



University College Dublin

REVIEW GROUP REPORT

Periodic Quality Review

UCD School of Chemical and Bioprocess Engineering

March 2018

**Accepted by the UCD Governing Authority at its meeting of
28 March 2019**

Table of Contents

Key Findings of the Review Group	2
1. Introduction and Context	4
2. Organisation and Management	7
3. Staff and Facilities	10
4. Teaching, Learning and Assessment	13
5. Curriculum Development and Review	16
6. Research Innovation and Impact	18
7. Management of Quality and Enhancement	19
8. Support Services	20
9. External Relations	21
Appendix 1: Summary of Commendations and Recommendations	
Appendix 2: UCD School of Chemical and Bioprocess Engineering Response to the Review Group Report	
Appendix 3: Schedule for Review Site Visit to UCD School of Chemical and Bioprocess Engineering	

Key Findings of the Review Group

The Review Group (RG) has identified a number of key findings in relation to areas of good practice operating within the School of Chemical and Bioprocess Engineering, and also areas which the RG would highlight as requiring improvement. The main section of this Report sets out all observations, commendations and recommendations of the RG in more detail. An aggregated list of all commendations and recommendations is set out in Appendix 1.

Examples of Good Practice:

The RG identified a number of commendations, in particular:

- 3.17 The Head of School and senior colleagues are commended for their collective leadership through the challenging transition in terms of extensive changes in the School's faculty profile, both in terms of focus and experience, and associated with curriculum development and enhancement.
- 4.6 The School has highly-qualified and enthusiastic staff, who are committed to providing top quality education to UCD students. Particularly noteworthy are the efforts of some staff members who have introduced evidence-based instructional strategies such as flipped classroom, problem-based learning, and peer-assisted learning, into several modules in the curriculum.
- 5.3 Industry representatives were unanimous in its praise of UCD students' professional skills. They were characterised as highly employable, technically competent, well-presented, polished, hungry for experience, ambitious, and collaborative.
- 6.6 A multidisciplinary engineering science research activity platform including the biological sciences (bio-pharmaceutical processes), chemistry (pharmaceutical engineering) and physics (materials and energy storage) underpinned by significant capabilities in characterisation, analytical techniques and multi-scale modelling.
- 9.2 The School has long-standing connections with national and international industry partners across the whole spectrum of its activities.

Prioritised Recommendations for Improvement

The full list of recommendations is set out in Appendix 1, however, the RG would suggest that the following be prioritised:

- 2.6 Using the strategic plan 2015/16 as the basis, an annual review of progress against each year's objectives should be conducted by the School community together with its key internal and external stakeholders and refreshed objectives formulated for each subsequent year and the remaining period of the plan. This would allow progress to be evaluated against defined

outcome measures for each objective and facilitate a joint prioritisation and focusing exercise for the subsequent year. As well as focusing on what activities need to continue and commence, the School should consider what areas of activity it needs to reduce or stop in order to create the capacity required to achieve its stated strategic objectives. Capacity-building activities should include a faculty mentoring initiative as discussed in recommendation 8.15.

- 3.23 The School should consider the development of a new chemical and bioprocess practice laboratory facility to enhance the student experience in the teaching of chemical process engineering principles and design. This should encompass both computational modelling and experiment facilities together with resources needed to support design group and final-year research project work.
- 4.14 Reduce the reliance on space- and labour- intensive pedagogies. The RG commends the use of learner-centred pedagogies in the curriculum; however, there was a concern over space- and labour- intensiveness of instruction. The RG recommends that the School examine how space requirements might be reduced through efficient design of multipurpose, collaborative, smart learning spaces or the use of delivery modes such as blended learning. The RG also recommends implementing strategies to reduce the labour-intensiveness of module work on both the staff and the students, for example through the redesign of assignments to focus on specific learning outcomes, and the effective use of teaching assistants and/or graders to provide formative feedback.
- 5.8 Future-readiness and industry engagement. Feedback from employers indicated a need for students who are future-ready, prepared to contribute to advanced manufacturing, process innovation (e.g., factories of the future, industry 4.0), and product design. The RG recommends engaging industry more closely in refreshing the curriculum to ensure the future-readiness of its graduates. As part of this process, benchmarking should be done against identified international peer and aspirational institutions such as Imperial College London.
- 6.7 Realign current research strategy, student education strategy and administrative duties to enable delivery of the School's mission to secure a significant improvement in its worldwide QS ranking. Specifically, this should address the need for an optimal profile of research and innovation activity; develop a forward looking, lean and creative student education experience; and provide enhanced professional development for both faculty and students.

1. Introduction and Overview of UCD School of Chemical and Bioprocess Engineering

Introduction

- 1.1 This report presents the findings of a quality review of the School of Chemical and Bioprocess Engineering (hereinafter referred to as SCBE), University College Dublin, which was undertaken on 13-15 December 2017. The School response to the Review Group Report is attached as Appendix 2.

The Review Framework

- 1.2 Irish Universities have collectively agreed a framework for their quality review and quality improvement systems, which is consistent with both the legislative requirements of the Qualifications and Quality Assurance (Education and Training) Act 2012, and international good practice (e.g. Standards and Guidelines for Quality Assurance in the European Higher Education Area, 2015). Quality reviews are carried out in academic, administrative and support service units.
- 1.3 The purpose of periodic review is to assist the University to assure itself of the quality of each of its constituent units, and to utilise learning from this developmental process in order to effect improvement, including:
- To monitor the quality of the student experience, and of teaching and learning.
 - To monitor research activity, including: management of research activity; assessing the research performance with regard to: research productivity, research income, and recruiting and supporting doctoral students.
 - To identify, encourage and disseminate good practice, and to identify challenges and how to address these.
 - To provide an opportunity for units to test the effectiveness of their systems and procedures for monitoring and enhancing quality and standards.
 - To encourage the development and enhancement of these systems, in the context of current and emerging provision.
 - To inform the University's strategic planning process.
 - The output report provides robust evidence for external accreditation bodies.
 - The process provides an external benchmark on practice and curriculum.

- To provide public information on the University's capacity to assure the quality and standards of its awards. The University's implementation of its quality procedures enables it to demonstrate how it discharges its responsibilities for assuring the quality and standards of its awards, as required by the Qualifications and Quality Assurance (Education and Training) Act 2012.

The Review Process

1.4 Typically, the review model comprises four major elements:

- Preparation of a self-assessment report (SAR)
- A visit by a RG that includes UCD staff and external experts, both national and international. The site visit normally will take place over a two or three day period
- Preparation of a review group report that is made public
- Agreement of an action plan for improvement (quality improvement plan) based on the RG report's recommendations. The University will also monitor progress against the improvement plan

Full details of the review process can be found on the UCD Quality Office website: www.ucd.ie/quality.

The Review Group

1.5 The composition of the RG for the UCD School of Chemical and Bioprocess Engineering was as follows:

- Professor Martin McNamara, UCD School of Nursing, Midwifery and Health Systems (Chair)
- Associate Professor Roisin Corcoran, UCD School of Education (Deputy Chair)
- Professor Stephanie Farrell, Experimental Engineering Education Rowan University, USA (Extern)
- Professor Kevin Roberts, School of Chemical and Process Engineering, University of Leeds, UK (Extern)

1.6 The RG visited the School from 13-15 December 2017 and held meetings with School staff; undergraduate and postgraduate students; graduates, employers, the SAR Co-ordinating Committee; other University staff, including the Principal of the College of Engineering/Dean of Engineering. The site visit schedule is included as Appendix 3. All members of the Review Group participated in all discussions and meetings.

- 1.7 In addition to the Self-assessment Report, the RG considered documentation provided by the School and the University during the site visit.
- 1.8 This Report has been read and approved by all members of the Review Group.

Preparation of the Self-assessment Report (SAR)

- 1.9 Following a briefing from the UCD Quality Office, a Self-assessment Report Coordinating Committee (SARCC) was established in January 2017.
- 1.10 The SAR was prepared in the period January 2017 – November 2017. Staff and selected students were consulted during the process with specific aspects of the report discussed in various fora. The final draft report was developed by the SAR Co-ordinating Committee reflecting the various inputs. All staff were invited to a meeting to discuss and comment on the final draft and to contribute to the final report. The SAR was agreed on 10 November 2017 and submitted to the UCD Quality Office on 27 November 2017.
- 1.11 In its Self-Assessment Report (SAR), the School clearly set out its strengths, identified key opportunities and provided a frank and honest appraisal of its weaknesses and the threats that it faces. The SAR also presented clearly established priorities in the areas of education, research and innovation, international students, resources, finance and human resources.

