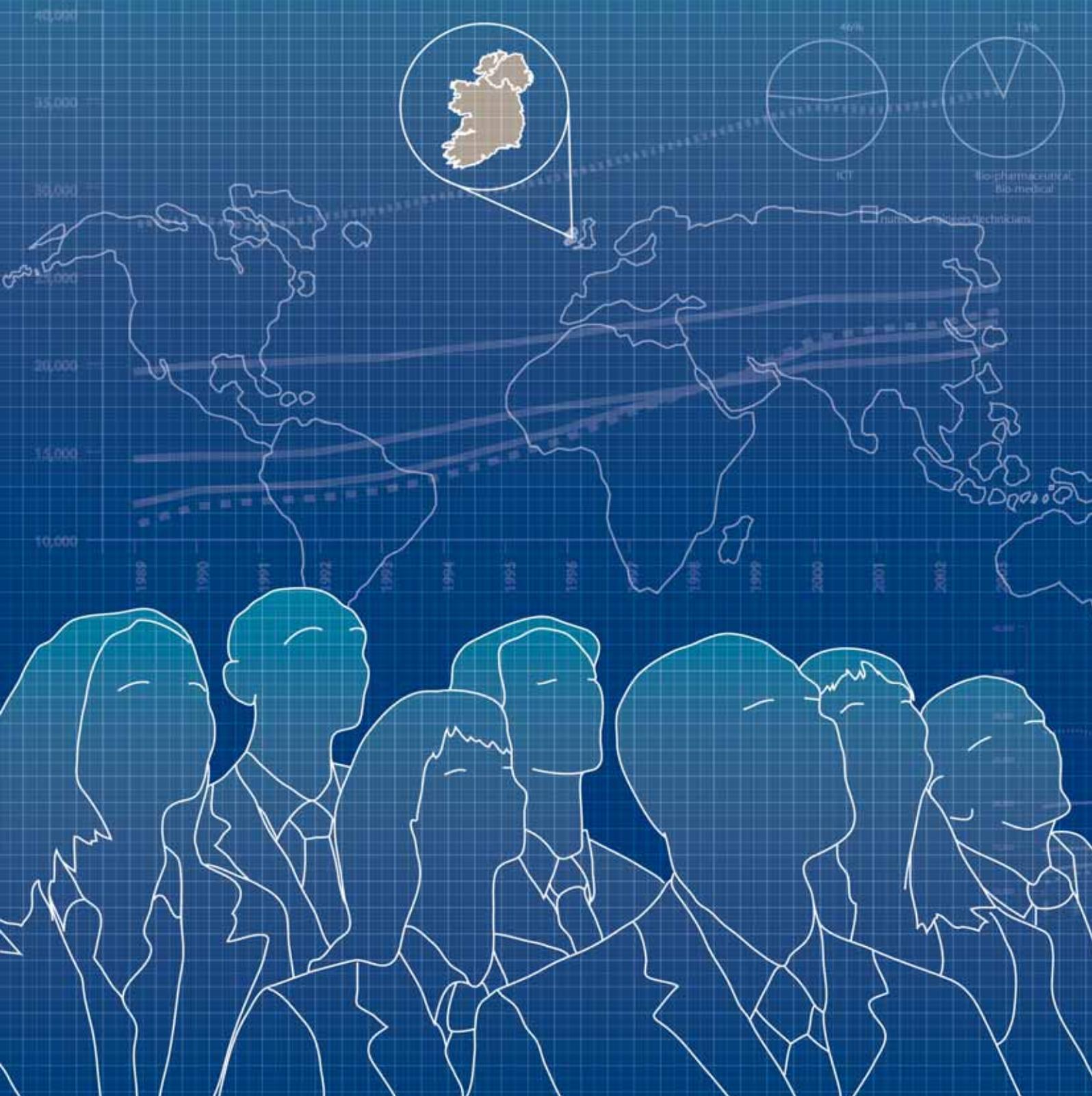


Engineering a Knowledge Island 2020

Executive Summary



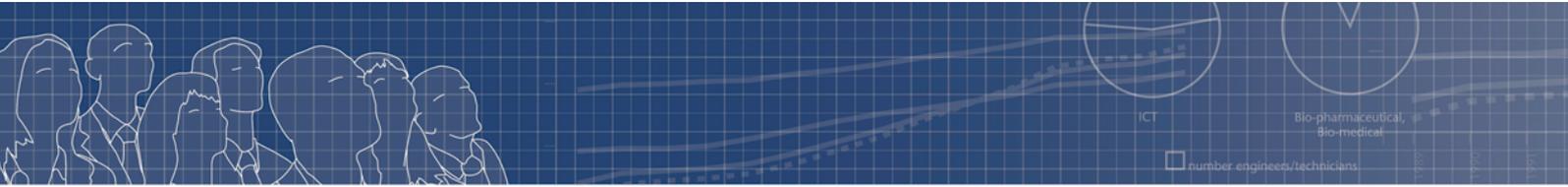
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Task Force Recommendations

- Adopt target for island of Ireland to be in Top 5 global economies, in terms of income per head, by 2020.
- Robust increase in supply of qualified engineers (7 per cent), IT staff (6 per cent) and PhDs (13 per cent) per annum.
- Develop world class centres of research linked to Engineering and IT schools that share resources.
- Promote engineering and science as career options much more intensively.
- Make greater efforts to attract women into engineering, targetting 50/50 gender distribution.
- Provide more substantial resources to increase graduate, and research output from higher educational institutions.
- Expand programmes supporting linkages between industry and third level institutions.
- Implement more programmes for continuing professional development and for obtaining higher level qualifications while remaining at work.
- Publish annual information on the number of computer engineering/science graduates.
- Support more complementarity between engineering and science studies.
- Attract and integrate engineering and IT professionals from abroad.
- Gather information on the engineering and IT qualifications of immigrants when they register with the social welfare systems on the island.



