Strengthening the university–industry relationship

A case study of the Electronics Department, TEI Crete

George Liodakis, Ioannis O. Vardiambasis, Evangelos Kartsonakis and Ioannis A. Kaliakatsos

Abstract: The Department of Electronics of the Technological Educational Institute of Crete (DoE/TEI Crete) enjoys good approval ratings from the market and its graduates have a high rate of employability. However, survey data collected over the last ten years from graduates and from the enterprises in which they have been employed, or have carried out their workplace learning, indicate the strong and weak aspects of the Department’s curriculum from the viewpoint of the job market. The authors identify issues that may improve the access of their graduates to the market and which may also bring enterprises closer to the DoE, thus offering both parties the opportunity to establish internships for research. It is proposed that the time is now right for a next step to be made towards achieving cooperative engineering education and the authors offer suggestions as to how this might be achieved.

Keywords: cooperative engineering education; curriculum development; electronics engineering; graduate employability; workplace learning; TEI Crete

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It is generally accepted that economic growth is stimulated by technological innovation and that engineers play a key role in this. Producing highly qualified engineers who will work in the sector under consideration in this paper – that is, the electronics industry – therefore poses unique challenges to existing educational systems worldwide. The past 50 years has seen continuing and constant technological breakthroughs in electronics technology; but this has resulted in a mismatch between the pace of these new developments and that of the education of electronics engineers.

The need to combine theoretical knowledge and practical skills in the education of electronics engineers...
the highly competitive corporate environment in a global economy and accomplishment of the research mission of a university in order to promote technology innovation all demand the adoption of a cooperative engineering education model (Gover and Huray, 2007). This model corresponds to an apprenticeship-based education that, it can be argued, best prepares students for jobs requiring knowledge of emerging aspects of electronics technology, mathematics and science as well as ‘soft’ skills such as a flair for invention, talent in business and management, leadership and communication skills and the ability to innovate in a team environment.

An initiative following the cooperative education model, albeit with an emphasis on two-year programmes in colleges in the USA, is that of the Advanced Technological Education (ATE) programme, supported financially by the US National Science Foundation (NSF). Specifically, there are some 39 ATE projects involving partnerships between academic institutions and employers to promote improvements in the education of science and engineering technicians at undergraduate level in advanced manufacturing technologies, electronics, micro- and nanotechnologies, information technologies, and so on (Patton, 2011).

Taking into account the above framework, the purpose of this paper is to present the strong and weak aspects of the Department of Electronics, Technological Educational Institute of Crete (DoE/TEI Crete) in terms of curriculum design and research internships with industry. Our case study is based on survey data on the adequacy of our students’ knowledge and skills and the need for expansion of knowledge in specific subjects. The survey data span a period of ten years, during which time there were two revisions of the curriculum. In addition, this work deals with issues regarding the job market for electronics engineering in the USA, an example of a world leader nation in terms of technological innovation and global competitiveness. The present analysis also deals with the research potential of DoE/TEI Crete with regard to the enhancement of research internships with industry. It is our belief that curriculum changes made in response to developments in electronics technology and job market changes, when combined with closer linkages with industry for collaborative R&D, will enhance the employability of our graduates (Kaliakatsos et al., 2005a; 2005b) and will be beneficial for all stakeholders: students, academic staff and industry.

The survey: methodology and results

The TEI Crete, as with any other university, has three major objectives: the education of students; producing and securing the employment in industry of competent engineers; and the evolution of basic and applied research. As such, the DoE revises its undergraduate curriculum regularly, in order:

1. to match the offerings and performance of other electronics engineering departments elsewhere in Europe;
2. to satisfy market needs and industry requirements; and
3. to accommodate trends in technology and scientific innovation.

In the current (2012) state of global and local financial and economic crisis, it is imperative that engineers are educated such that they can compete in the market when seeking and retaining suitable, relevant employment. We have succeeded in keeping the rate of unemployment of our graduates very low: this is one of our Department’s major achievements. To do so we cultivate strong bilateral relations with most of the domestic industries and enterprises involved with electronics engineering and we take careful note of and adapt appropriately to any changes or advances taking place in the ‘academia–research–technology–markets’ nexus. To determine the strong and the weak aspects of DoE’s present curriculum, we distributed anonymous questionnaires to three interdependent target groups: our graduates, academic staff at DoE/TEI Crete and enterprises employing our electronics engineers.

