

**University College Cork
National University of Ireland, Cork**

Quality Improvement/Quality Assurance

Peer Review Group Report

Department of Microelectronic Engineering

Academic Year 2003/2004

23rd April 2004

Members of the Peer Review Group (PRG)

Professor Michael Mansfield, UCC (Chair)

Mr. Tom O'Dwyer, Analog Devices, Limerick, Ireland

Professor Georges Gielen, K.U. Leuven-ESAT/MICAS, Belgium

Ms. Kathryn Neville, UCC (Rapporteur)

Timetable of the Site Visit

The timetable for the visit allowed adequate time to meet the stakeholders in the Department and to assess the activities of the Department.

The timetable for the visit is attached as Appendix A.

Peer Review

Methodology

Professor Michael Mansfield was responsible for chairing the Review Group and for ensuring the timetable was followed. Professor Mansfield steered discussion on the recommendations and was also responsible for the delivery of the Review Group Report within the specified timeframe.

Professor Georges Gielen acted as the expert in the area of microelectronics and reviewed the Department against international norms.

Mr. Tom O'Dwyer, an expert in the microelectronics industry, assessed the Department's responsiveness to the requirements of industry in relation to research and postgraduate programmes.

Ms. Kathryn Neville acted as Internal Reviewer and was responsible for ensuring that a record was kept of all discussions.

Site Visit

The PRG considered that it was important that the review be conducted in the Department. It allowed the reviewers to meet formally and informally with staff members and to determine whether the current facilities meet the needs of the Department.

Compilation of the Peer Review Group Report

All members of the group contributed equally to the composition of the report.

Overall Analysis

1.0 Self-Assessment 16 January 2004 Report

The self-assessment report presented by the Department was comprehensive and well organised. Issues were addressed in a concise but considered manner. Four additional items could have been referenced in the documentation presented:

- It would have been helpful to clarify the position of the associate professor and of NMRC staff who are responsible for a number of modules but are not listed under the staff of the Department. A curriculum vitae for the associate professor in the Department, and summary CVs for the part-time staff used by the Department could have been included. This would be important in the context of the Department's request for additional staff.
- Unit cost figures for the undergraduate programme to establish a baseline, and for comparison to like programmes at the College, and national norms.

- Reference to the accreditation plans, if any, for example by the Institution of Engineers of Ireland of the undergraduate programme. The plan would have been sufficient, since the PRG understands that this accreditation cannot commence until the first graduates are produced.
- A summary of the safety statement, and the departmental policy and responsibilities, if any, in relation to safety.

In addition, the information provided on benchmarking against comparable departments elsewhere was not sufficiently detailed.

However, much of the above information, in particular a comprehensive safety statement, was presented during the visit.

The PRG was satisfied with the information presented in the report and verified the information with internal and external staff members during the site visit.

1.1 SWOT Analysis

The analysis presented by the Department showed that they had addressed the issues affecting their current situation and future development. The SWOT analysis showed that the departmental co-ordinating committee had conducted an accurate assessment of the strengths of their activities and had identified future actions.

However, the reviewers would have expected one central threat to the Department to be addressed, namely the low numbers of students opting for the undergraduate programme. In spite of the Department making considerable efforts to attract such students the numbers have remained low. (This issue is a national problem at present due to the negative image of information technology among school leavers and not confined to this Department alone.) The potential confusion and difficulty for leaving certificate students having to choose between the (initially quite similar) undergraduate programmes of

Microelectronic Engineering and Electrical & Electronic Engineering at the College may also have contributed to the low numbers.

On the other hand, the research programs (Master and Doctorate) seem successful in attracting students.

1.2 Benchmarking

The mission of the Department was clearly stated as providing excellence in teaching and research in Microelectronic Circuit Design and Technology, comparable with groups in Berkeley, CMU and K.U. Leuven. However, the Department does not present statistics showing comparisons of their activities with those of the benchmarked universities. Examples which the PRG might have expected was the number of publications per staff member compared with international groups. The establishment of measurable targets for the Department, using for instance standard international criteria such as publications and research grants, is important in demonstrating future progress towards its objectives, and allows the Department to compare itself with like Departments at the international level.