Foreword

The focus of this report is to propose a vision for a knowledge-based economy which would place the island of Ireland in the forefront of the most advanced economies by 2020. Achievement of this goal will require close collaboration in fulfilling the economic and skills development potential of the people of the island. The foundation blocks already exist: InterTradelreland, one of the six cross-border bodies established in 1999, has a vision of a globally competitive all-island economy characterised by the optimal utilisation of the island's resources, particularly knowledge resources. This report seeks to indicate the trends in demand for people with engineering and information technology (IT) qualifications which will allow the target of reaching a ranking for the economy of the island in the Top 5 countries in the world to be achieved. This target is the benchmark against which the supply needs for engineers and IT specialists is assessed.

The Task Force believes that the target is achievable. At present, the combined economies of the island of Ireland rank about 14th in the world in per capita income. When account is taken of the forecast growth of the leading economies, the island economy would need to grow by about 4.5 per cent per annum – slightly less than that achieved over the last decade.

Sustainable economic growth is a complex phenomenon. A focus on maintaining a strong forward momentum increases the likelihood of success. This report examines the important contributions which the high-technology manufacturing and traded services and the construction sectors have made in the past, and are required to make in future. The fast growing high technology sectors have the potential to be key drivers of the required growth performance. Manufacturing and IT service activities will require a steadily increasing element of research, development and innovation. The Task Force is of the view that there will be an increased demand for engineers and computer scientists with higher qualifications to drive the process towards a high global ranking. A sustainable high economic growth rate is vitally dependent on strengthening the capacity of the Research and Development (R&D) base in business and higher education, and this has led to recommendations for a substantial increase in the output of trained PhD researchers. Already some countries, particularly in Asia, have established world leadership positions in niche areas of the IT sector. This is the environment in which the island must strive to achieve its goal.

The report estimates the orders of magnitude of increased engineering and IT staff with third- and fourth-level qualifications necessary to reach the economic target by 2020. This is not the only condition for success but it is a vital one. The Task Force recognises that reaching the supply targets will pose major challenges for the educational institutions at second- and third-level, for research bodies, for public authorities and for industry. A 6-7 per cent annual increase in overall supply will prove very difficult in the current climate of falling number of entrants to third-level courses in engineering and IT. Inward migration in the context of the wider European Union (EU) is likely to play a significant role.

The Task Force recommends that the limited resources of the universities, of the Institutes of Technology, and of the research units on the island be used to maximum complementary effect so that economies of scale, and world-class performance are realised.

The Task Force is confident that with sustained commitment by all the relevant authorities, and the appropriate and selective allocation of resources, the engineering and IT manpower development targets outlined in this report can be achieved. This would provide a key ingredient in raising the output and incomes of the citizens of the island to a ranking in the Top 5 countries in the world by 2020.

In conclusion, I wish to express my thanks to all the members of the Task Force who responded so generously to the invitation to participate in our work and gave their time on a *pro bono* basis to this important project. I also wish to thank particularly Finbar McDonnell of Hibernian Consulting, the Project Facilitator, for his assiduousness in ensuring that all of the main points raised at meetings of the Task Force are reflected in a coherent manner in the final document. Finally, I wish to thank InterTradelreland for its active and wholehearted support.

Liam Connellan, Chartered Engineer
Past President of the Irish Academy of Engineering
Chairman of the Task Force

October 2005



Executive Summary

The aim of this report is to propose a vision which would enable income per head on the island of Ireland to reach the level of the Top 5 economies in the world by 2020. Achievement of this target will require close collaboration in fulfilling the economic and skills potential of the people of the island. Collaboration already exists at the highest levels of government and policy, exemplified in the establishment of the cross-border institutions, particularly InterTradelreland, whose mission is to enhance the global competitiveness of the island economy to the mutual benefit of the island, North and South.

A. Evolution of the Island Economy

The economies of Ireland and Northern Ireland have grown strongly in the past 15 years ...

From a situation in 1989 where the average income per head on the island was 61 per cent of the OECD average, this figure had moved to 92 per cent by 2003. This was driven by strong growth in the economies of both Ireland and Northern Ireland relative to the OECD average.

... with key drivers of growth being high-tech manufacturing and construction.

Growth on the island has caused, and has been driven by, significant structural changes in manufacturing. Labour intensive sectors (such as textiles) have seen job losses, with growth in the output and employment of high-tech sectors such as IT and pharmaceuticals (especially in Ireland). As output per head tends to be much higher in high-tech sectors, this shift in the structure of manufacturing contributes to overall economic growth.

Growth in manufacturing output on the island has been supported by strong growth in construction activity over the past 15 years.

This has moved the island to a Number 14 position in the global economy ...

