THE FUTURE FOR PHDS IN IRELAND:

OBJECTIVES, IMPLICATIONS AND RECOMMENDATIONS FOR ENGINEERING AND COMPUTER SCIENCE IN THE CONTEXT OF 'INNOVATION 2020'

A SUMMARY REPORT ON A ONE-DAY EVENT HELD AT THE ROYAL IRISH ACADEMY
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Executive summary

In December 2015 the government produced a new strategy for science, called 'Innovation 2020'. This was based on a wide consultation among higher education institutions, industry, research funding agencies and other stakeholders; the input directly from researchers was more limited. The Royal Irish Academy's (RIA) Engineering and Computer Science Committee convened a day-long event, on 14 March 2016, to examine the proposed strategy and how the objectives set out therein would affect PhD students, specifically within engineering and computer science disciplines.

PhD students and other early-stage career researchers are the 'foot soldiers' of Irish science, technology, engineering and mathematics. Collectively, they represent a huge investment by government and by enteprise, and they are key stakeholders for Ireland as it develops a growing and sustainable knowledge -based economy. However, PhD students have little or no voice in developing and implementing any form of science strategy. As a consequence, the impact of Innovation 2020 on the future role and contribution of PhD students, and the degree to which Innovation 2020 might change the circumstances and environment for PhD students, deserve serious consideration and reflection.

The mission of the Academy's Engineering and Computer Science Committee is to promote co-operation across and within relevant scholarly disciplines, to advise, contribute and guide Academy policy in these areas, and to engage the public on issues of topical interest, on an all-island basis. The committee are of the view that the implementation of Innovation 2020 and its impact on present and future PhD students are of significant importance. Therefore, this event was convened to bring together a wide range of representatives with an involvement with or as the beneficiary of PhD education in Ireland, who could speak about and discuss the implications Innovation 2020 has for the various groups they represent. The event was a closed discussion group with 40 invited delegates from academia, funding agencies, government and industry, including PhD students.

The event had four presentation sessions and discussion, structured as follows:

An introduction to Innovation 2020
Dr Roger O'Connor—Director of Business and Technology, Department of Communications, Energy and Natural Resources
The funding agencies' perspective
Professor Jane Ohlmeyer—Chair of the Irish Research Council
Dr Mairead O'Driscoll—Director of Research Strategy and Funding, Health Research Board
PhD education in Ireland: facts and figures
Ms Denise Frawley—Data and Policy Analyst, Higher Education Authority
Dr Jennifer Brennan—European Advisor (NCP) and Marie Skłodowska-Curie Actions and National Delegate, Irish Universities Association
The PhD student and early-career researcher's perspective
Dr Gordon Dalton—Senior Research Fellow, University College Cork and Chair of the International Consortium of Research Staff Associations (ICoRSA)

These sessions were followed by a wide-ranging discussion, moderated by Dr Eleni Pratsini, Director of IBM Research, Ireland.

This document presents a summary of the material presented during the day; gathers together the key points from the discussion; and offers a series of suggestions aimed at ensuring that the value PhD students represent to Ireland is fully realised as Innovation 2020 is implemented.

An introduction to Innovation 2020

Dr Roger O'Connor, Director of Business and Technology at the Department of Communications, Energy and Natural Resources, presented an overview of the development and contents of Innovation 2020. This covered the recent history of science strategies in Ireland as well as the objectives in developing a new strategy at this time. He noted that the previous Strategy for Science Technology and Innovation (SSTI) had expired in 2013 and was deemed successful in positioning Ireland in terms of research and innovation. He also noted that research prioritisation was introduced in 2014; consequently, a new strategy was now needed to copper-fasten investments made based on the earlier strategies.

The development of Innovation 2020 was a highly consultative process, with inputs from ten government departments plus the Higher Education Authority (HEA) and the Chief Scientific Adviser to the government. Many stakeholder meetings took place with written inputs, as well as a Consultative Forum meeting before the final draft was presented to Cabinet in November 2015.