2.0 Findings of the Peer Review Group

2.1 Department Details

The PRG was very impressed by the enthusiasm, commitment and dedication of the staff of the Department. In order to establish the Department, staff had taken on heavy workloads without complaint. The Department has demonstrated the viability of both undergraduate and postgraduate courses and of an academic department devoted to microelectronics research in UCC.

The PRG is concerned that, with only three fulltime academic staff, one administrative staff member and one technician, the Department is very vulnerable to illnesses or resignations among the staff. Furthermore the heavy teaching and administrative load

leaves the academic staff little time for research. While a case can be made to recruit a further member of staff in the area of analogue design and device physics, it may be difficult to argue this case in the light of the current financial constraints on UCC. The Department will be more secure if it can be linked formally to a larger department, or departments, allowing it to share and reduce undergraduate and administrative load, freeing time for postgraduate and research work. While the current use of NMRC staff as part-time lecturers goes some way towards providing a safety net, a stable arrangement or arrangements with other academic departments is highly desirable.

2.2 Departmental Organisation and Planning

The Department of Microelectronic Engineering is well organised and efficiently run. The committee structure was considered appropriate to the size of the Department but there is a need for a staff-student committee. The Department have themselves identified this need and are taking steps to establish such a committee.

In general the administrative load on staff was considered to be excessive. A significant contributory factor was the need to have a departmental presence on several college committees, placing a strain on already hard pressed staff.

The present location of the Department, far from main campus is very unsatisfactory. Students often have to travel large distances to attend lectures and are cut off from facilities such as the Boole Library and catering facilities. The remote location also inhibits full interaction with cognate departments. UCC planners regard the present location as temporary. A number of relocation options are likely to be available in new arrangements for IT research in UCC.

The facilities in the Department itself are generally good but there is no room for expansion. In particular, on the research side there will soon be a need for Test Laboratory facilities once working circuits have been manufactured. The current space

allocated to the Department does not encompass such a laboratory. In the future it may be possible to avail of the facility located in the NMRC.

There is also little or no space left for an expansion of the number of Ph D research students at the current location. In addition, the lack of a secure network link to the university and the very small size of the kitchen facility were a difficulty for the students and staff. A larger room for socialising between all members of the Department should be established and a reliable high-bandwidth link to the main cognate groups and the main campus needs to be installed.

The Department did not, until recently, receive a financial allocation from the Engineering Faculty. Start up funding has been raised from postgraduate programmes and from research funds and by accumulating a large deficit. Moreover financial data from the Department and from the NMRC are often bundled together so that it is not possible to obtain a clear picture of staff/student ratios or of departmental costs. In these circumstances it is not possible to assess the cost effectiveness of the Department.

2.3 Teaching and Learning

On the question of class sizes, the PRG was very concerned by the low number of CAO first preferences given to both Microelectronic and Electrical & Electronic Engineering by Leaving Certificate students but considered this to be a national problem rather than a UCC problem; indeed there is evidence that this problem is less severe at UCC than elsewhere. Projections of national needs for Microelectronic and Electrical & Electronic Engineering graduates, however, indicate that there will be an acute shortage of such students within a few years. The low number of CAO first preferences should therefore correct itself as soon as students become aware of a recovery in the IT industry, although it may always be difficult to find a sufficient number of qualified students to fill the current quotas of the two Departments.

The Department has made strenuous efforts to recruit students through interactions with secondary students, active participation in MIDAS Ireland, the Young Scientist Exhibition, and the Women in Science and Technology initiative. In particular it has attempted to redress the gender imbalance in its student intake. With an upturn in the IT market, these efforts should bear fruit. The Department also intends to recruit about ten overseas students per year at undergraduate level as a means of making up the current shortfall in its intake and has already taken steps to achieve this. Some of these students may continue as postgraduates or may work in Irish industry to the benefit of all concerned. It is unlikely that an intake of ten overseas students will significantly limit the Department's ability to serve demand from Irish students when the IT market recovers.