The growth achieved from 1989-2003 meant that, excluding very small economies (such as Bermuda, the Caymen Islands etc.) that depend on financial services, Ireland rose to a number 10 ranking in the world economy in terms of income per head, with Northern Ireland ranked at number 19. The combined island economy had a ranking of 14 in 2003.

... - to reach the level of the Top 5 economies by 2020 would require average economic growth rate of 4.5 per cent per year.

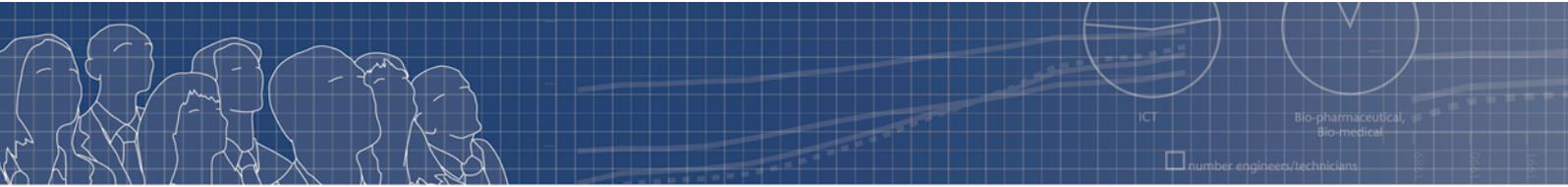
If the island economy is to continue to climb the league table of global economies, it will need to continue to grow at a higher rate than the leading economies. Based on Goldman Sachs forecasts for the leading economies, the Task Force estimates that the island economy would need to grow at an average rate of 4.5 per cent per year between 2003 and 2020 to move into the Top 5 economies in terms of income per head. This would give the island the same level of income per head as the US and Japan by 2020.

Such growth will need to occur in the context of a much changed international economic landscape ...

The growth of China, India and other Asian economies is changing the global economic context. While many of these countries are starting from a low economic base, they are moving aggressively into high-tech sectors and represent a threat to (as well as an opportunity for) the island in carving out global niches as a "knowledge island". The emergence of these economies reinforces the urgency of the economic development strategies required by the island.

... and would require continued change in the economies of Ireland and Northern Ireland.

Moving to a Top 5 knowledge economy will require a range of strategies, most outside the scope of this report. However,



the Task Force believes that exports (of manufactured goods and of services) will remain central to the island of Ireland's economic growth. It believes *all* manufacturing sectors will need to upgrade their processes, and move towards 'smart' and 'adaptive' practices. The size and scope of the high-tech sectors of ICT and bio-technology/ pharmaceuticals means these sectors are of particular strategic importance for development. Improving the productivity of the non-traded service sectors, and building the returns of companies from the island that operate overseas will also support economic growth.

While knowledge is increasingly embedded in processes, the Task Force believes that high-quality human resources are central to creating a 'knowledge island'.

B. Changing Demand for Engineering and IT Workers

The number of people in engineering and IT occupations on the island grew sharply between 1991 and 2001-2002 ...

Growth in those working in science, engineering and IT occupations is shown below.

Table 1 Number of Workers in Science, Engineering and IT Occupations on the Island of Ireland, 1991 and 2001-2002

	1991	2001-2002	Change Percentage
Scientists and Science Technicians	14,317	24,100	68
Engineers and Associated Technicians	19,110	40,383	111
IT and Computer Workers	9,882	42,079	326
Total SET Workers	43,309	106,562	146
Total Labour Force	2,062,000	2,540,000	23

Figure 1 Number of Workers in Science, Engineering and IT Occupations on the Island of Ireland, 1991 and 2001-2002

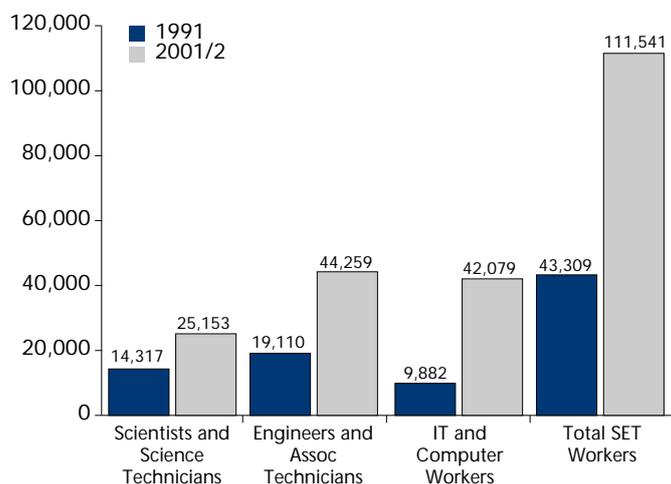
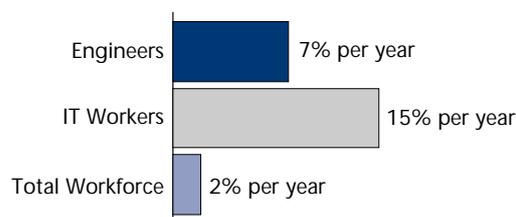


Figure 2 Average Annual Increase 1991 to 2001-2002

Over the 1991 to 2001-2002 period:

- The number of people working as engineers on the island grew by over 7 per cent per year;
- The number of IT workers grew by an average of almost 15 per cent per year.