Among the key targets for Innovation 2020 are an increase in the number of researchers in enterprise by 60% to 40,000 by 2020; an increase in enrolments in research master's degrees and PhDs from 1,750 (in 2015) to 2,250 by 2020, and a doubling of private investment in research and development performed in the public research system.

Innovation 2020 has a total of 91 actions, and the work programme has already started. Twenty-two actions are directly related to PhD students. These include: ensuring that world-class standards apply to the quality of postgraduate researcher education and training; addressing gaps in the funding system for postdoctoral researchers; ensuring support for researcher career development; and a new programme of funding for frontier research. These actions will take place across all disciplines and some have a focus on interdisciplinary research. There are also actions around developing a coherent policy for structured progression and career support for PhD students and postdoctoral researchers; enhancing innovation and entrepreneurship skills; addressing gender issues; and addressing barriers to pension portability that can restrict researcher mobility.

Besides an increase in researcher numbers, Innovation 2020 will also increase the critical mass of research centres and establish a new programme for funding infrastructure, following the Programme for Research in Third Level Institutions (PRTLI).

Dr O'Connor concluded that Innovation 2020 had significant positive developments for PhDs in engineering and computer science; with additional funding possibilities; enhanced career development supports, with a focus on mobility between academia and industry; and gender equality for career progression. However, while we acknowledge the positive developments that Innovation 2020 will bring to PhD students, the present system is not without its weaknesses and these need to be recognised and addressed to ensure we can maximise the value that PhD students represent to Ireland as Innovation 2020 is implemented.

The funding agencies' perspective

Professor Jane Ohlmeyer, Chair of the Irish Research Council (IRC), began this session by outlining the wide variety of programmes currently offered by the IRC, emphasising that the programmes are across all disciplines. Professor Ohlmeyer highlighted the Employment Based Postgraduate Programme and the Enterprise Partnership Scheme, both of which engage with enterprise partners. There are a diverse number of partners, from multi-national corporations based in Ireland to indigenous small and medium sized enterprises, and more recently these have also included government departments and other agencies.

The IRC funds 280 new awards each year. Approximately 3,500 postgraduate students, the vast majority being at PhD level, have been funded by the council in the last decade. Professor Ohlmeyer noted that in the present system students face several challenges after obtaining IRC funding. These relate to the amount of the stipend, which has not increased in several years; the requirement for the award to pay for the students' university fees, which increase each year whereas the award does not; and the problem of research costs being very high for some areas, e.g. laboratory-based research, which also have to come from the IRC award. As the award is the same across all disciplines, some students end up with less.

Professor Ohlmeyer noted that action items 3.5 and 3.12 of the Innovation 2020 science strategy, which address increasing postgraduate enrolment and enhancing support for bi-lateral flow of researchers between academia and industry, are the key action items for the IRC. She also explained that national postgraduate research enrolments have seen a steady decline, from a high of 10,774 total enrolments in research PhDs and master's in 2009/10 down to 9,279 students in 2013/14; however, this decline had been reversed in subsequent years.

Dr Mairead O'Driscoll, Director of Research Strategy and Funding for the Health Research Board (HRB), a funding agency of the Department of Health, provided an overview of the HRB's work. She revealed that 83% of the HRB's budget is spent funding research—clinical, biomedical, health services and population health sciences. In January 2016 the HRB launched its own five-year strategy for 2016 -2020. She noted that while the focus of Innovation 2020 seems to be primarily economic development, Chapter 4 (Innovation for Social Progress and the Economy) is welcome as is Chapter 3 (Education for Innovation).

Dr O'Driscoll highlighted how the nature of PhD training in Ireland had changed in the last few years, including the change in training duration from three to four years; the emergence of structured programmes; the emphasis on interdisciplinary research and the importance of 'soft skills', such as understanding context, communications, networking, entrepreneurship and the application of research. She noted that researcher career frameworks are an important issue for health researchers, as it is for all researchers. She pointed out that researcher career frameworks should be easier to implement in similar disciplines like engineering and computer science. This is something that could be addressed across the research funding agencies by implementing some form of normalisation for career frameworks.