There was general agreement that it was unreasonable to expect leaving certificate students to be able to make informed choices between Microelectronic and Electrical Engineering courses. The current situation, whereby both Departments market their courses separately, is confusing for students. There is also a danger that, in competing for the same cohort of students, the two Departments may be tempted to divert their energies into pointing out disadvantages in the course with which they are competing. It is considered very important that the two Departments deliver a cohesive message to Leaving Certificate students.

It is an asset for the Department that they use experts from the NMRC as part-time lecturers and as co-supervisors for PhD research work in areas such as microelectronics technology and device modelling. However, additional training is required for such part-time teachers.

As the undergraduate course has not yet been formally accredited by an external body such as the Institution of Engineers of Ireland, the PRG would have liked to have conducted a detailed review, but time did not permit this. However, a brief overview by the external expert noted the following:

- The focus of the course on microelectronic circuit design is good and corresponds to the needs identified by industry (see the report from McIver Consulting, “The Demand and Supply of Engineers and Engineering Technicians – A Study for the Expert Group on Future Skills Needs”, May 2003).

The following suggestions should be considered in relation to the current undergraduate course programme:

- There does not seem to be a course on real-time systems and embedded software.
- More emphasis could be put on Computer Aided Design (CAD) and Design Automation in the programme.
- It is important that IC designers cover sufficiently advanced IC technologies (e.g. nanotechnology, biotechnology) and advanced devices and their models, as well as technology-related aspects such as reliability, yield and testing. Sensors and actuators are also important for many applications.
- It is not clear whether application domains such as communication networks and multimedia are covered sufficiently (syllabi of Electrical & Electronic Engineering course modules were not provided).
- There should be a module on economics/business and law (intellectual property) aspects to enable engineering students to understand the broader context of the job in industry.

The Department did not emphasise the very high retention rates for their students. Excellent reports of the quality of teaching were received from students and graduates, and this quality of the student experience would seem to contribute to the high completion rates. Some postgraduate students however did report that there should be more structured opportunities for postgraduate students to present their work to their contemporaries. In this way, knowledge will be passed on more effectively to succeeding generations of students (a mechanism of learning from peers). Also, some undergraduate students reported that the timing of some assignments could be better co-ordinated.

The PRG supports the recruitment of overseas students and believes that this will benefit the work of the Department. One matter of concern is the delay in issuing acceptance to overseas students well in advance of the start of the programme so that visa requirements can be fulfilled. An added problem is the difficulty organising accommodation, despite the excellent help provided by the International Students Office.

Discussions with students, graduates and employers confirmed a very high level of satisfaction with the course content and with the high quality of the graduates produced by the Department. Employers were particularly appreciative of the fact that they had been consulted in drawing up the course content. The following points were also made:

- An Engineering Management module would make a valuable addition to the syllabus. A single course that would cover economics/business and law (covering such areas as Intellectual Property rights), but would not significantly displace core engineering material, was suggested.
- Some employers would like to see graduates emerging with skills that would allow them to make an immediate contribution to industry. Others put the emphasis more on giving graduates a broad basis that would enable them to adapt readily to the changes in the industry, and consequent challenges/opportunities, that they were sure to encounter in the course of their careers.
- Employers were concerned that UCC might react to the drop in first preference CAO choices in Electrical & Electronic and Microelectronic Engineering by lowering entry standards. They considered it very important that standards be maintained. Excellent reports of the quality of teaching were received from students, graduates and employers.

The PRG was supportive of the recent change in entry requirements introduced by the Microelectronic Engineering Department whereby the need for a C grade or higher in honours physics had been dropped. The Department compensates for this by allocating a two semester physics courses to 1st year students, as against the one semester course

taken by Electrical & Electronic Engineering students. Such a measure doubles the size of the available pool of candidates (from 5,400 to 9,400 approx.) as well as helping to address the issue of gender balance in the programme (from 29% to 45% approx.).