... and was an important contributory factor to economic growth on the island.

Data from the Higher Education Authority in Ireland on the sectoral destination of graduates shows that between 50 per cent and 60 per cent of engineering graduates go into the ICT, bio-tech/bio-pharma and construction sectors. There is evidence that this figure reached 80 per cent in 2000. Thus, the sharp rise in engineering and IT personnel has been directly linked to key growth sectors in the economy.

Companies in leading economic sectors employ more people with engineering and IT qualifications than companies in other sectors

The above trend in relation to recruitment is confirmed by data from Engineers Ireland, which shows that a high proportion of the employees of companies in the ICT, bio-pharma and construction sectors are engineers and engineering technicians, relative to the wider economy.

.... and the profile of qualifications in leading companies is "flatter".

A survey of 12 leading companies in the three sectors mentioned, undertaken by the Task Force, shows a relatively strong tendency to employ people at sub-degree level (although primary degree level remains the most common point of graduate entry). The leading companies in these sectors also tend to employ more engineering, IT and science personnel with postgraduate qualifications compared to all companies. The bio-med/bio-pharma sector has the highest proportion of people with postgraduate qualifications – these tend to be science rather than engineering or IT graduates.

While qualifications at sub-degree level will remain important, the leading companies are employing more people with post-graduate qualifications.

The view of the leading companies surveyed was that they will require more people with postgraduate qualifications in the future, with one ICT company saying that the proportion of new recruits with PhDs could be 30-40 per cent by 2020 and a pharmaceutical/health care company estimating the figure at 15-20 per cent.

C. Creating a World Class R&D Capability

Building Research and Development capability is critical for a "knowledge island" ...

The importance of innovation and R&D has been explicitly recognised in policy documents in Ireland and Northern Ireland.

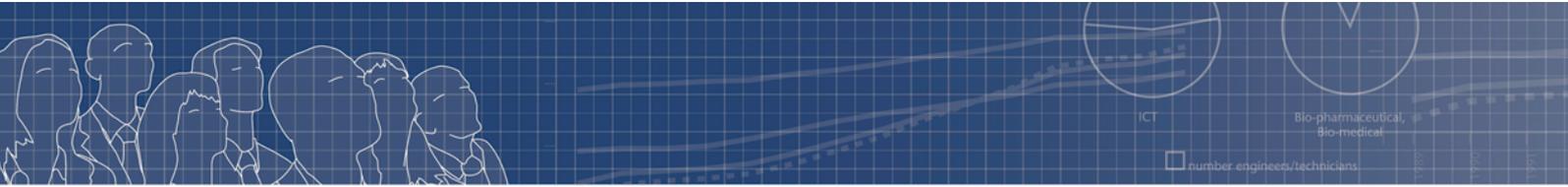
... yet the island currently lags leading countries in its R&D spend.

The EU's Lisbon Agenda sets a target of 3 per cent of GDP for Gross Expenditure on R&D in EU Member States by 2010. Figures for 2001 show Ireland and Northern Ireland as both below 1.5 per cent of GDP. All of the Top 5 countries are ahead of the island on this measure, and four of the Top 5 had R&D expenditure of over 2.5 per cent of GDP in 2001 (with Japan at over 3 per cent).

Data for Ireland shows that it lags both in relation to business R&D and for R&D in higher education. In recent years, efforts have been made to close the gap in both of these areas. Northern Ireland also lags on business R&D spend but its higher education sector performs well on R&D by international standards.

To become a leading knowledge economy will require a large expansion in the number of researchers on the island between now and 2020 ...

Based on a comparison of the number of researchers on the island with the numbers employed in leading global economies, a considerable expansion is required in the number of personnel engaged in R&D on the island.



... this will be aided by R&D centres of excellence that have emerged in recent years.

While the island lags the leading economies in R&D, it does contain centres of excellence. In Ireland, centres in the ICT and bio-technology/ bio-pharmaceutical sectors are driven by the HEA's Programme for Research in Third-Level Institutions (PRTL) and by Science Foundation Ireland's Centres for Science, Engineering and Technology (CSETs) programme. Centres of excellence in Northern Ireland build on the strong R&D in the higher education sector, with support from Invest NI's Centres of Excellence programme. Industry/academic links are supported by several initiatives and programmes.

D. Supply of Engineering and IT Graduates

The island produces 5,200 engineering graduates and 2,600 IT graduates each year ...

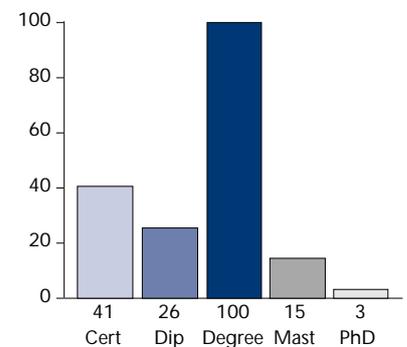
A breakdown of the approximately 5,200 engineering graduates is shown below.

Table 2 Current breakdown of Number of Engineers Graduating, by Level of Qualification in Ireland and Northern Ireland

	Certificate	Diploma	Degree	Masters	PhD
Ireland	1,128	703	2,339	238	51
Northern Ireland		30	475	170	40
Ratio	41	26	100	15	3

Table 2 includes some graduates in computer engineering. While precise figures are not available for computer science graduates, they are estimated to number a further 2,600 graduates per year.