The University

- 1.12 University College Dublin (UCD) is a large and diverse university whose origins date back to 1854. The University is situated on a large modern campus about 4 km to the south of the centre of Dublin.
- 1.13 The University Strategic Plan (to 2020) states that the University’s mission is: “to contribute to the flourishing of Dublin, Ireland, Europe and the world through the excellence and impact of our research and scholarship, the quality of our graduates and our global engagement; providing a supportive community in which every member of the University is enabled to achieve their full potential.”

The University is currently organised into six colleges and 37 schools:

- UCD College of Arts and Humanities
- UCD College of Business
- UCD College of Engineering and Architecture
- UCD College of Health and Agricultural Sciences

- UCD College of Social Sciences and Law
- UCD College of Science

1.14 As one of the largest universities on the island of Ireland, UCD supports a broad, deep and rich academic community in Science, Business, Engineering, Health Sciences, Agriculture, Veterinary Medicine, Arts, Law, Celtic Studies and Human Sciences. There are currently more than 26,000 students in our UCD campus (approximately 16,300 undergraduates, 7,800 postgraduates and 2,200 Occasional and Adult Education students) registered on over 70 University degree programmes, including over 6,300 international students from more than 121 countries. The University also has over 5,400 students studying UCD degree programmes on campuses overseas.

UCD School of Chemical and Bioprocess Engineering

- 1.15 UCD's SCBE is situated in the Engineering Building on the Belfield campus.
- 1.16 SCBE is one of six schools in the College of Engineering, and is the largest and oldest chemical engineering degree granting School in Ireland, with its integrated BE/ME programme accredited by the Institute of Chemical Engineers (IChemE).
- 1.17 The School offers at postgraduate level the MEngSc in Biopharmaceutical Engineering and the MEngSc in Chemical Engineering, and a structured PhD programme.
- 1.18 Since 2010 the School has seen significant growth in graduate taught and non-EU student numbers.
- 1.19 The School has a strong research profile broadly in two areas of Pharmaceuticals and Bioprocess Engineering, featuring Multiphase-Systems Technology, and Energy-Conversion & Storage Materials and Systems Engineering, featuring Multiscale Simulation.
- 1.20 SCBE is ranked number one in Ireland in the QS Chemical Engineering Subject Rankings 2017.
- 1.21 Commercialisation of research has included two successful spinout companies.

2. Organisation and Management

General Comments and Context

- 2.1 The purpose of this Review is to recommend ways in which the School can consolidate and focus its strengths and address its weaknesses so that it can leverage opportunities and ameliorate threats. In formulating its recommendations, the Review Group (RG) focused on the need for

ongoing review and prioritisation of the School's stated strategic objectives, evaluation of progress against defined metrics and a consideration of the ways in which strategic alignment, engagement and capacity can be further enhanced.

Commendations

- 2.2 The RG was very impressed by the commitment of those members of the faculty and staff of the School that it met to realising the School's mission.
- 2.3 The RG was equally impressed by the vision of the Head of School, his ambition for the School and his commitment to engaging and supporting faculty and staff in a collegial manner.
- 2.4 The School's distinct identity and strong reputation were apparent to the RG as was the loyalty of industry partners and students to its faculty and staff.
- 2.5 The RG commends the leadership of the School for its success in improving and sustaining the financial position of the School, notably by increasing fee income from international students.

Recommendations

- 2.6 Using the strategic plan 2015/16 as the basis, an annual review of progress against each year's objectives should be conducted by the School community together with its key internal and external stakeholders and refreshed objectives formulated for each subsequent year and the remaining period of the plan. This would allow progress to be evaluated against defined outcome measures for each objective and facilitate a joint prioritisation and focusing exercise for the subsequent year. As well as focusing on what activities need to continue and commence, the School should consider what areas of activity it needs to reduce or stop in order to create the capacity required to achieve its stated strategic objectives. Capacity-building activities should include a faculty mentoring initiative as discussed in recommendation 8.15.
- 2.7 Such prioritisation and focusing is important and necessary because the RG was of the view that the School does not currently have the necessary infrastructural and human resources to realise all of its stated ambitions, therefore its strategic objectives and the capacity-building activities required to attain them should be subject to ongoing re-appraisal. This may require difficult choices and decisions to be made. The calibre and commitment of the School's faculty and staff, its culture of collegiality and openness, and the esteem in which it is held by external stakeholders will be a major asset in debating these choices and making decisions that can command the support of the School community and its key internal and external stakeholders.
- 2.8 The annual review should integrate the findings of a continuous strategic planning and deployment cycle arising from ongoing strategic dialogue within the School, with relevant schools in the College of Engineering and Architecture, with the College Principal and with key external stakeholders, and should align and be integrated with annual financial, staffing and student enrolment planning. The Head of School should consider engaging regularly with relevant peer Heads of School in the College in a structured way to develop and advance shared objectives and to identify enablers of, and barriers to, their achievement.

- 2.9 This dynamic approach to strategy formulation and implementation would promote better strategic engagement, alignment and ownership within the School and enable its strategic objectives to be tested against current capacity, and internal and external constraints. It would also structure and inform the work of School committees and facilitate their closer alignment with the strategic plan. This would ensure a more efficient, effective, coherent, cohesive and integrated annual strategic review and planning process without creating additional administrative work; in fact, done well it should reduce the administrative burden.
- 2.10 The RG recommends that in implementing the new management structure mentioned in its SAR the School's committee structure should be formalised so that it aligns with and supports its strategic plan in a coherent, effective and efficient manner. Committees' Terms of Reference should derive from the latest iterations of the strategic plan. Only high-level, action-oriented synopses of meetings on a simple template are required to monitor progress and actions should be designed to advance strategic objectives with defined, named responsibilities and timelines. Committees should be convened at least once a semester. Brief oral reports from chairs of committees should be provided at each School Council with brief written summary reports for each School Executive Committee meeting.
- 2.11 The RG notes the concentration of a considerable number of key leadership roles in a relatively small number of faculty and staff and therefore recommends a greater distribution of responsibility among all faculty and staff in the new management structure. Individuals should be assigned responsibility for leading each key strategic area and work with a team to implement the key objectives for that area. These leadership roles should rotate after a defined period to be determined by the School in order to promote succession planning, build capacity, distribute expertise and facilitate leave of absence to build capacity in research and innovation.
- 2.12 The RG notes that the administrative staff complement has decreased since the last review, that the School in its SAR recognises the need for greater administrative resourcing, and the high administrative load on faculty and staff. We therefore recommend that priority be given to obtaining additional administrative support, including by exploring the extent to which such support could be shared among relevant schools within the College of Engineering and Architecture. Such support should be aligned with the School's key strategic objectives, for example in research, innovation and external engagement. The RG was particularly concerned at the risk in terms of succession planning and access to professional development opportunities of reliance on a single administrative officer. At the very least the School should immediately commence discussions on the potential of 'cross-cover' arrangements within the College to support the professional and career development of its sole Administrative Officer.
- 2.13 The RG recommends that the mix among and within the employee categories of faculty, administrators and technicians be reviewed so that it aligns with and supports the School's strategy to build research capacity and diversify funding sources; innovate, 'de-crowd' and rationalise the curriculum; attract international students and engage proactively with its key external stakeholders.

- 2.14 The RG recommends formalising an External Advisory Board and refreshing its membership on a regular basis so that it functions to test, challenge, evaluate and support the School's progress towards the achievement of its strategic objectives. Terms of reference should be established to govern and guide this work. The Board should be chaired by an appropriate senior external stakeholder and should meet at least annually.
- 2.15 The RG recommends that the School, with the full support of the College, give serious consideration to mechanisms that would enable the School to recruit cohorts of international students directly to its undergraduate programme.