It also brings practice into line with many other EU countries such as Belgium, where K.U. Leuven is located, an institution which the Department seeks to emulate. When this initiative has been taken elsewhere the standard of graduate has been maintained. The reasoning in Belgium was that even students who - for whatever reason - did not choose physics at secondary level but who have the intrinsic capacities and skills to become an engineer, should be allowed entry to engineering.

The PRG believes that maintenance of entry standards is adequately safeguarded by the requirement of at least a C grade in Leaving Certificate Honours Mathematics.

2.4 Research and Scholarly Activity

The research strengths of the Department are in the area of circuit design and CAD. Research potential in this area is significant and the Department has already benefited from a research grant from Science Foundation Ireland.

As the Department is new, its research output and publication record has not yet reached full strength, although the PRG notes the strong prior publication record of some staff. The high teaching and administrative load of departmental staff may hinder full research deployment at this stage.

Postgraduate research is viewed by the PRG as the main strength of the Department, and postgraduate numbers are very high in comparison to undergraduate students. The Department also seems to be able to recruit internationally at this level.

The research is however hampered by the limitations of the computer network link, and the lack of on-line access to the major IEEE publications (e.g. through IEEE Explore) is a

major weakness. The PRG recommends the installation of a reliable high-bandwidth link and the availability of on-line access to IEEE Explore.

Other research facilities in terms of space, etc appear to be adequate for the current numbers involved, but will clearly be insufficient when the number of PhD research students expands. In addition, there will soon be a need for Test Laboratory facilities for which there is no space in the current location.

2.5 External Relations

The Department of Microelectronic Engineering interacts with the support services of the University, with research funding bodies, with the Department of Electrical Engineering and with the NMRC. In particular, the Department should be able to benefit from the interaction with the NMRC and vice versa. The knowledge and experts from NMRC are used to benefit Departmental teaching programmes, and the Department serves as academic interface to many of the NMRC's PhD researchers. The firewall between the university network and the NMRC network did seem to create some inconveniences and this should be smoothed, without creating confidentiality and disclosure problems. The PRG had the impression that, currently, the Department was not able to take advantage of the NMRC's infrastructure. In the longer term, the integration between the Department and the NMRC should strengthen with the Department becoming the core research group in IC design and CAD for the NMRC or the future new ICT centre.

Interviews with support services conducted as part of the review show that the Department is viewed as responsive in a timely manner to requests. In terms of suggested improvement, the PRG suggests that, in the case where the Department makes use of staff from other groups, it is important to co-ordinate and give adequate advance notice of changes in timetables to ensure smooth changeover.

Relations and links with industry are very strong, through joint research projects, and active participation in the MIDAS Ireland organisation. Links with other cognate

international centres and universities have also begun and are likely to grow strongly in the future. In addition, the Department is taking several initiatives to put itself on the international scene, such as the organisation of the IEEE IC Test Workshop in Limerick in September 2004 and the organisation of the European Conference on Circuit Theory and Design in Cork in 2005. The Department Head is also very involved in international IEEE activities. He has served as Associate Editor of the IEEE Transactions on Circuits and Systems, he continues to serve as Chair of the Ireland Chapter of the IEEE Solid-States Chapter, and he was elected Fellow of the IEEE, all testifying to his scientific reputation. He is also President-Elect of the European Circuits Society.

3.0 Recommendations for Improvement

3.1 Undergraduate Teaching

3.1.1 The Department of Microelectronic Engineering recommends integration of the Microelectronic Engineering undergraduate course with that of the Department of Electrical & Electronic Engineering, with a common entry point and a joint programme in the first few years but with Microelectronics as one of the specialisation streams towards the later years. The PRG supports this option and recommends that such an arrangement be brokered between the Departments. The issues which will need to be addressed include:

- Common marketing of the course programme towards Leaving Certificate students, and common entry requirements, namely the question of the need for a C grade or higher in Honours Leaving Certificate honours physics.
- The nature of the introduction to microelectronics given to students in the early years.
- The year in which the course should become specialised: the course should be common for two years and for no more than three years.
- An appropriate name for the resulting degree.