Figure 3 Current breakdown of Number of Engineers Graduating, by Level of Qualification in Ireland and Northern Ireland



Note: Ratios relate to degree index at 100

... with the number receiving post-graduate qualifications higher in Northern Ireland.

In Northern Ireland, the ratio of those graduating at PhD level, and with post-graduate qualifications below PhD level, compared to the numbers graduating with primary degrees, is higher than in Ireland. There is also evidence of more specialisation in Northern Ireland, linked to areas of research excellence in Queen's University and the University of Ulster. However, funding of postgraduate studies in Ireland has grown considerably in recent years.

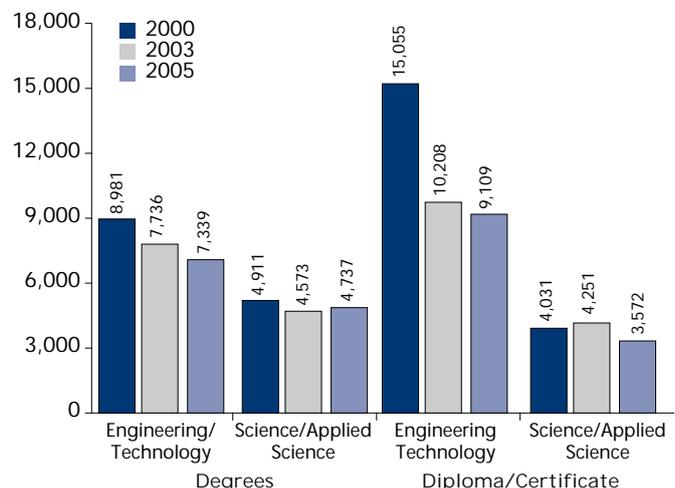
Data on student numbers shows evidence of some cross-border mobility

Cross-border mobility is higher from Ireland to Northern Ireland, in particular for post-graduate studies. One in eight post-graduate students in Northern Ireland comes from Ireland.

... but also that the numbers studying engineering and science courses have fallen sharply in recent years.

Available data shows that the numbers applying for, and studying, science, engineering and IT courses have fallen sharply since 2000, by as much as 25 per cent in Ireland and by a smaller amount in Northern Ireland.

Figure 4 CAO Applications for SET courses (first preferences)



E. Estimating Demand for Engineers and IT Workers to 2020

A “knowledge island” will require continuing significant growth in the number of people in engineering and IT occupations ...

A number of trends seem set to continue on the island. Manufacturing continues to evolve towards high-technology sectors (in particular ICT and bio-pharma). The high-tech sectors are themselves upskilling over time. Construction activity is projected to remain strong. There is a requirement for all manufacturing sectors to upgrade their processes. The employment of engineers and IT personnel is expanding in non-industrial sectors of the economy. And the island requires a significant expansion in its R&D capability.

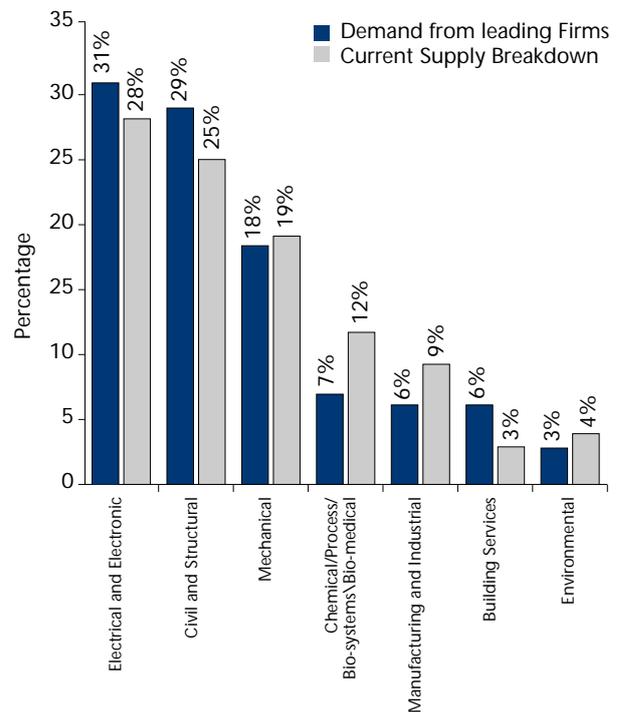
These trends suggest that the numbers in engineering and IT occupations will continue to increase strongly. In relation to engineering, there is no reason to believe the relationship between the rate of growth in the numbers of engineers and engineering technicians and the rate of growth of the economy will change. Furthermore, the current profile of demand from leading firms seems well aligned to the profile of engineers being trained per discipline. However, there is an emerging significant shortfall in the supply of electrical/electronic graduates. In relation to IT, the rate of growth in the numbers employed is likely to slow down, as the numbers grew from a small base in the 1990s and the period included the IT “boom”. The relationship between the rate of growth in IT personnel and the rate of growth in the economy is more likely to approach the rate seen in relation to engineers.

If the scenario of a 4.5 per cent rate of growth required by the island economy to reach the level of the Top 5 global economies is to be achieved, the Task Force projects that the number of people in engineering occupations will be required to rise from 40,000 (in 2001-2002) to 110,000 (by 2020). The number in IT occupations will be required to rise from 42,000 to 115,000. This represents a compound annual rate of growth of 5.6 per cent.