Taking the average marks of all answers given by each target group to the questionnaire item, ‘Mark the DoE/TEI Crete graduates’ knowledge of the following educational subjects, using grades ranging from 0 (inadequate knowledge) to 4 (very good knowledge)’, Figure 1 shows the results for 15 different topics covered by at least one course within our present curriculum. According to the enterprises, the knowledge of our graduates is weak not only in Management and Marketing and Economics of Enterprises – a result that was largely anticipated by us – but also in Mass Media Electronics, Microcomputers, and Computer Architecture (subjects that also scored below 1.5). The survey results for these latter three subjects are surprising and need to be given careful consideration because (a) for these subjects we had the opposite understanding, that these were among the best in our curriculum; and (b) graduates themselves seem, with their answers about these subjects, to hold contrary views (as shown in Figure 1). In contrast, enterprises believe that our graduates’ knowledge is very strong in Digital Electronics, Computer Networks, Computer Programming, Physics, and Mathematics (these all scored above 2.5).
Figure 1. Survey results for the average adequate knowledge (graded 0–4) of DoE/TEI Crete’s graduates of 15 educational subjects of the present curriculum (according to lecturers, students and enterprises).

Figure 2. Survey results for the average need for knowledge expansion (graded 0–4) of DoE/TEI Crete’s graduates on 27 scientific/technological/educational topics (according to lecturers, students and enterprises).

Furthermore, in Figure 2 we present the average marks, for 27 different topics, of all answers given by each target group to the question, ‘Mark the DoE/TEI Crete graduates’ need for knowledge expansion in the following educational subjects, using grades ranging from 0 (expansion not needed) to 4 (expansion...
required). According to the enterprises, our curriculum needs to be enhanced mostly in Marketing and Management, Economics of Enterprises, Analogue Electronics, Digital Electronics, Digital Control Systems, AutoCAD Design, and Product Design (all of which scored above 3.0). These results provide an indication of market needs and will inform our developments with regard to technical economics, technical reports, sales and human resource management principles, entrepreneurship instructions, and other related topics. In contrast, the collaborating enterprises indicated that Digital Signal and Image Processing, Mass Media Electronics, and Microcomputers (subjects that scored below 1.0) do not require any further attention at present. This result, for the latter two subjects, is in direct contrast to the results shown in Figure 1, something for which we can offer no obvious explanation.

We have compared and noted the differences between our curriculum and the curricula of five different UK universities ranking amongst the best in the area of electronics engineering (Imperial College London, University of Surrey, University of Bristol, University of Southampton and University of Edinburgh). These universities were chosen as benchmarks because (a) they involve similar undergraduate studies to ours; (b) we are familiar with the UK higher education system; and (c) the majority of our students who choose to progress into postgraduate studies prefer to do so in a UK university. This comparison revealed that the UK universities give more emphasis to computer-related topics such as real-time computing, embedded systems, artificial intelligence and neural networks; and economics-related topics.

Taking into account only those courses which appeared to match exactly, it was found that our curriculum coincides by some 50–60% with each of the aforementioned UK curricula; and if we also consider topics that are similar then the extent of congruence rises to some 80%, on average. This suggests that our present curriculum, which is based on lifelong learning principles (Varthamisbas et al., 2007), is largely in line with current practice elsewhere. However, taking into consideration the previous analysis of our curriculum’s weak aspects, as expressed by the collaborating enterprises, together with the comparison of the curricula, our undergraduate programme needs to be enhanced in areas such as computer hardware, management and economics.

**Job market trends**

It is accepted that any revision of the curriculum at DoE/TEI Crete should take into account the following.

![Figure 3. Job postings for electronic engineers by indeed.com, January 2005–June 2012. The data are for jobs posted by indeed.com using the search term ‘electronics-engineer’. Source: http://www.indeed.com/jobtrends?q=electronics-engineer&l=](image-url)

(1) There is normally a time lag of some six years between initial student enrolment and when they start to seek gainful employment.

(2) The demand from the jobs market for electronics engineers needs to be met (Liodakis et al., 2007).