The common programme should increase the generalist nature of the programmes but should allow students to specialise easily in microelectronics. The existing Engineering Management module, or a development thereof, would be available to Microelectronic Engineering students.

It is essential that the quality of the graduating student should be maintained to the same high standard as heretofore. The integration of these programmes should be arranged so as to take account of the Bologna agreement.

3.1.2 Better co-ordination of assignments for undergraduates. The PRG recommends that the Department consider coordination of task deadlines across modules to provide better balance of the student workload.

3.1.3 Better notice of changes in teaching times should be given to part time lecturers.

3.1.4 Additional training in teaching is required for part time teachers.

3.2 Postgraduate Teaching and Research

3.2.1 The Department of Microelectronic Engineering has established strong programmes in the area of postgraduate training with extensive links to industry. From the industry viewpoint, it is considered essential that the Integrated Circuit Design field remains a key area of strategic research for the College. It is essential that the Department maintain its current high quality in this area and throughput of postgraduates. Also the international programme is highly appreciated. The PRG suggests that the Department of Microelectronic Engineering become a graduate school, maintaining at the minimum its present shape and staffing which concentrates on the postgraduate programmes and research, but which also provides education services in the undergraduate programme for the microelectronics course modules and specialisation stream. This school would allow programmes to respond to industry and graduate needs in a flexible and proactive manner.

The Department should further develop its research plan, based on individual strengths and the needs of industry

3.2.2 There should be more structured opportunities for postgraduate students to present their work to their contemporaries. In this way, knowledge will be passed on more effectively to succeeding generations of students (establishing a mechanism of learning from peers).

3.2.3 Going forward, postgraduate activity will soon require access to a Measurement Laboratory containing automatic test equipment. The PRG recommends that, in the absence of such facilities, some form of agreed access should be arranged with the facility currently existing in the NMRC.

3.3 General Teaching

3.3.1 The PRG supports the recruitment of overseas students and believes that this will benefit the work of the Department. One matter of concern is the delay in issuing acceptance to overseas students well in advance of the start of the programme so that visa requirements can be fulfilled. An added problem is the difficulty organising accommodation, despite the excellent help provided by the International Education Office. The PRG recommends that the College review its offer policy to overcome the visa delay problem, and consider provision of temporary accommodation for a ten-day period on campus for new international students to give them time to organise more permanent accommodation.

3.3.2 The Department should establish a staff-student committee.

3.4 Location

Locating the Department of Microelectronic Engineering in a more integrated setting would allow the Department and its students to benefit from full interaction with cognate Departments and Research Centres, specifically Computer Science, Electrical & Electronic Engineering and the NMRC. The research interests of the four are closely linked and their needs are broadly similar in terms of computer hardware, network needs, software and associated system administration.

Ideally all four should be located together but the PRG recognises that, within current space constraints, this may not be possible.

The PRG is aware that plans are in place to co-locate the Departments of Microelectronic Engineering and Computer Science in a new building. This would greatly benefit the Department and, should the Department of Electrical & Electronic Engineering also be located in the new building, possibilities for enhanced co-operation would result and would benefit a new joint undergraduate programme (as recommended in 3.1.1).

A possible alternative is to locate the graduate and research activities of Microelectronic Engineering, Electrical & Electronic Engineering and NMRC in the Maltings as part of the new ICT centre proposed for that area. Given the competence of the Department of Microelectronic Engineering in circuit design and CAD this Department should form a core group in the new ICT centre. This will help grow research funding in the microelectronics and IC design area and would allow the Department access to the facilities they require for research and postgraduate education.