... and in those with engineering and IT qualifications.

For a given number of engineers in the economy, a higher number of people with engineering qualifications is needed in the labour force, as a proportion of people with the relevant qualifications work in other jobs. Based on data from Ireland’s 2002 Census, it is possible to project the numbers required with engineering and IT qualifications, in the labour force, by 2020, to meet the Top 5 growth scenario.

Figure 5 Current Demand from Leading Firms for Engineers (by discipline) and Current Supply of Graduates from Ireland and Northern Ireland



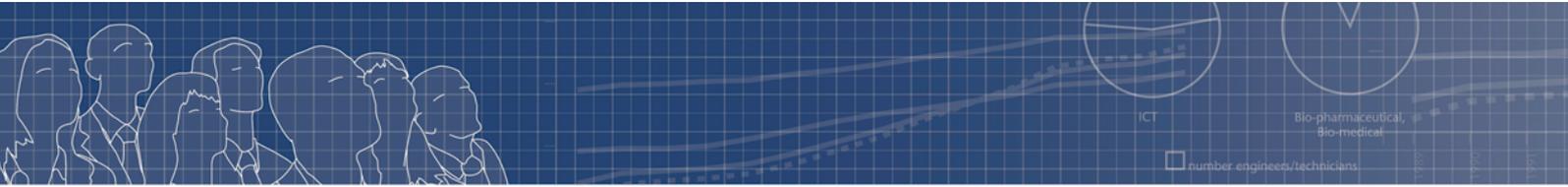
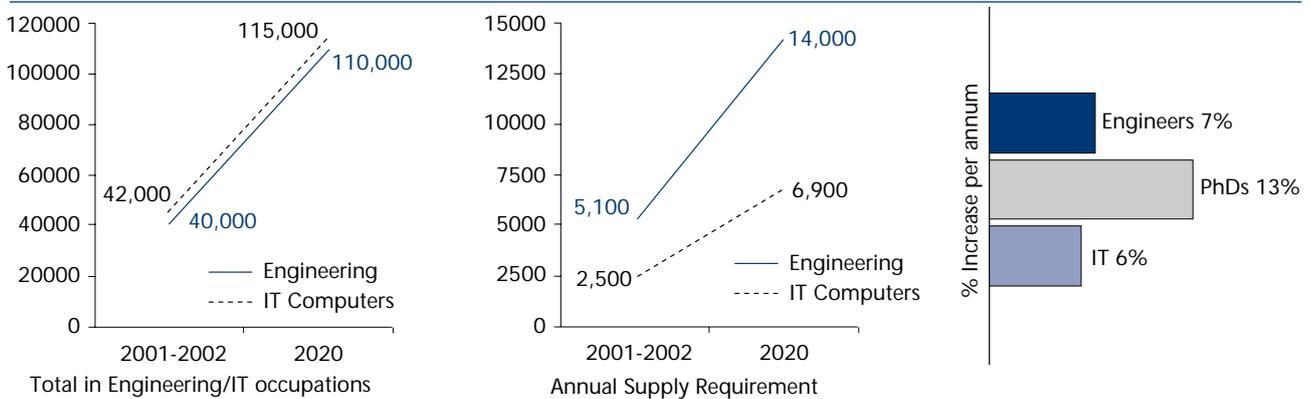


Table 3 Summary of Estimated Manpower Requirements for Engineering and IT on Island

	2001 – 2002	Percentage of Annual Growth Required	2020
Number of People in Engineering/IT Occupations			
Engineering	40,000	+ 5.6	110,000
IT/Computers	42,000	+ 5.6	115,000
Number of People with Relevant Third-Level Qualifications in Labour Force			
Engineering	73,000	+ 5.6	200,000
IT/Computers	42,000	+ 5.6	115,000
Number of New People Required to Enter Labour Force per annum			
Engineering	5,100	+ 7.0	14,000
IT/Computers	2,500	+ 6.0	6,900

Note: Growth rates in Number of New People Required to Enter Labour Force Each Year allow for attrition

Figure 6 Summary of Estimated Manpower Requirements for Engineering and IT on Island



The final part of Table 3 takes account of likely rates of retirement from the two sets of occupations. Once these are taken into account, the number of new people entering the labour force with engineering qualifications will need to rise by 7 per cent per year and those with IT qualifications by 6 per cent per year.

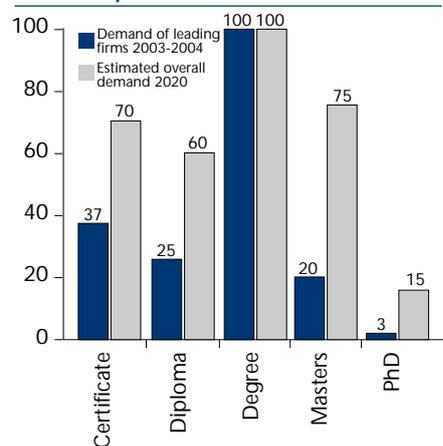
The island economy is likely to require a higher proportion of graduates at post-graduate and at sub-degree level, compared to today ...