Since the publication of Innovation 2020, the HRB, like the IRC, has been developing plans for how to spend an increased funding allocation and is ready to deploy whatever additional funding it receives.

PhD education in Ireland: facts and figures

Ms Denise Frawley, Data and Policy Analyst with the Higher Education Authority (HEA), began this session with a presentation on PhD enrolments, specifically in engineering and computer science, between 2007/8 and 2014/15. She covered trends in these fields as well as addressing their destinations on graduation. The material was based on the data returned by universities, colleges and institutes of technology in March of each year.

She indicated that for the most recent data available, the year 2014—2015, there are 8,158 full-time and part-time PhD enrolments, of which 89% are in universities and 83% are full-time, with a 50-50 split between genders. Of these, 22% are in natural and mathematical sciences, which would include computer science, while 13% are in engineering and construction. An eight-year trend analysis shows a year-on-year increase in numbers followed by a gradual decline over a two-year period. This decline is apparent across all disciplines.

Over an eight-year period there has been an increase from 792 to 1,076 PhD engineering enrolments, though with a 3:1 gender bias in favour of males. A large proportion of computer science PhDs are aged 30 years or over. In analysing an eight-year average, 62% of these enrolments are Irish while 33% are international students. Between 2007/8 and 2014/15, there has been a decline of 26% in Irish computer science PhD enrolments and an increase (of 3%) in international numbers. In terms of the year of enrolment, even though most funding is for a four-year period for PhDs, there are as many PhD students enrolled in years five and six of their PhDs as there are in year one. The audience postulated that this is probably due to university fees in the fifth year being negligible in some institutions, and students may have completed their studies but not yet graduated. Over the eight-year period of the HEA analysis there is an increase of 36% in enrolments in engineering, while computer science decreased by 12%.

Ms Frawley presented information on the first destinations of all PhD graduates in 2014. She showed that 83% of all PhD graduates are in employment, 65% employed in Ireland and 18% overseas, with 9% in further study or training. This was almost equal across genders. Computer science and engineering graduates have higher-than-average employment rates, at 85% and 84% respectively. When surveyed as to whether they found the topic of their PhD relevant to their present work, 2% of engineering graduates responded that their topic was either 'irrelevant' or 'most irrelevant'. The corresponding figure for computer science graduates was 12%.

There were many requests from attendees for further tracking of graduates: where they go, what they work at, how relevant their PhD has been to their career, given that this HEA data is the most comprehensive dataset available. The need for better tracking of PhD graduates following graduation was a consistent message from attendees at the event. The IRC had commissioned a report from the University of Warwick to do such tracking of its own graduates and that represents a start, but more is needed. The HEA are in the process of developing a new annual graduate outcomes survey (to include all higher education institutions) from March 2017, with the added dimension of a longitudinal study. It is intended that this new survey will provide a better evidence base and address important gaps in knowledge about graduate outcomes.

Dr Jennifer Brennan, European Advisor (NCP) and Marie Skłodowska-Curie Actions and National Delegate from the Irish Universities Association gave a presentation on how the nature of PhD education has changed in Ireland since 2005 and how this seems to be having a positive effect on the employability of graduates. She pointed out how few researchers end up in actual research careers, raising the question of what we are training them for. She illustrated, as examples of this change, how we have moved away from the traditional apprentice-master model for supervision; how structured PhDs have emerged right across Europe; and how career paths for researchers have broadened beyond just academic positions as the PhD qualification has evolved to meet the needs of the wider economy. She also noted that more PhD projects are carried out with at least some input from enterprise partners, and that there are more research employees in companies looking to up-skill. To help understand these changes in doctoral education, Dr Brennan referenced several European policies such as the Salzburg Principles, established in 2005 as part of the Bologna Process as a basis for reform of doctoral education in Ireland. In addition to this reform, since the mid-2000s there is recognition that the majority of researchers who take up a postdoctoral position will not have the opportunity to remain in academia and as a result, professional career development supports and researcher career frameworks are in place in many higher education institutions (HEIs), but not all.