3.5 Resources/Services

3.5.1 Financial data for the Department of Microelectronic Engineering and the NMRC should be completely separated to enable accurate measurement of Departmental costs and to track improvement over the coming years.

3.5.2 The PRG recommends that a mechanism be found whereby the financial deficit of the Department, created at time of start-up and due to the lack of funding from the Engineering Faculty, be eventually written off.

3.5.3 The PRG recommends the installation of a reliable high-bandwidth link to the main cognate groups: Electrical & Electronic Engineering, Computer Science, and the NMRC as well as to the main campus.

3.5.4 The library should cater to the needs of the Department. Access to IEEE Explore is essential and the PRG feels strongly that this should be arranged as a matter of priority.

Conclusion

Finally the Peer Review Group wishes to express its appreciation of the excellent support and generous hospitality shown by the Quality Promotion Unit and by the Department of Microelectronic Engineering in the course of this review.

Timetable for conduct of Peer Review Visit

Department of Microelectronic Engineering

Sunday 29th February 2004

- 18.00 Meeting of members of the Peer Review Group
Briefing by Director of Quality Promotion Unit, Dr. N. Ryan.
Group agrees final work schedule and assignment of tasks for the following 2 days.
Views are exchanged and areas to be clarified or explored are identified.
- 20.00 Dinner for members of the Peer Review Group and for members of the Department:

Monday 1st March 2004

- 08.30 Convening of Peer Review Group
Consideration of Self-Assessment Report
- 09.00 Professor Peter Kennedy, Head of Department
- 09.30 Meeting with all staff of Department
- 10.30 Tea / coffee for PRG + all staff
Meetings with individual members of staff
- 11.00 Mr Gerard Hooton
11.30 Dr. Sverre Lidholm
12.00 Dr Emanuel Popovici
12.30 Ms. Niamh O'Sullivan
- 13.00 Working private lunch for members of Peer Review Group
- 14.00 Visit to core facilities of Department
- 14.30 Undergraduate Student)
Robert Reynolds (Second Year)
David O'Riordan (Fourth Year)
- 15.00 Postgraduate Students
John Buckley (Taught H.Dip.)
Rathnait Long (Research M.Eng.Sc.)
Chandrika Sahajanand (Taught M.Eng.Sc.)
Barry O'Sullivan (PhD)
- 16.00 Researchers
Dr Carsten Wegener
Dr Byungin Chun
- 17.00 Recent graduates, employers and other stakeholders

Graduates

Dr. Eoin O Ciardha, PhD (2003)
Mr. Diarmuid McSwiney, MEngSc (2003)
Dr. Tudor Vinereanu, MEngSc (2000)

Employers

Mr. James Blair, S3
Dr. Colin Lyden, Analog Devices
Ms. Catherine Wiley, Motorola SPS

19.00 Meeting of Peer Review Group to identify remaining aspects to be clarified and to finalise tasks for the following day, followed by a working private dinner for members for the Peer Review Group.

Tuesday 2nd March 2004

08.30 Convening of Peer Review Group
09.00 Professor Aidan Moran, Registrar & Vice-President for Academic Affairs
09.30 Professor Patrick Murphy, Head, Department of Electrical & Electronic Engineering
10.00 Mr. Michael O'Sullivan, Vice-President for Planning, Communications & Development.
10.30 Ms. Margot Conrick, Head, Information Services, Boole Library
12.00 Professor Kevin Collins, Vice-President for Research Policy & Support
12.30 Mr. Michael Kelleher, Secretary & Bursar
13.00 Working private lunch for members of Peer Review Group
14.00 Professor Gabriel Crean, Head, NMRC
15.00 Professor Peter Kennedy, Head of Department
15.30 Preparation of first draft of final report
17.00 Exit presentation made to all staff of the Department by the Chair of the Peer Review Group, summarising the principal findings of the Peer Review Group.
19.00 Working private dinner for members of the Peer Review Group to complete drafting of report and finalisation of arrangements for speedy completion and submission of final report.

Wednesday 3rd March 2004

Externs depart