Based on the evidence of the leading companies today, there will be a different pattern of graduate demand by 2020. Table 4 shows the projected required ratios and how this would translate into required actual numbers graduating in 2020.

Table 4 Estimated Balance of Demand in 2020 by Level of Engineering and IT Qualifications and Estimated Number of New Labour-Market Entrants Required in 2020 by Level of Qualification

	Certificate	Diploma	Degree	Masters	PhD	Total
Ratio of Qualifications	70	60	100	75	15	
Engineering Grads	3,000	2,600	4,400	3,300	700	14,000
IT/Computing	1,500	1,300	2,200	1,600	300	6,900

Figure 7 Balance of demand by level of qualifications



Note: Ratios relate to degree index at 100



The projected requirement for people with engineering and IT qualifications to reach the level of a Top 5 economy by 2020 can be met in a number of ways.

Options include one or more of the following:

- More people graduating from engineering and IT courses on the island;
- More existing workers returning to education to upgrade or acquire skills in engineering or IT; and
- The recruitment of people with relevant qualifications from outside the island to the island labour force.

F. Task Force Conclusions

Top 5 Target attainable by 2020 with 4.5 per cent growth.

The target of having income per head on the island in the Top five globally with an expanded population can be achieved with an annual average GNP growth rate of 4.5 per cent. This would require lower average growth than has been achieved on the island in the past 15 years.

High-tech sectors are key growth drivers.

Key drivers of growth are expected to be the ICT and bio-pharmaceutical/bio-medical sectors, with the support of the construction sector.

Substantial increase needed in qualified engineering and IT staff.

The expansion of the high-tech sectors, and other sectors across the economy, will require a substantial increase in engineering and IT professionals. This will represent a continuation of a trend seen on the island since 1990, as the island becomes a 'knowledge economy'.

R & D resources a vital ingredient for the "knowledge island".

R&D expenditure and personnel on the island lag substantially behind the levels of the leading economies, and this gap will need to be closed to achieve a "knowledge island".

Competitive threats exist and are changing.

There is a threat to building a Top 5 economy from rapidly emerging Asian economies, such as China, India and Taiwan. The island will also receive a much lower level of EU Structural Funds from 2005 to 2020 compared to 1990-2004.

Almost three-fold increase in stock of qualified staff required.

There will be a need to increase the stock of people with engineering and IT qualification by a factor of 2.75, from its level in 2001-2002 to its required level in 2020.

Strong annual increase in supply of engineering and IT personnel necessary.

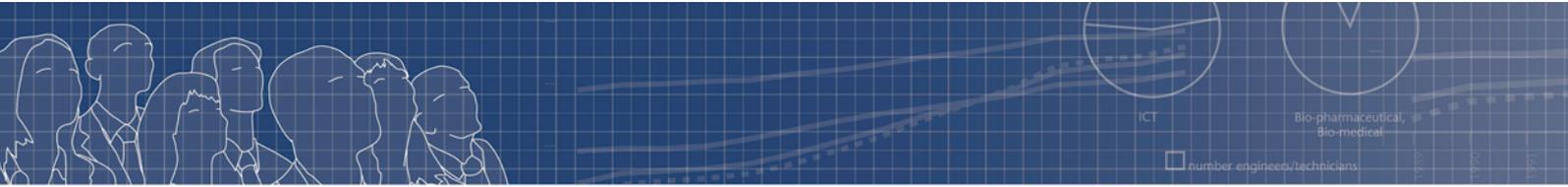
An increase in the number of those with engineering qualifications in the labour force of 7 per cent per year is required. An increase in the number of those with IT qualifications in the labour force of 6 per cent per year is required.

Distribution of engineering disciplines reflects expected demand.

The current distribution of graduates across the different engineering disciplines appears to broadly reflect expected demand patterns, at least in the medium-term.

Greater complementarity is needed between engineering and science.

There will be greater interaction between engineering and science disciplines in the key growth sectors. This reflects a convergence of science and engineering in sectors such as nanotechnology (which brings together biological and engineering sciences).



Demand for PhDs expected to increase almost ten-fold.

The opinions of the leading firms today suggest strong growth in demand for professionals with post-graduate qualifications. Demand for PhDs is expected to increase almost ten-fold by 2020.

A threat is posed by the sharp fall in number of applications.

While the annual supply of engineers and IT professionals is required to grow strongly (to achieve 'Top 5' economic status), this must be seen in the context of a sharp fall in the number of applications to IT and engineering courses since 2000.

A strong recovery in demand for IT professionals is evident.

There is international evidence in 2005 to indicate a sharp recovery in the demand for IT professionals after the slowdown in 2001-2003.

G. Task Force Recommendations¹

Adopt target for island of being in Top 5 global economies by 2020.

The Task Force believes that the island can reach the level of the Top 5 global economies in terms of income per head by 2020. To this end, it believes achievement of a 4.5 per cent per annum economic growth rate for the island to 2020, and the creation of a 'knowledge island', should be adopted as feasible targets. The achievement of these targets will require close collaboration in fulfilling the economic and skills development potential of the people of the island. Collaboration already exists at the highest levels of government and policy.

Robust increase in the supply of qualified engineers, IT staff and PhDs needed.

Measures should be set in train by the relevant authorities on the island to increase the supply on the island by 2020 of

- (a) Engineering professionals and technicians by 7 per cent per year;
- (b) IT professionals and technicians by 6 per cent per year; and
- (c) Engineering and IT PhDs by 13 per cent per year.