3. Staff and Facilities

General Comments and Context

A. Staff

- 3.1 This is a comparatively small but ambitious School currently comprising thirteen (10.8 FTEs) academic staff, eight technical staff and one administrative officer. One of these posts is fixed term with the others permanent contracts. In addition there are seventeen research staff positions (16 FTEs) all on fixed-term contracts. Total academic headcount is expected to rise over the next planning period to c. 15 but further expansion appears to be limited by constraints on increasing international student numbers. The percentage of female academic staff is low (currently 15.4%) and none of these are at professorial level. The School notes that this falls below the UK average of 26%.
- 3.2 The RG met with all faculty, administrative and technical staff during the site visit, including one-to-one meetings with a selection of newly-appointed faculty.
- 3.3 Academic staffing in the School has undergone substantial change since the last review associated with the retirement of four highly- experienced senior members of faculty, which has been balanced, to some degree, by the partial re-engagement of some retired staff through post-retirement contracts, together with the appointment of four assistant professors and one professor (joint with the National Institute for Biotechnology Research and Training [NIBRT]). In addition, three further appointments of two assistant professors, and a further joint professorship with NIBRT (dependent on SFI funding), are in the various stages of recruitment.
- 3.4 The School highlights the challenges associated with the appointment of new high-calibre faculty due *inter alia* to competition from the private sector, other higher education providers and relocation issues related to high living costs in the Dublin area. The School also recognises that the replacement of experienced faculty by junior and highly research-active colleagues represents significant challenges in terms of striking the optimal balance between, on the one hand, the effective academic development, performance and retention of new faculty and, on the other, the potential to overload existing experienced colleagues.

- 3.5 In addition, available leadership capacity within the School has been reduced due to faculty secondment to spin-off company activities.
- 3.6 Technical staffing will also undergo significant change over the next review period associated with a significant proportion of the technical staff retiring. The School is currently taking the opportunity to reassess technical staffing needs as part of its strategic planning.
- 3.7 In addition, technical staff encompasses the manager of the Nano Imaging and Materials Analysis Centre (NIMAC) based in the School, which offers a wide range of state-of-the-art electron optic imaging, characterisation and analysis services to UCD and external academics as well as to industrial clients.
- 3.8 Administrative support comprises one FTE, a reduction since the last review.
- 3.9 The School highlights the need for more resources to provide opportunities for staff development and, in particular, to build capacity to support the School's strategy to enhance and leverage its external relations with industry, research funders and internationally.
- 3.10 The University provides a range of employee development opportunities for all faculty and staff including induction, certification in teaching and learning, career development and research skills as well as a leave of absence for research scheme. However, as the School points out, existing faculty have not yet been able to avail of the latter scheme.
- 3.11 The probation period for newly-appointed faculty and staff provides an opportunity for them to meet with the Head of School or nominee on a quarterly basis as part of a broader mentorship and developmental programme.

B. Space and Facilities

- 3.12 The School occupies an area of ca. 1875 m² in total comprising 64% for laboratories (72% research and 22% teaching), 22% offices, 11% classrooms and 3% workshop.
- 3.13 Research laboratory space within the Engineering Building is generally of appropriate quality and, in addition, researchers have access to high-grade facilities available in NIBRT, NIMAC and the O'Brien Science Centre. As research student and staff numbers increase through the implementation of the strategic plan further research office space will be needed.
- 3.14 Classroom teaching space within the School limits module class sizes to c. 50 students with implications for any potential expansion of student numbers, particularly for non-EU students, for both UG and Graduate cohorts.
- 3.15 Practical laboratories for teaching are extensive but very dated both in layout and content and in need of some modernisation and re-focussing to reflect changes to the curriculum, the industrial landscape and the School's research focus. As examples, there are opportunities in

the emerging areas of process analytical technology for process monitoring and control, in particle technology and in product formulation.

- 3.16 There are no dedicated practical laboratories in computational process engineering and multi-scale modelling to support teaching and understanding of process principles and design. This represents a major challenge in terms of delivering a modern chemical and bioprocess engineering curriculum where current trends worldwide are seeing a greater emphasis on the development of digital design predictive capabilities for developing modern process plant such as the factory of the future. Concomitantly, there is international consensus that there needs to be less emphasis on experimental training beyond their use as an aid in developing a student's appreciation and understanding of process principles.

Commendations

- 3.17 The Head of School and senior colleagues are commended for their collective leadership through the challenging transition in terms of extensive changes in the School's faculty profile, both in terms of focus and experience, and associated with curriculum development and enhancement.
- 3.18 The RG was impressed with the School's clear collegial culture as well as the dedication, hard work and commitment of faculty and staff to the delivery of an excellent and industrially-focussed student experience as evidenced through feedback from students and employers.
- 3.19 The RG was impressed with the feedback from industry, particularly regarding the excellence of the School's industrial internship scheme and the employability of the School's graduates. Industrial partners also highlighted the added value of their greater involvement in UG teaching, particularly in industrial practice, design and modelling.
- 3.20 The RG commends the School on the development of its research and teaching facilities and associated new staffing, jointly with NIBRT, in the biopharmaceutical area.
- 3.21 The RG also commends the School on its NIMAC facility, which provides a state of the art analytical facility for the School's researchers in advanced electron-optical microscopy and surface analysis as well as in advanced teaching.

Recommendations

- 3.22 The School should engage with the Athena Swan scheme with the aim of improving gender balance within the School, mindful of the impact of gender imbalance upon the student profile and concomitantly on the career progression of female engineers with the profession.
- 3.23 The School should consider the development of a new chemical and bioprocess practice laboratory facility to enhance the student experience in the teaching of chemical process engineering principles and design. This should encompass both computational modelling and

experiment facilities together with resources needed to support design group and final-year research project work.

- 3.24 Building on Recommendations 2.6, 2.7 and 2.9, the School should review the current planned staffing numbers and profile (among faculty, technical and administrative staff) and align this to the effective development of its faculty consistent with its strategic ambition to obtain a significant increase in its current QS ranking. This will involve a critical assessment regarding which of its current activities to stop, continue and enhance, and what new activities to start.
- 3.25 Despite the School's excellent industrial connections, there are clear opportunities to further enhance industrial connectivity through involvement in UG teaching and hosting students for design project work, the latter particularly for companies within the Dublin area.
- 3.26 Opportunities for ongoing career development of faculty and staff should be clearly articulated and communicated to all, building on the quarterly meetings that are required for newly-appointed employees. A mentoring scheme for early career faculty and staff should be established and supported by senior colleagues.
- 3.27 Mindful of the changes to the School's staffing profile, the School should develop a clear road map for succession planning for all the major school administrative roles. This should be communicated to all faculty and staff, and updated annually.

4. Teaching, Learning and Assessment

General Comments and Context

- 4.1 The School of Chemical and Bioprocess Engineering offers a number of degree options that focus on producing graduates well prepared for careers in the chemical, bioprocess and biopharmaceutical industry or academe. A focus on high standards and accreditation through both Engineers Ireland and IChemE remain priorities for the School. Since the last programme review the School has introduced two core degree programmes: a 5-year integrated ME programme in Chemical and Bioprocess Engineering and a BE in Chemical Engineering with a Biochemical Engineering minor.
- 4.2 Recent years have seen an increase in the number of graduate students from countries outside of the EU.
- 4.3 Bioseparations laboratory equipment has been acquired for the teaching laboratory (membrane separations, fermentation, chromatography). This will support the School's strength in preparing students for the biopharmaceutical industry.
- 4.4 External recognition of excellence in teaching and learning from national organisations and industry.

- 4.5 The team met with undergraduate and graduate students during the site visit. These students provided very positive feedback on their educational experience. Students highlighted the small class sizes, access to professors, technical rigor, and relevant examples and practical applications in their courses.