Specifically within Ireland, to promote the development of structured PhDs, there were grants for a small number of domain-specific Graduate Research Education Programmes (GREP), funded by the predecessors of the IRC. PRTLI Cycle 5 provided funding for the establishment of similar structured PhD programmes. These promoted co-operation across HEIs by part-funding certain targeted areas in an attempt to build critical mass in these areas. We also had 4th Level Ireland, an initiative catalysed by a HEA grant, aiming to work with research funding agencies to ensure the Salzburg principles are transferred into structured PhD programmes.

As funding for the GREPs and PRTLI Cycle 5 programmes comes to an end, we are left with some of the features of a structured PhD. For example, soft skill modules; structured progression; supervisory rather than single-supervisor panels; four-year duration instead of three, and more; these are now widespread in forming part of what the current PhD student experiences. The audience commented that, individually, the GREPs have been variable in terms of their success; some have been good and some have not, depending on the topic and the support required to make a programme successful. In areas within Arts, Humanities and Social Sciences (AHSS) there appear to be greater embracing of the structured PhD in terms of cross-discipline, cross-institutional courses/modules, than there is in Science, Technology, Engineering and Mathematics (STEM).

In 2015 the HEA and Quality and Qualifications Ireland (QQI), in collaboration with the IUA and IOTI, developed and published a National Framework for Doctoral Education in Ireland to facilitate enhanced excellence in the quality of postgraduate education and training (including master's and doctoral-level research) consistently across the HEIs.

Regarding Innovation 2020, whilst Dr Brennan was very positive about the actions in the document that refer to doctoral and postdoctoral researchers, she pointed out that there are only three-and-a-half years of Innovation 2020 left and there are 91 actions, split among many stakeholders; there is a sense of urgency to fully implement the strategy.

Another issue Dr Brennan raised, which had come up previously, is the need for an Irish equivalent of Vitae, a UK organisation supporting researcher career development which tracks graduates through their careers, surveys them on their needs and offers supportive training for both researchers and researcher developers. In the UK, this is the national organisation for researcher development, ensuring that the service is not fragmented between multiple providers.

It was raised by the floor that there is no system in place for credit sharing at doctoral level across the universities and institutes of technology. Module sharing and credit transfers, for example, make plain sense. Unless a centralised national system is established we will have institution-specific systems being created in all HEIs, which would certainly lead to a duplication of work. While there is formal inter-institutional recognition of credits for transfers across the seven universities and institutes of technology, often in practice no such recognition is made.

The PhD student and early-career researcher's perspective

In the final presentation, Dr Gordon Dalton, Senior Research Fellow, University College Cork and Chair of the International Consortium of Research Staff Associations (ICoRSA) gave a wide-ranging presentation with a focus on postdoctoral researchers and PhD students, and researcher career frameworks. He pointed out that the Fixed Term Workers Act 2003 applies to researchers and has meant that universities and institutes of technology have had to implement a range of measures to reduce exposure to Contracts of Indefinite Duration (CIDs) for postdoctoral researchers after four years on contract. Removing the entitlement to CIDs has been achieved by categorising postdoctoral researchers as undertaking 'training and development' roles, which has had a negative impact on morale among many postdoctoral researchers. Dr Dalton also pointed out that the direct funding opportunities for postdoctoral researchers, not under mentorship of a principal investigator, are limited to just the SFI SIRG awards (ten in total) and President of Ireland Young Investigator awards (one or two in total); and that while there are opportunities in Horizon 2020, the European Research Council and Marie Curie, these are very competitive and often need to be completed under the supervision of a permanent academic.