Develop world class centres of research linked to Engineering and IT schools that share resources.

Engineering and computer engineering/science schools on the island are small by international standards and do not have sufficient economies of scale. There should be intensive efforts both to develop world class R&D centres of excellence and to share resources to benefit from economies of scale.

Promote engineering and science as career options much more intensively.

A co-ordinated and adequately funded promotional campaign to attract applicants for engineering and science courses at third-level should be launched throughout the island (e.g. Ireland's Discover Science and Engineering Initiative and STEPS – Science, Technology and Engineering Programme for Schools). The resources required will be determined by the campaign's success in meeting the targeted number of course entrants. There should also be efforts to attract more students at second-level into mathematics and science subjects, and to ensure consistently high standards of relevant second-level teaching and facilities.

Make greater efforts to attract women into engineering, targeting 50/50 gender distribution.

Particular attention should be given to attracting more women into engineering, and in supporting their careers, including through the development of more flexible career paths and working arrangements, with the aim of moving towards a 50/50 gender distribution by 2020.

¹ The Task Force recognises that some of these recommendations were addressed in a broader context in the Enterprise Strategy Group's 2004 report "Ahead of the Curve" and that some preliminary actions have been taken.



Provide more substantial resources to increase graduate, and research, output from higher educational institutions.

Third-level institutions throughout the island should be allocated sufficient resources to enable them to achieve the sharp increase in annual graduate output required, including in supporting more students to progress to PhD level. The increase in resources should be sufficient to cover both R&D and teaching.

Expand programmes supporting linkages between industry and third level institutions.

The current successful programmes supporting linkages between industry and third-level institutions on the island should be expanded to involve a higher proportion of Masters and PhD graduates. This would assist integration between academic research and innovation in indigenous industry. Systems are needed to ensure that sufficient projects, companies and post graduates are attracted to achieve the necessary degree of expansion.

Implement more programmes for continuing professional development and for obtaining higher level qualifications while remaining at work.

The continuing professional development of engineering and IT staff should be intensified by industry, and complemented by the provision of better facilities, curricula and timetables by higher education institutions, to enable company employees to attain higher qualifications, up to PhD level, in a way that integrates work and learning.

Publish information on the number of computer engineering/science graduates annually.

Details should be published of the number of computer engineering and computer science qualifications awarded annually by higher education institutions on the island. Such information will enable third-level institutions and development authorities to assess the adequacy of the supply system.

Support more complementarity between engineering and science studies.

Higher education institutions should take action to enable greater interaction between engineering and science qualifications to meet the needs of the key growth sectors.

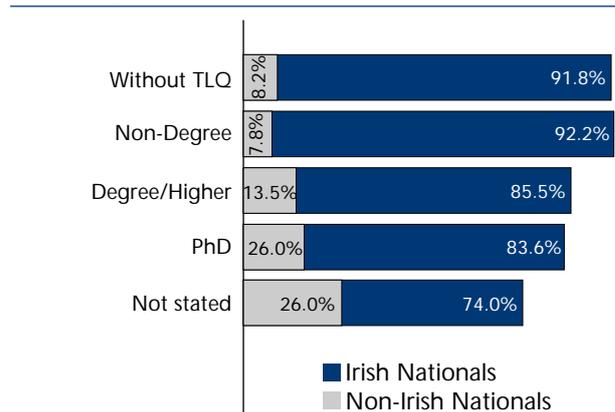
Attract and integrate engineering and IT professionals from abroad.

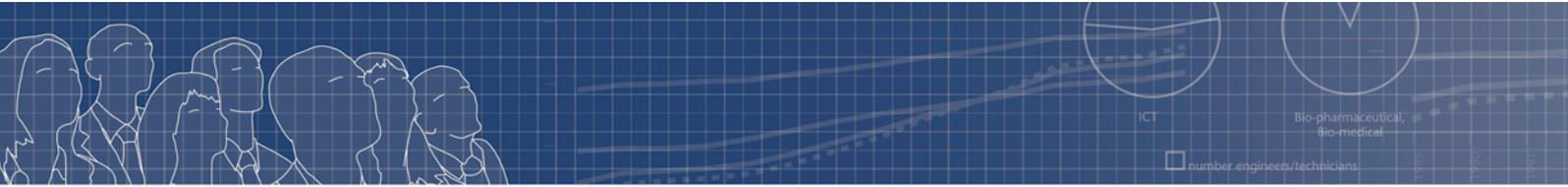
To the extent that the supply of engineers and IT professionals from third-level institutions in Ireland falls below the required amount, the gap should be bridged through immigration, primarily from other EU Member States. It is recommended that clear and specific policies be developed by the relevant authorities to facilitate the integration of such migrants.

Gather information on the engineering and IT qualifications of immigrants when they register with the social welfare systems on the island.

Immigrant workers registering with the social welfare systems should be asked to provide information on their third-level qualifications, including in engineering and computer engineering/science, and a summary of the qualifications of these labour market entrants should be published annually. This will enable the development authorities to assess the degree to which immigration is supplementing the supply of graduates by the third-level institutions on the island.

Figure 8 Breakdown of People in Ireland with Third Level Qualifications into Irish/Non-Irish Nationals





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