Commendations

- 4.6 The School has highly-qualified and enthusiastic staff, who are committed to providing top quality education to UCD students. Particularly noteworthy are the efforts of some staff members who have introduced evidence-based instructional strategies such as flipped classroom, problem-based learning, and peer-assisted learning, into several modules in the curriculum.
- 4.7 The School continues to address stakeholder needs through creation of new pathways and programmes in key areas. The four degree option pathways for Chemical and Bioprocess Engineering provide choice and flexibility that meet different student goals. The ChE with BE minor pathway will prepare students for careers in biopharma, and the Chemical and Bioprocess engineering pathway provides versatile preparation for employment in a variety of sectors including chemical, consumer product and food industry. The 4-year BE and the 5-year BE/ME programmes provide well-planned mechanisms for achieving different academic credentials.
- 4.8 The integrated industry experience for the 5-year programme is excellent preparation for chemical engineering careers in industry. This is supported by exceptional placement rates as well as positive feedback from industry and student stakeholder groups.
- 4.9 Co-ordinated assessment across modules helps distribute multiple assessments throughout the semester. In addition, a variety of types of student assessment are used.
- 4.10 Opportunity for student feedback via a single end-of-semester survey across all modules provides an effective process to identify and address issues. Effective communication of improvements to the next incoming class provides transparency and empowers students by making them aware that their voices are heard.
- 4.11 Feedback from other stakeholder groups (graduates, employers, recent graduates, students) is valued and used for continuous improvement. Employers, some of whom were also recent graduates, expressed very positive feedback regarding the development of professional skills in addition to excellent technical preparation. Students pointed to technical rigor, effective pedagogy, practical examples and applications, and outstanding mentoring and advising.
- 4.12 Coordinated recruitment efforts between the School and University via significant outreach activities.

- 4.13 Excellent research experiences for undergraduate students are offered internally in the areas of pharmaceutical and bioprocess engineering and energy conversion and storage. In addition, students may avail of research experiences through international programmes.

Recommendations

- 4.14 Reduce the reliance on space- and labour- intensive pedagogies. The RG commends the use of learner-centred pedagogies in the curriculum; however, there was a concern over space- and labour- intensiveness of instruction. The RG recommends that SCBE examine how space requirements might be reduced through efficient design of multipurpose, collaborative, smart learning spaces or the use of delivery modes such as blended learning. The RG also recommends implementing strategies to reduce the labour-intensiveness of module work on both the staff and the students, for example, through the redesign of assignments to focus on specific learning outcomes, and the effective use of teaching assistants and/or graders to provide formative feedback.
- 4.15 Streamline assessment. Both undergraduate and graduate students indicated that there was a very high weighting of summative assessment (final examination) in many modules. In some modules the students felt over-assessed, for example, through multiple lengthy laboratory reports. The RG recommends that the School continue its iterative refinement of a coordinated assessment plan to decrease the emphasis on summative assessment. In addition, for laboratory courses with multiple reports, the School should consider designing more learning-efficient assignments (for example, by replacing some lengthy laboratory reports with a memo that focuses on data analysis). This will help mitigate the discrepancy between credit load and student effort hours reported for some modules.
- 4.16 Provide timely feedback. Both undergraduate and graduate students indicated that there was a lack of timely feedback on continuous assessments. The RG recommends that in developing its assessment plan it establishes mechanisms to increase the amount of formative feedback provided to students throughout the module. As mentioned above, teaching assistants can greatly alleviate the burden of providing timely feedback on formative assessments.
- 4.17 Introduce peer assessment and reduce summative evaluation in design and laboratory modules. Feedback from students indicated that there was a need for increased peer assessment of contributions to teamwork. Consider using research-based tools (such as CATME online peer evaluation) to provide multiple opportunities for efficient peer assessment throughout the module, and assigning a weight to a teamwork component of the grade in a given module. By providing a mechanism to evaluate an individual's contribution to teamwork, this would also support the reduction of the emphasis on summative individual assessment (final examination) recommended above.
- 4.18 Transfer Assessments and Doctoral Studies Panels for PhD candidates. The RG recommends that the School develop and implement a system to ensure compliance with academic regulations in its graduate research programme with particular reference to the scheduling of Transfer

Assessments and Doctoral Studies Panels, eliminating sole dependence on the individual research supervisor for decisions relating to progression and the quality of the overall student experience.

- 4.19 Number of modules taught per faculty member. The RG recommends the development of a faculty staffing and workload plan to reduce the teaching load of staff to a level consistent with the research expectations of the School. The School should explore the opportunity to better engage industry partners in adjunct teaching, which will leverage industrial partnerships to provide relevant practice-based academic experiences *and* reduce the teaching load of faculty.
- 4.20 Effective, Efficient Teaching. The RG recommends that SCBE consider requiring all new faculty members to engage in training and development for effective, efficient and innovative teaching and learning practices.
- 4.21 Safety training. The School should ensure that the centrality and importance of its mandatory laboratory safety training is communicated to all faculty, staff and undergraduate and postgraduate students, and that that training complies with relevant legislative, regulatory, professional and organisational requirements. In order to ensure universal compliance, the School should maintain accurate and up-to-date records of students who have attended mandated safety training and ensure that any students who have missed training are excluded from the laboratories until they are provided with opportunities to undertake it. The Review Group recommends that the School conduct regular safety audits to ensure that (a) planned safety training is being delivered in accordance with relevant guidelines and planned provision, and (b) that the training translates into consistent practice across all its laboratories.

5. Curriculum Development and Review

General Comments and Context

- 5.1 SCBE has recently introduced a 5-year integrated BE/ME Programme in Chemical and Bioprocess Engineering and a BE degree in Chemical Engineering with a Biochemical Engineering Minor, in response to changing accreditation requirements and stakeholder needs. In addition, the School offers MEngSc degrees (full time and part time) in Biopharmaceutical Engineering, MEngSc Chemical Engineering (Int.), MEngSc Chemical and Bioprocess Engineering (full time), PhD in Chemical and Bioprocess Engineering (full time and part time). A graduate certification in Biopharmaceutical Engineering is also offered.
- 5.2 The School has recently undertaken a 15-month systematic review of its taught programmes. This review resulted in several recommendations which have been recently implemented in the development of the new integrated ME Programme. These noteworthy improvements include (1) a required, for-credit professional work experience, (2) enhanced research experiences and an associated credit increase from 10 credits to 30 credits, (3) restructuring of design teaching, currently two modules of 10 stage 3 and 10 credits in stage 4,

(4) meeting the requirements of Engineers Ireland for Chartered Engineer status and (5) expanded elective options in Year 5 which provide an opportunity for students to broaden or deepen their knowledge.

Commendations

- 5.3 Industry representatives were unanimous in its praise of UCD students' professional skills. They were characterised as highly employable, technically competent, well-presented, polished, hungry for experience, ambitious, and collaborative.
- 5.4 Continuing a long history of accreditation with regular review and revision of the curriculum.
- 5.5 Engagement of all stakeholder groups in the process of curriculum development and revision.
- 5.6 Ambitious curriculum reform to address stakeholder needs: professional work experiences, research experiences, design teaching.

Recommendations

- 5.7 Balance of experimental laboratory work and modelling. Feedback from students and employers indicated that the current exposure to chemical engineering practice is heavily weighted toward laboratory work, and that students would benefit from increasing their exposure to computational process engineering throughout the curriculum. The RG recommends that the School continue to expand on the current model of integrated modelling and simulation with hands-on laboratory work and data analysis, by increasing the emphasis placed on modelling and simulation.
- 5.8 Future-readiness and industry engagement. Feedback from employers indicated a need for students who are future-ready, prepared to contribute to advanced manufacturing, process innovation (e.g., factories of the future, industry 4.0), and product design. The RG recommends engaging industry more closely in refreshing the curriculum to ensure the future-readiness of its graduates. As part of this process, benchmarking should be done against identified international peer and aspirational institutions such as Imperial College London.
- 5.9 Industry involvement in design projects. Feedback from industry partners indicated an enthusiastic willingness to assist with the teaching of design courses. Consider models of instruction that engage industry experts in the teaching of the design sequence, e.g., by providing real-world design problems with support for obtaining hard-to-find data, or by mentoring student design teams.
- 5.10 Multidisciplinary exposure in the curriculum. Examine the opportunity to develop multidisciplinary team-based experiences within the curriculum by leveraging existing coursework across the College or with schools in other colleges.

6. Research Innovation and Impact

General Comments and Context

- 6.1 Broadly speaking, research in the School is consolidated into two areas: pharmaceuticals and bioprocess engineering; and energy-conversion and storage materials. Current activities support 35 graduate research students and seventeen post-doctoral research staff, though through alignment with new faculty appointments this is planned to increase to 50 and 25, respectively.
- 6.2 Research income is strong, c. €13m over the past five years, with School members leading and contributing to a range of research programmes. Forward strategy envisages a number of major targeted SFI research grant initiatives, notably in the biopharmaceutical area, in energy materials and through the School's continuous involvement in the SSPC programme.
- 6.3 Numbers and citations for published work have increased since the last review and are comparable to other leading domain area centres. The School notes that publication volume compares less favourably when compared to competitors, consistent with the relatively lower critical mass in the School when compared to other leading research-intensive chemical engineering institutions.