Other issues raised included an increasing trend that some early-stage researchers, including postdoctoral researchers, are delivering teaching or laboratory supervision in some of our HEIs which, although it is a limited amount, they do not get remunerated for. Principal investigators, who are successful and bring in research funding and thus have resources to hire postdoctoral researchers, use their own research staff to help with their teaching.

The thrust of Dr Dalton's presentation was that research is not a career, that the recruitment constraints force postdoctoral researchers out of the system many of them want to stay in and contribute to, and that as a result they do not feel valued.

Summary of suggestions

Following the presentations, Dr Eleni Pratsini moderated a lengthy discussion among all attendees. Out of the 40 people present, almost all contributed actively to the debate. The following are a series of suggestions made during the discussion:

1 There is a need to look at a career structure for researchers and the whole shape of the workforce pyramid in Ireland. Should we have lots of level-ten PhD graduates and fewer technical staff, or fewer PhDs but of higher quality with a longer duration to completion? Whatever the shape of this pyramid, the career frameworks in HEIs, as they are rolled out, are fragmented and incomplete. There is need for a national organisation, like Vitae in the UK, to give consistency and to drive its implementation. Such an organisation would deliver a normalisation of researcher career frameworks across HEIs, with the objective of making a researcher career more attractive to the best students by providing greater recognition of research as a career in an Irish context and by including longer fixed term contracts.

2 There cannot be growth in PhD numbers and early-stage postdoctoral researchers without a similar growth in the capacity to supervise these students. There is a need to target funding further up the workforce pyramid to ensure there are sufficient senior postdoctoral researchers and research fellows as 'proxies' for academics, given that there aren't enough academic posts to take up the supervision needs of increasing PhD numbers.

3 Better tracking of graduates right across the system is required, similar to the work completed by the University of Warwick for the IRC and something akin to that of Vitae in the UK.

4 Action is needed to enhance diversity among PhD researchers, in particular to ensure greater gender equality. Additionally, the tendency to provide one-year-only contracts instead of a more sustainable career path is not 'family friendly', in particular for women.

5 It is essential not only to protect but to increase funding for 'blue sky' research as our PhD graduates must not be seen solely as a service provision for industry. PhD graduates who come from the blue-sky side of research are just as successful in securing employment, and we genuinely need creative problem-solvers rather than just people trained in an area.

6 Module sharing and credit transfers for PhD and research master's students across HEIs need to be implemented to take account of specialism in different institutions and to move away from domain expertise silos. Consideration should be given to a consistent HEI-wide implementation of a credit reward system for periods spent in industry as part of a structured PhD. This will need support, and existing PhD funding mechanisms must evolve, as those funding mechanisms are not currently supportive of PhD students spending a period of time in industry.

7 Career guidance provision for PhD students needs to strengthened, as present career guidance is dealt with in most institutions as an extension of undergraduate career guidance. PhD career guidance needs a specialist focus that recognises the particular challenges and needs of PhD students.
Action is required to ensure that career guidance at secondary level understands and recommends careers in engineering and computer science, especially among female students.

8 Research costs and university fees in areas including engineering and computer science are increasingly high, and the stipend amounts awarded to PhD students have not changed in many years. Given there has been stagnation in the per-student funding amounts to cover stipends, research costs and university fees, there needs to be a re-examination of these costs.

9 Actions that improve networking among PhD students are needed, such as in the United States where networking is stronger. This will need investment but there is evidence that improved networking leads to higher quality outcomes for PhD students.

10 Some initiatives, like Coderdojo, which seed the recruitment of graduate students in computing and mathematics, are the equivalent of 'hedge schools'. These initiatives should be funded so as to increase the numbers recruited into this area, at its source.

