little future for Australian Industry, and the graduates of the early 1980's will be servicing equipment manufactured overseas, or sweeping the streets.

3. LINEAR NETWORK THEORY

Simultaneous with the introduction of 'Digital' technology a shift in emphasis has been required in linear network theory.

For instance, students are exercised in manipulation of filter transfer functions, changing pole zero positions to realize a specified response in the frequency domain.

The manipulation of time domain characteristics, if taught at all, is usually given only cursory treatment.

Yet, in a digital system, the time domain may be much more important.

We teach the LOWPASS to HIGHPASS transformation which preserves the magnitude response but destroys the transient characteristic of the network[1].

How many graduating engineers would realize that when they perform a LP-HP transform of the BESSEL polynomial they will not achieve maximally flat delay?

How much emphasis is placed on the STEP RESPONSES of linear filters?

Many students fail to realize that a quick transition in the frequency domain implies a slow transition in the time domain.

Can we afford the luxury of teaching linear semiconductor device models in early years and then telling (rarely teaching) the student in his project work that real devices cannot be accurately analysed using these techniques?

What place have Computer Aided Circuit Analysis and numerical optimization techniques in an undergraduate course?

4. TEACHING ELECTRONIC DESIGN

Even if its only raison d'être was to attempt to correct some of the anomalies already mentioned a formal course in practical ELECTRONIC DESIGN would be a valuable addition to an undergraduate syllabus.

The DESIGN unit at the W.A.I.T. is allocated 2 hours laboratory and 2 hours lecture/tutorial during the third year of the B.E. course options in Communications and Electronics.

Continuous assessment is used, with loosely structured laboratory timetabling and computer aided circuit analysis (using SPICE) to allow the weaker students to 'self- pace' their learning whilst not inhibiting those who grasp design concepts readily.

Students are allowed to schedule their own laboratory experiments as they see fit, and the experiments are designed so that the sequence in which they are attempted should not materially affect the assessment effectiveness.

Laboratory reports have been marked with the students present, and little abuse of this, or other laboratory privileges, has occurred.

The students are given a task, expressed as an aim, and are left to prepare their own proceedure, decide what test equipment will be required and then request it in the 'class diary'.

This request is then serviced, if possible, by the technical support staff.

The length of each task varies, the SERVO AMP and R.F. POWER AMP labs each being allocated 8 to 10 hours, whilst the XTAL OSCILLATOR lab should only take 4 hours.

Some students cannot complete the labs within the scheduled times, and assistance is given them to complete the task outside the formally allocated class schedule. Others attain a high standard with time to spare.

Students thus have to spend considerable time in what may be termed 'administrative tasks'.

Their initial reaction is generally bewilderment, with at least one semester needed by most students before they are able to adequately prepare for the laboratory sessions.

Even though the assessment is continuous, with the student at any stage being able to calculate his final grade, the failure rate in the first semester was 20%.

Were these students thrust into engineering projects, or industry, it is likely that they would face the same difficulties in self- organization there.

5. ENGINEERING IN THE 1980s

The qualities that are most likely to ensure success in an engineer in this coming decade include

a) An ability to adapt readily to change

b) A willingness to accept the benefits of advancing technology

c) Confidence to tackle new devices and technologies

d) A thorough basic professional education

e) A desire to continue the learning process.

Continuing education can be accomplished by either self education (in exceptional cases) or by formal courses such as the GRADUATE DIPLOMA courses offered at the W.A.I.T.

The other qualities can be encouraged during undergraduate education.

Course structures which require students to learn 'facts' and regurgitate those 'facts' at examinations will not encourage them.

This is shown by the inability of students who have completed primary, secondary and 2 years of tertiary education, yet are unable to pace their progress so as to pass a continuously assessed subject.

That the intention of the subject is to simulate, as closely as practical, the daily routine of a junior engineer makes the inadequacies in our present educational system even more obvious.

6. EDUCATING THE EDUCATORS

It is incumbent upon acadamics to ascertain or anticipate the basic educational requirements for a graduate engineer.

It is essential for Industry to co- operate in setting these standards, but in a climate of rapid technological change more anticipation may be required than has been usual in the past.

'The Digital Revolution' is a good example of the pace of advancing technology outstripping Industry's ability to utilize it and academia's ability to anticipate its educational requirements.

If Electrical Engineering Education, as it currently exists, is to survive it must service the community at large, and Industry in particular.

As I attempted to demonstrate in sections 1 to 3,the next decade will probably require the most change in those of us most highly educated in the current technology.

Unless an Electrical Engineering course AS A WHOLE is capable of producing competent design and project engineers new technology will not be able to be effectively exploited.

7. CONCLUSIONS

The coming decade will be one of profound change in the level of electronic technology in use throughout the community.

It would seem that the present Electrical Engineering course structures, and maybe the content, will need rapid change if the Electronics Industry is to possess a design or project capability comparable to that existing in the more technologically advanced countries.

An expansion of opportunities for students from other countries of the Pacific Region will be necessary if they also are to participate in expanding technology.

More expenditure than has been usual in the past will have to be found to continue the education of academics and practising engineers.

REFERENCE

1. BLINCHIKOFF,H.J. & ZVEREV,A.I.;'Filtering in the Time and Frequency Domains', Chapter 4, Published by JOHN WILEY AND SONS,1976