Commendations

- 6.4 Timely and highly relevant research underpinned by very strong industrial connectivity delivering research outcomes through work ranging from fundamental first principles studies through enabling innovation in terms of industrial practice, as evidenced by a number of priority patents and two successful spin out companies.
- 6.5 Strong industrial and SFI research income related to timely industrially relevant research topics.
- 6.6 A multidisciplinary engineering science research activity platform including the biological sciences (bio-pharmaceutical processes), chemistry (pharmaceutical engineering) and physics (materials and energy storage) underpinned by significant capabilities in characterisation, analytical techniques and multi-scale modelling.

Recommendations

- 6.7 Realign current research strategy, student education strategy and administrative duties to enable delivery of the School's mission to secure a significant improvement in its worldwide QS ranking. Specifically, this should address the need for an optimal profile of research and innovation activity; develop a forward looking, lean and creative student education experience; and provide enhanced professional development for both faculty and students.

- 6.8 Industry confirms the School's strong performance in delivering research to match to current industrial need. The School should develop strategies and activities to deliver industry's future needs post-2020 notably by exploiting opportunities afforded by industry 4.0 to enable the factories of the future (continuous manufacturing, PAT closed-loop process control, portable reconfigurable processing systems etc.)

7. Management of Quality and Enhancement

General Comments and Context

- 7.1 The School system of management and quality enhancement processes includes programme review, engagement with external accreditation processes, student feedback, closing the feedback loop, HR processes and the School strategic planning process.

Commendations

- 7.2 Faculty, staff and students are committed to maintaining high standards, as well as the efficient operation of the School with the best possible outcomes.
- 7.3 Accreditation by professional organisations such as IChemE and, in the near future, Engineers Ireland, are important professional-based validation of the School's quality of educational programmes.
- 7.4 The continued recruitment and successful progression of graduates in industry and in academia are to be commended.

Recommendations

- 7.5 The School takes part in various review and accreditation processes, which results in increased administrative loads. There is therefore a need for a coordination function among these processes.
- 7.6 The School should make better use of available survey data.
- 7.7 The School needs to ensure PhD Transfer Assessments and Doctoral Studies Panel processes are undertaken in line with Academic Regulations.
- 7.8 The School could consider using public domain reports from the UK Research Excellence Framework (REF) exercise, for example, for benchmarking research quality.

- 7.9 The School must prioritise high-quality independent evaluation to develop a quality culture that goes beyond accreditation requirements.

8. Support Services

General Comments and Context

- 8.1 University support facilities include the UCD Student Advisory Service, UCD Library, IT Computer Services, UCD Research and Innovation, UCD Estates, the College Programme Office, UCD HR.

Commendations

- 8.2 UCD Research and Innovation provides faculty with support for the application preparation/submission and management of research-funded grants.
- 8.3 Recognising the resource issue, particularly the lack of qualified mental health professionals, the UCD Student Advisory Service provides support and referral for all students throughout their studies.
- 8.4 The UCD Library gives strong support for all aspects of the School's work in teaching and learning, and research. It provides hard-copy and electronic resources, including specified undergraduate texts, standards and handbooks as well as research periodicals, reports and databases. All main subject areas in (bio-)chemical engineering are well supported, despite budgetary constraints.
- 8.5 IT Computer Services provides students with access to e-mail, internet, course materials, data storage, laser printing and a range of standard software packages via the network to a large number of terminals across campus.
- 8.6 Within their remit, particularly in the routine maintenance of classroom teaching facilities, UCD Estate Services provides a generally satisfactory service.
- 8.7 UCD HR service, in particular, the HR Partner, provides a valuable service to the School.
- 8.8 The School receives excellent support from the Programme Office in respect of undergraduate programmes and from the Engineering Internship Managers, with regard to ME Interns.
- 8.9 The recent introduction of research partners with discipline-specific expertise.

Recommendations

- 8.10 Feedback from employers indicated a need for students who are socially and emotionally competent (non-cognitive skills). The School should embed evidence-based social and

emotional learning programmes and practices across the curriculum to ensure the future-readiness of the School's graduates.

- 8.11 Administrative supports are needed in targeted areas to support the School's strategic plan.
- 8.12 The School should operate a rotation scheme so that faculty are provided an opportunity to avail of leadership roles.
- 8.13 The School should avail of and engage with University supports such as UCD Agile to build a community of practice for faculty and staff.
- 8.14 The School should engage with the Athena Swan scheme to improve gender balance within the School.
- 8.15 The RG recommends implementing a faculty mentoring initiative to support and facilitate the development of early career and mid-career faculty. The initiative should provide mentorship in the areas of academic support and career development, including scholarship, teaching, service, and leadership. The aim should be to help mentees build relationships to achieve their specific professional goals, aiding them in forging connections with internal and external networks of colleagues, and fostering professional and intellectual independence.

9. External Relations

General Comments and Context

- 9.1 The School has fostered links with industry, key professional bodies and other universities. The School maintains meaningful engagement with industry, key professional bodies, alumni and other universities.

Commendations

- 9.2 The importance of interactions with Professional Bodies such as the IChemE, in terms of all aspects of the School's mission in education, research and staff professional development.
- 9.3 The School has long-standing connections with national and international industry partners across the whole spectrum of its activities.
- 9.4 The School maintains particularly strong links with its spin-out companies. The successes of APC Ltd. (www.approcess.com) and OxyMem (www.oxymem.com) offer opportunities to extend and further develop School links with Industry.
- 9.5 International links have been developed between the School and a number of Departments/Schools of Chemical Engineering in Europe and the United States.

- 9.6 Several members of the School are PIs or FIs in existing SFI Research Centres (SSPC and BEACON) and others are involved in centres under review (e.g. MaREI).
- 9.7 The School maintains connections with its alumni. The School, in partnership with the UCD Alumni office, maintains an up-to-date alumni database.
- 9.8 A number of staff are engaged in external activities which help raise the visibility of the School and forge new networks.

Recommendations

- 9.9 The School should provide evidence-based emotional competencies programmes and practices, broadly non-cognitive skills, to better prepare graduates for the demands of industry and the profession.
- 9.10 An additional and explicit focus to the mission of the School: outreach and service in addition to research and education. The School might serve as model of a School that responds to local needs while working in partnership with community, and simultaneously using that work as a springboard for international research.
- 9.11 Strategic alignment of research and partnership activities should be a long-term goal of the School.
- 9.12 The School should organise more formal events (e.g., industry forum/conference) and touchpoints to further develop informal contacts with alumni and employers. This will enhance relationships, better inform the curriculum and potentially develop into fundraising opportunities.
- 9.13 The School should focus on establishing relationships with universities and organisations outside Europe and the UK, particularly Asia.
- 9.14 The School should prioritise student recruitment from outside Europe, particularly Asia.
- 9.15 The School should develop a strategy for maintaining, enhancing and leveraging strategic partnership with industry.
- 9.16 A reflective and outward-looking School is recommended with careful consideration of where industry is going (e.g., Industry 4.0).

UCD School of Chemical and Bioprocess Engineering – Full List of Commendations and Recommendations

This Appendix contains a full list of commendations and recommendations made by the Review Group for the UCD School of Chemical and Bioprocess Engineering and should be read in conjunction with the specific chapter above. *(Please note that the paragraph references below refer to the relevant paragraphs in the report text)*

2. Organisation and Management**Commendations**

- 2.2 The RG was very impressed by the commitment of those members of the faculty and staff of the School that it met to realising the School's mission.
- 2.3 The RG was equally impressed by the vision of the Head of School, his ambition for the School and his commitment to engaging and supporting faculty and staff in a collegial manner.
- 2.4 The School's distinct identity and strong reputation were apparent to the RG as was the loyalty of industry partners and students to its faculty and staff.
- 2.5 The RG commends the leadership of the School for its success in improving and sustaining the financial position of the School, notably by increasing fee income from international students.