With regard to the latter, because reliable statistical data about the jobs market in Greece are not well documented, we used instead data available for the corresponding jobs market in the USA. The continuing trend towards globalization, despite the recent recession, and the high status of the USA with regard to electronics engineering technology, justifies this approach, we would argue. In particular, the percentage of matching job postings for electronic engineers from the www.indeed.com website (Indeed.com, 2012) and the number of positions offered in sub-major areas of electronics engineering studies (Figure 3) show a growing demand for electronics engineers over a six-year period. The situation for telecommunications engineers is similar, according to projections of the US Department of Labor Statistics concerning employment for the foreseeable future (Table 1): telecommunications engineering is the most preferred sub-major topic selected by students at DoE/TEI Crete.

It should be mentioned that pursuing a career in engineering is related to the fact that the student’s choice is often made on the basis of job opportunities and salary data. In particular, the average salaries of engineers working in electronics engineering (see Indeed.com, 2012) are presented in Figure 4. In addition, according to the IEEE annual survey of its members’ salaries the starting salary of electrical and
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Table 1. Number of current and projected positions (in thousands) in the area of electronics engineering.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Employment</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications equipment manufacturing</td>
<td>8.7</td>
<td>-28.7%</td>
</tr>
<tr>
<td>Semiconductor and other electronic component manufacturing</td>
<td>25.4</td>
<td>-10.8%</td>
</tr>
<tr>
<td>Navigational, measuring, electromedical, and control instruments manufacturing</td>
<td>26.3</td>
<td>-12.2%</td>
</tr>
<tr>
<td>Scheduled air transportation</td>
<td>0.2</td>
<td>1.1%</td>
</tr>
<tr>
<td>Radio and television broadcasting</td>
<td>0.9</td>
<td>11.4%</td>
</tr>
<tr>
<td>Wired telecommunications carriers</td>
<td>17.3</td>
<td>-2.7%</td>
</tr>
<tr>
<td>Wireless telecommunications carriers (except satellite)</td>
<td>7.4</td>
<td>41.4%</td>
</tr>
<tr>
<td>Satellite communications</td>
<td>0.2</td>
<td>54.5%</td>
</tr>
<tr>
<td>Other telecommunications</td>
<td>2.8</td>
<td>9.9%</td>
</tr>
<tr>
<td>Testing laboratories</td>
<td>2.7</td>
<td>20.2%</td>
</tr>
<tr>
<td>Research and development in the physical, engineering and life sciences</td>
<td>14.7</td>
<td>21.7%</td>
</tr>
<tr>
<td>Electronic and precision equipment repair and maintenance</td>
<td>0.6</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Source: Based on data from US Department of Labor Statistics.

Electronics engineers is perceived to be ‘high’. However, when these data are corrected with regard to the consumer price index, to derive salary levels in ‘real’ dollars, the starting salaries of engineers at graduate level have effectively remained unchanged over the last 30 years. During the career lifetime of an IEEE engineer, for all degree levels, on average the real salary doubles.

Student and research internships with industry

Fostering relationships with local, national and international partners for research and technological development (R&TD) is a major task undertaken by the DoE/TEI Crete. The aim is to broaden current partnerships and to encourage new arrangements for R&TD between the DoE and technology-based industries and to raise awareness of specific industries and promote career opportunities for our graduates. Such partnerships, mostly supported with funding provided through EU and national resources, were established in the period 2004–2012 within the framework of 32 R&TD projects, with the active engagement of academic staff at DoE/TEI Crete: they also provide direct and indirect benefits for our students. In some 20 of these projects research internships – having a significant impact on prospects for further research collaboration prospects between DoE and industry – were established in

Figure 4. Average annual salary in the area of electronics engineering (in US dollars, as of May 2012). Source: http://www.indeed.com.
development and collaboration with the industry. The analysis was carried out in the context of international academic practice and job market requirements. We conclude that the Electronics Department needs to modify its curriculum, to take into account the experiences of our graduates, suggestions from academic staff and the opinions of enterprises (employers). Such a revision of the curriculum could result in something like 80% congruence with the curricula of other universities. There would be a need for continuous updating to accommodate job market trends and to align with other relevant initiatives such as, for example, the NSF’s ATE programme. As a result, our graduates would have the knowledge and skills needed to enter successfully into competitive jobs markets. Moreover, closer linkages with industry through research internships will help academic staff members to monitor efficiently the needs of the jobs markets and conduct research designed to solve real-world problems.

References


Figure 5. Evaluation of students’ theoretical knowledge and technical abilities by industry supervisors.

Conclusions

This study set out to analyse the strong and weak aspects of DoE/TEI Crete as they relate to curriculum


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