List of attendees

Name	*Role and Organisation*
Richard Barrett	PhD student, Engineering, National University of Ireland, Galway
Marcus Breathnach	Principal Officer, Department of Enterprise, Jobs and Innovation
Conor Brennan	Senior Lecturer, School of Electronic Engineering, Dublin City University
Jennifer Brennan	European Advisor (NCP) & Marie Skłodowska-Curie Actions & National Delegate, Irish Universities Association
Claire Brougham	PhD student, Engineering, Royal College of Surgeons, Ireland/Dublin Institute of Technology
Lucy Byrnes	Dean of Graduate Studies, National University of Ireland, Galway
Peter Clifford	Manager – Performance Improvement Division, Science Foundation Ireland
Gordon Dalton	Senior Research Fellow, University College Cork and Chair of the International Consortium of Research Staff Associations (ICoRSA)
Elizabeth Daly	Research Scientist, IBM and Adjunct Assistant Professor of Computer Science, Trinity College Dublin
Ivana Dusparic	Lecturer, School of Computer Science, University College Dublin
Gerald Farrell	Dean of the College of Engineering and Built Environment and Director, Photonics Research Centre, Dublin Institute of Technology
Marie Farrell	PhD student, Computer Science, Maynooth University
Dara Fitzgerald	Executive Director, The Fullbright Commission
Denise Frawley	Data and Policy Analyst, Higher Education Authority
Fatemeh Golpayegani	PhD student, Computer Science, Trinity College Dublin
Maebh Grace	PhD student, Engineering, National University of Ireland, Galway
Jane Grimson	Fellow Emerita and Professor of Health Informatics, Trinity College Dublin
Emlyn Hegarty-Kelly	PhD student, Computer Science, Maynooth University
Peter Kennedy	International Relations Secretary, Royal Irish Academy
Eugene Kennedy	Secretary, Royal Irish Academy
Aideen Long	Dean of Graduate Studies, Trinity College Dublin

John Maguire	Acting Head of Policy and International Relations, Royal Irish Academy
Liam Marnane	Dean of Graduate Studies, University College Cork
Eucharia Meehan	Director, Irish Research Council
Conor Minogue	Senior Innovation and Education Policy Executive, IBEC
Jim Murray	Director of Academic Affairs, Institutes of Technology Ireland
Reyhaneh Neghabat Shirazi	PhD student, Engineering, National University of Ireland, Galway
Mairead O'Driscoll	Director of Research Strategy and Funding, Health Research Board
Roger O'Connor	Director of Business and Technology, Department of Communications, Energy and Natural Resources
Jane Ohlmeyer	Chair of the Irish Research Council
Peyman Passban	PhD student, Computer Science, Dublin City University
Eleni Pratsini	Director, IBM Research Ireland
Tom Ray	Professor of Astrophysics, Dublin Institute for Advanced Studies
Nabeel Riza	Head of School of Engineering, University College Cork
Mark Roantree	Senior Lecturer, School of Computing, Dublin City University
Alan Smeaton	Chair of the Engineering and Computer Science Committee, Royal Irish Academy and Director, Insight Centre for Data Analytics
Emma Tarpey	PhD student, Engineering, National University of Ireland, Galway
Marie Travers	PhD student, Computer Science, University of Limerick
Padraig Walsh	Chief Executive, Quality and Qualifications Ireland
Andy Way	Deputy Director, ADAPT Centre

Members of the Engineering and Computer Science Committee of the RIA

Name

Professor Thomas Brazil MRIA	University College Dublin
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Professor Orla Feely MRIA	University College Dublin
Professor Michael Gilchrist	University College Dublin
Mr Will Goodbody	RTÉ
Professor Jane Grimson MRIA	Trinity College Dublin
Professor Eileen Harkin-Jones	Ulster University
Professor Fiona Lyddy	Maynooth University
Professor James McLaughlin	Ulster University
Dr Roger O'Connor	Department of Communications, Energy and Natural Resources
Professor Padraic O'Donoghue	NUI Galway
Professor Máirtín Ó Droma	University of Limerick
Mr Damien Owens	Engineers Ireland
Professor Alan Smeaton MRIA	Dublin City University (*Chair*)
Professor Richard Reilly MRIA	Trinity College Dublin

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