Recommendations

- 2.6 Using the strategic plan 2015/16 as the basis, an annual review of progress against each year's objectives should be conducted by the School community together with its key internal and external stakeholders and refreshed objectives formulated for each subsequent year and the remaining period of the plan. This would allow progress to be evaluated against defined outcome measures for each objective and facilitate a joint prioritisation and focusing exercise for the subsequent year. As well as focusing on what activities need to continue and commence, the School should consider what areas of activity it needs to reduce or stop in order to create the capacity required to achieve its stated strategic objectives. Capacity-building activities should include a faculty mentoring initiative as discussed in recommendation 8.15.
- 2.7 Such prioritisation and focusing is important and necessary because the RG was of the view that the School does not currently have the necessary infrastructural and human resources to realise all of its stated ambitions, therefore its strategic objectives and the capacity-building activities required to attain them should be subject to ongoing re-appraisal. This may require difficult choices and decisions to be made. The calibre and commitment of the School's faculty and staff,

its culture of collegiality and openness, and the esteem in which it is held by external stakeholders will be a major asset in debating these choices and making decisions that can command the support of the School community and its key internal and external stakeholders.

- 2.8 The annual review should integrate the findings of a continuous strategic planning and deployment cycle arising from ongoing strategic dialogue within the School, with relevant schools in the College of Engineering and Architecture, with the College Principal and with key external stakeholders, and should align and be integrated with annual financial, staffing and student enrolment planning. The Head of School should consider engaging regularly with relevant peer Heads of School in the College in a structured way to develop and advance shared objectives and to identify enablers of, and barriers to, their achievement.
- 2.9 This dynamic approach to strategy formulation and implementation would promote better strategic engagement, alignment and ownership within the School and enable its strategic objectives to be tested against current capacity, and internal and external constraints. It would also structure and inform the work of School committees and facilitate their closer alignment with the strategic plan. This would ensure a more efficient, effective, coherent, cohesive and integrated annual strategic review and planning process without creating additional administrative work; in fact, done well it should reduce the administrative burden.
- 2.10 The RG recommends that in implementing the new management structure mentioned in its SAR the School's committee structure should be formalised so that it aligns with and supports its strategic plan in a coherent, effective and efficient manner. Committees' Terms of Reference should derive from the latest iterations of the strategic plan. Only high-level, action-oriented synopses of meetings on a simple template are required to monitor progress and actions should be designed to advance strategic objectives with defined, named responsibilities and timelines. Committees should be convened at least once a semester. Brief oral reports from chairs of committees should be provided at each School Council with brief written summary reports for each School Executive Committee meeting.
- 2.11 The RG notes the concentration of a considerable number of key leadership roles in a relatively small number of faculty and staff and therefore recommends a greater distribution of responsibility among all faculty and staff in the new management structure. Individuals should be assigned responsibility for leading each key strategic area and work with a team to implement the key objectives for that area. These leadership roles should rotate after a defined period to be determined by the School in order to promote succession planning, build capacity, distribute expertise and facilitate leave of absence to build capacity in research and innovation.
- 2.12 The RG notes that the administrative staff complement has decreased since the last review, that the School in its SAR recognises the need for greater administrative resourcing, and the high administrative load on faculty and staff. We therefore recommend that priority be given to obtaining additional administrative support, including by exploring the extent to which such support could be shared among relevant schools within the College of Engineering and Architecture. Such support should be aligned with the School's key strategic objectives, for

example in research, innovation and external engagement. The RG was particularly concerned at the risk in terms of succession planning and access to professional development opportunities of reliance on a single administrative officer. At the very least the School should immediately commence discussions on the potential of 'cross-cover' arrangements within the College to support the professional and career development of its sole Administrative Officer.

- 2.13 The RG recommends that the mix among and within the employee categories of faculty, administrators and technicians be reviewed so that it aligns with and supports the School's strategy to build research capacity and diversify funding sources; innovate, 'de-crowd' and rationalise the curriculum; attract international students and engage proactively with its key external stakeholders.
- 2.14 The RG recommends formalising an External Advisory Board and refreshing its membership on a regular basis so that it functions to test, challenge, evaluate and support the School's progress towards the achievement of its strategic objectives. Terms of reference should be established to govern and guide this work. The Board should be chaired by an appropriate senior external stakeholder and should meet at least annually.
- 2.15 The RG recommends that the School, with the full support of the College, give serious consideration to mechanisms that would enable the School to recruit cohorts of international students directly to its undergraduate programme.

3. Staff and Facilities

Commendations

- 3.17 The Head of School and senior colleagues are commended for their collective leadership through the challenging transition in terms of extensive changes in the School's faculty profile, both in terms of focus and experience, and associated with curriculum development and enhancement.
- 3.18 The RG was impressed with the School's clear collegial culture as well as the dedication, hard work and commitment of faculty and staff to the delivery of an excellent and industrially-focussed student experience as evidenced through feedback from students and employers.
- 3.19 The RG was impressed with the feedback from industry, particularly regarding the excellence of the School's industrial internship scheme and the employability of the School's graduates. Industrial partners also highlighted the added value of their greater involvement in UG teaching, particularly in industrial practice, design and modelling.
- 3.20 The RG commends the School on the development of its research and teaching facilities and associated new staffing, jointly with NIBRT, in the biopharmaceutical area.

- 3.21 The RG also commends the School on its NIMAC facility, which provides a state of the art analytical facility for the School's researchers in advanced electron-optical microscopy and surface analysis as well as in advanced teaching.

Recommendations

- 3.22 The School should engage with the Athena Swan scheme with the aim of improving gender balance within the School, mindful of the impact of gender imbalance upon the student profile and concomitantly on the career progression of female engineers with the profession.
- 3.23 The School should consider the development of a new chemical and bioprocess practice laboratory facility to enhance the student experience in the teaching of chemical process engineering principles and design. This should encompass both computational modelling and experiment facilities together with resources needed to support design group and final-year research project work.
- 3.24 Building on Recommendations 2.6, 2.7 and 2.9, the School should review the current planned staffing numbers and profile (among faculty, technical and administrative staff) and align this to the effective development of its faculty consistent with its strategic ambition to obtain a significant increase in its current QS ranking. This will involve a critical assessment regarding which of its current activities to stop, continue and enhance, and what new activities to start.
- 3.25 Despite the School's excellent industrial connections, there are clear opportunities to enhance industrial connectivity further through involvement in UG teaching and hosting students for design project work, the latter particularly for companies within the Dublin area.
- 3.26 Opportunities for ongoing career development of faculty and staff should be clearly articulated and communicated to all, building on the quarterly meetings that are required for newly-appointed employees. A mentoring scheme for early career faculty and staff should be established and supported by senior colleagues.
- 3.27 Mindful of the changes to the School's staffing profile, the School should develop a clear road map for succession planning for all the major school administrative roles. This should be communicated to all faculty and staff, and updated annually.

4. Teaching, Learning and Assessment

Commendations

- 4.6 The School has highly-qualified and enthusiastic staff, who are committed to providing top quality education to UCD students. Particularly noteworthy are the efforts of some staff members who have introduced evidence-based instructional strategies such as flipped

classroom, problem-based learning, and peer-assisted learning, into several modules in the curriculum.

- 4.7 The School continues to address stakeholder needs through creation of new pathways and programmes in key areas. The four degree option pathways for Chemical and Bioprocess Engineering provide choice and flexibility that meet different student goals. The ChE with BE minor pathway will prepare students for careers in biopharma, and the Chemical and Bioprocess engineering pathway provides versatile preparation for employment in a variety of sectors including chemical, consumer product and food industry. The 4-year BE and the 5-year BE/ME programmes provide well-planned mechanisms for achieving different academic credentials.
- 4.8 The integrated industry experience for the 5-year programme is excellent preparation for chemical engineering careers in industry. This is supported by exceptional placement rates as well as positive feedback from industry and student stakeholder groups.
- 4.9 Co-ordinated assessment across modules helps distribute multiple assessments throughout the semester. In addition, a variety of types of student assessment are used.
- 4.10 Opportunity for student feedback via a single end-of-semester survey across all modules provides an effective process to identify and address issues. Effective communication of improvements to the next incoming class provides transparency and empowers students by making them aware that their voices are heard.
- 4.11 Feedback from other stakeholder groups (graduates, employers, recent graduates, students) is valued and used for continuous improvement. Employers, some of whom were also recent graduates, expressed very positive feedback regarding the development of professional skills in addition to excellent technical preparation. Students pointed to technical rigor, effective pedagogy, practical examples and applications, and outstanding mentoring and advising.
- 4.12 Coordinated recruitment efforts between the School and University via significant outreach activities.
- 4.13 Excellent research experiences for undergraduate students are offered internally in the areas of pharmaceutical and bioprocess engineering and energy conversion and storage. In addition, students may avail of research experiences through international programmes.

Recommendations

- 4.14 Reduce the reliance on space- and labour- intensive pedagogies. The RG commends the use of learner-centred pedagogies in the curriculum; however, there was a concern over space- and labour- intensiveness of instruction. The RG recommends that SCBE examine how space requirements might be reduced through efficient design of multipurpose, collaborative, smart learning spaces or the use of delivery modes such as blended learning. The RG also recommends implementing strategies to reduce the labour-intensiveness of module work on both the staff

and the students, for example, through the redesign of assignments to focus on specific learning outcomes, and the effective use of teaching assistants and/or graders to provide formative feedback.

- 4.15 Streamline assessment. Both undergraduate and graduate students indicated that there was a very high weighting of summative assessment (final examination) in many modules. In some modules the students felt over-assessed, for example, through multiple lengthy laboratory reports. The RG recommends that the School continue its iterative refinement of a coordinated assessment plan to decrease the emphasis on summative assessment. In addition, for laboratory courses with multiple reports, the School should consider designing more learning-efficient assignments (for example, by replacing some lengthy laboratory reports with a memo that focuses on data analysis). This will help mitigate the discrepancy between credit load and student effort hours reported for some modules.
- 4.16 Provide timely feedback. Both undergraduate and graduate students indicated that there was a lack of timely feedback on continuous assessments. The RG recommends that in developing its assessment plan it establishes mechanisms to increase the amount of formative feedback provided to students throughout the module. As mentioned above, teaching assistants can greatly alleviate the burden of providing timely feedback on formative assessments.
- 4.17 Introduce peer assessment and reduce summative evaluation in design and laboratory modules. Feedback from students indicated that there was a need for increased peer assessment of contributions to teamwork. Consider using research-based tools (such as CATME online peer evaluation) to provide multiple opportunities for efficient peer assessment throughout the module, and assigning a weight to a teamwork component of the grade in a given module. By providing a mechanism to evaluate an individual's contribution to teamwork, this would also support the reduction of the emphasis on summative individual assessment (final examination) recommended above.
- 4.18 Transfer Assessments and Doctoral Studies Panels for PhD candidates. The RG recommends that the School develop and implement a system to ensure compliance with academic regulations in its graduate research programme with particular reference to the scheduling of Transfer Assessments and Doctoral Studies Panels, eliminating sole dependence on the individual research supervisor for decisions relating to progression and the quality of the overall student experience.
- 4.19 Number of modules taught per faculty member. The RG recommends the development of a faculty staffing and workload plan to reduce the teaching load of staff to a level consistent with the research expectations of the School. The School should explore the opportunity to better engage industry partners in adjunct teaching, which will leverage industrial partnerships to provide relevant practice-based academic experiences *and* reduce the teaching load of faculty.

- 4.20 Effective, Efficient Teaching. The RG recommends that SCBE consider requiring all new faculty members to engage in training and development for effective, efficient and innovative teaching and learning practices.
- 4.21 Safety training. The School should ensure that the centrality and importance of its mandatory laboratory safety training is communicated to all faculty, staff and undergraduate and postgraduate students, and that that training complies with relevant legislative, regulatory, professional and organisational requirements. In order to ensure universal compliance, the School should maintain accurate and up-to-date records of students who have attended mandated safety training and ensure that any students who have missed training are excluded from the laboratories until they are provided with opportunities to undertake it. The Review Group recommends that the School conduct regular safety audits to ensure that (a) planned safety training is being delivered in accordance with relevant guidelines and planned provision, and (b) that the training translates into consistent practice across all its laboratories.

5. Curriculum Development and Review

Commendations

- 5.3 Industry representatives were unanimous in its praise of UCD students' professional skills. They were characterised as highly employable, technically competent, well-presented, polished, hungry for experience, ambitious, and collaborative.
- 5.4 Continuing a long history of accreditation with regular review and revision of the curriculum.
- 5.5 Engagement of all stakeholder groups in the process of curriculum development and revision.
- 5.6 Ambitious curriculum reform to address stakeholder needs: professional work experiences, research experiences, design teaching.

Recommendations

- 5.7 Balance of experimental laboratory work and modelling. Feedback from students and employers indicated that the current exposure to chemical engineering practice is heavily weighted toward laboratory work, and that students would benefit from increasing their exposure to computational process engineering throughout the curriculum. The RG recommends that the School continue to expand on the current model of integrated modelling and simulation with hands-on laboratory work and data analysis, by increasing the emphasis placed on modelling and simulation.
- 5.8 Future-readiness and industry engagement. Feedback from employers indicated a need for students who are future-ready, prepared to contribute to advanced manufacturing, process innovation (e.g., factories of the future, industry 4.0), and product design. The RG recommends

engaging industry more closely in refreshing the curriculum to ensure the future-readiness of its graduates. As part of this process, benchmarking should be done against identified international peer and aspirational institutions such as Imperial College London.

- 5.9 Industry involvement in design projects. Feedback from industry partners indicated an enthusiastic willingness to assist with the teaching of design courses. Consider models of instruction that engage industry experts in the teaching of the design sequence, e.g., by providing real-world design problems with support for obtaining hard-to-find data, or by mentoring student design teams.
- 5.10 Multidisciplinary exposure in the curriculum. Examine the opportunity to develop multidisciplinary team-based experiences within the curriculum by leveraging existing coursework across the College or with schools in other colleges.

6. Research Innovation and Impact

Commendations

- 6.4 Timely and highly relevant research underpinned by very strong industrial connectivity delivering research outcomes through work ranging from fundamental first principles studies through enabling innovation in terms of industrial practice, as evidenced by a number of priority patents and two successful spin out companies.
- 6.5 Strong industrial and SFI research income related to timely industrially relevant research topics.
- 6.6 A multidisciplinary engineering science research activity platform including the biological sciences (bio-pharmaceutical processes), chemistry (pharmaceutical engineering) and physics (materials and energy storage) underpinned by significant capabilities in characterisation, analytical techniques and multi-scale modelling.

Recommendations

- 6.7 Realign current research strategy, student education strategy and administrative duties to enable delivery of the School's mission to secure a significant improvement in its worldwide QS ranking. Specifically, this should address the need for an optimal profile of research and innovation activity; develop a forward looking, lean and creative student education experience; and provide enhanced professional development for both faculty and students.
- 6.8 Industry confirms the School's strong performance in delivering research to match to current industrial need. The School should develop strategies and activities to deliver industry's future needs post-2020 notably by exploiting opportunities afforded by industry 4.0 to enable the factories of the future (continuous manufacturing, PAT closed-loop process control, portable reconfigurable processing systems etc.)

7. Management of Quality and Enhancement

Commendations

- 7.2 Faculty, staff and students are committed to maintaining high standards, as well as the efficient operation of the School with the best possible outcomes.
- 7.3 Accreditation by professional organisations such as IChemE and, in the near future, Engineers Ireland, are important professional-based validation of the School's quality of educational programmes.
- 7.4 The continued recruitment and successful progression of graduates in industry and in academia are to be commended.

Recommendations

- 7.5 The School takes part in various review and accreditation processes, which results in increased administrative loads. There is therefore a need for a coordination function among these processes.
- 7.6 The School should make better use of available survey data.
- 7.7 The School needs to ensure PhD Transfer Assessments and Doctoral Studies Panel processes are undertaken in line with Academic Regulations.
- 7.8 The School could consider using public domain reports from the UK Research Excellence Framework (REF) exercise, for example, for benchmarking research quality.
- 7.9 The School must prioritise high-quality independent evaluation to develop a quality culture that goes beyond accreditation requirements.

8. Support Services

Commendations

- 8.2 UCD Research and Innovation provides faculty with support for the application preparation/submission and management of research-funded grants.
- 8.3 Recognising the resource issue, particularly the lack of qualified mental health professionals, the UCD Student Advisory Service provides support and referral for all students throughout their studies.

- 8.4 The UCD Library gives strong support for all aspects of the School's work in teaching and learning, and research. It provides hard-copy and electronic resources, including specified undergraduate texts, standards and handbooks as well as research periodicals, reports and databases. All main subject areas in (bio-)chemical engineering are well supported, despite budgetary constraints.
- 8.5 IT Computer Services provides students with access to e-mail, internet, course materials, data storage, laser printing and a range of standard software packages via the network to a large number of terminals across campus.
- 8.6 Within their remit, particularly in the routine maintenance of classroom teaching facilities, UCD Estate Services provides a generally satisfactory service.
- 8.7 UCD HR service, in particular, the HR Partner, provides a valuable service to the School.
- 8.8 The School receives excellent support from the Programme Office in respect of undergraduate programmes and from the Engineering Internship Managers, with regard to ME Interns.
- 8.9 The recent introduction of research partners with discipline-specific expertise.

Recommendations

- 8.10 Feedback from employers indicated a need for students who are socially and emotionally competent (non-cognitive skills). The School should embed evidence-based social and emotional learning programmes and practices across the curriculum to ensure the future-readiness of the School's graduates.
- 8.11 Administrative supports are needed in targeted areas to support the School's strategic plan.
- 8.12 The School should operate a rotation scheme so that faculty are provided an opportunity to avail of leadership roles.
- 8.13 The School should avail of and engage with University supports such as UCD Agile to build a community of practice for faculty and staff.
- 8.14 The School should engage with the Athena Swan scheme to improve gender balance within the School.
- 8.15 The RG recommends implementing a faculty mentoring initiative to support and facilitate the development of early career and mid-career faculty. The initiative should provide mentorship in the areas of academic support and career development, including scholarship, teaching, service, and leadership. The aim should be to help mentees build relationships to achieve their specific

professional goals, aiding them in forging connections with internal and external networks of colleagues, and fostering professional and intellectual independence.

9. External Relations

Commendations

- 9.2 The importance of interactions with Professional Bodies such as the IChemE, in terms of all aspects of the School's mission in education, research and staff professional development.
- 9.3 The School has long-standing connections with national and international industry partners across the whole spectrum of its activities.
- 9.4 The School maintains particularly strong links with its spin-out companies. The successes of APC Ltd. (www.approcess.com) and OxyMem (www.oxyMem.com) offer opportunities to extend and further develop School links with Industry.
- 9.5 International links have been developed between the School and a number of Departments/Schools of Chemical Engineering in Europe and the United States.
- 9.6 Several members of the School are PIs or FIs in existing SFI Research Centres (SSPC and BEACON) and others are involved in centres under review (e.g. MaREI).
- 9.7 The School maintains connections with its alumni. The School, in partnership with the UCD Alumni office, maintains an up-to-date alumni database.
- 9.8 A number of staff are engaged in external activities which help raise the visibility of the School and forge new networks.

Recommendations

- 9.9 The School should provide evidence-based emotional competencies programmes and practices, broadly non-cognitive skills, to better prepare graduates for the demands of industry and the profession.
- 9.10 An additional and explicit focus to the mission of the School: outreach and service in addition to research and education. The School might serve as model of a School that responds to local needs while working in partnership with community, and simultaneously using that work as a springboard for international research.
- 9.11 Strategic alignment of research and partnership activities should be a long-term goal of the School.

- 9.12 The School should organise more formal events (e.g., industry forum/conference) and touchpoints to further develop informal contacts with alumni and employers. This will enhance relationships, better inform the curriculum and potentially develop into fundraising opportunities.
- 9.13 The School should focus on establishing relationships with universities and organisations outside Europe and the UK, particularly Asia.
- 9.14 The School should prioritise student recruitment from outside Europe, particularly Asia.
- 9.15 The School should develop a strategy for maintaining, enhancing and leveraging strategic partnership with industry.
- 9.16 A reflective and outward-looking School is recommended with careful consideration of where industry is going (e.g., Industry 4.0).

UCD School of Chemical and Bioprocess Engineering

Response to the Review Group Report

The School recognises the importance of the Periodic Quality Review. We were pleased with the thorough and thoughtful engagement by the Review Group and we will incorporate each recommendation into the School's Quality Improvement Plan. In terms of an initial response to the recommendations made by the Review Group we would like to comment on one aspect, safety. We view recommendations regarding safety with particular acuity. The School has already acted upon the core tenant of recommendation 4.21, namely reinforcing rigor with regard to the safety culture and training within the School. These actions include i) an ongoing review of our Safety Statement and associated procedures, ii) the requirement that all safety training records are also to be held electronically (currently held in paper copy only) and iii) including explicit training-related checks as part of our existing internal audit practices. We look forward to welcoming any future opportunity to review these and other such actions arising. Notwithstanding this, the School is disappointed that any perceived shortcomings relating to safety, or the basis for them, arising during the review were not identified or immediately discussed with the School at the review closing session and that no evidence was sought from the School at the time of the site visit to either validate or invalidate such perceptions.



Review Visit Timetable
UCD School of Chemical and Bioprocess Engineering
13-15 December 2017

Pre-Visit Briefing Prior to Site Visit – Tuesday, 12 December 2017

- 17:00-19:00 RG meet to review preliminary issues and to confirm work schedule and assignment of tasks for the site visit – **RG and UCD Quality Office only**
- 19:30 Dinner hosted for the RG by the UCD Registrar and Deputy President – **RG, UCD Deputy President and UCD Quality Office only**

Day 1: Wednesday, 13 December 2017

Venue: 142 Engineering Building

- 09.30-10.00 Private meeting of Review Group (RG)
- 10.00-10.45 RG meet with Principal, College of Engineering & Architecture and Head of School
- 10.45-11.15 Tea/coffee break
- 11.15-12.15 RG meet with members of SAR Coordinating Committee
- 12.15-12.45 Break – RG review key observations and prepare for lunch time meeting
- 12.45-13.45 RG meet with a representative group of postgraduate students and postdoctoral fellows
- 13.45-14.15 RG review key observations
- 14.15-15.30 RG meet with representative group of academic staff – primary focus on Teaching and Learning, and Curriculum issues
- 15.30-15.45 RG tea/coffee break

15.45-16.15	RG meet with support staff representatives (e.g. administrative / technical etc.)
16.15-16.20	Break
16.20-17.20	Tour of Facilities - NIMAC & Engineering, Science South
18.15	RG depart

Day 2: Thursday, 14 December 2017
Venue: 142 Engineering Building

08.45-09.00	Private meeting of the RG
09.00-10.00	RG meet support service representatives from Human Resources, Student Advisors, Library, Educational Technology Services, UCD Research, UCD Estates
10.00-10.20	Break
10.20-11.00	RG meet representative group of undergraduate students
11.00-11.15	RG tea/coffee break
11.15-12.15	RG meet with the School Research Committee
12.15-12.30	Break - RG review key observations
12.30-14:00	Lunch – Review Group only, meeting with employers
14.00-14.15	RG private meeting - review key observations
14.15-15.00	RG meet with College Finance Manager and Head of School to outline School's financial situation
15.00-15.15	Break
15.15-16.15	RG meet with recently appointed members of staff (if any)
16.15-17.15	RG available for private individual meetings with staff
17.15-18.00	RG private meeting – review key observations/findings
18.00	RG depart

Day 3: Friday, 15 December 2017

Venue: 142 Engineering Building

- 09.00-09.30 Private meeting of RG
- 09.30-10.30 Private meeting of RG
- 10.30-10.45 Break
- 10.45-12.00 RG continue preparing draft RG Report
- 12.30-13.15 Lunch
- 13.30-13.45 RG finalise first draft of RG Report and feedback commendations/recommendations
- 14.00-15.00 Leeway for flexibility with meetings
- 15.00-15.15 RG meet with College Principal & Head of School to feedback initial outline commendations and recommendations
- 15.20-16.00 Exit presentation to all available staff of the School
- 16.00 Review Group depart