Institute of Physics

Science Higher Education in 2015 and beyond

An Institute of Physics response to a Royal Society call for evidence

28 July 2006

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Science Policy Section
The Royal Society
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Institute *of* **Physics**

Dear Dr Pierson

Science Higher Education in 2015 and beyond

The Institute of Physics is a scientific membership organisation devoted to increasing the understanding and application of physics. It has an extensive worldwide membership (currently over 35,000) and is a leading communicator of physics with all audiences from specialists through government to the general public. The Institute believes in and promotes ethical integrity in all scientific activity, including education, research, publication and the exploitation of knowledge. Its publishing company, Institute of Physics Publishing, is a world leader in scientific publishing and the electronic dissemination of physics.

The Institute is pleased to submit its views to inform the Royal Society's project, 'Science Higher Education in 2015 and beyond'.

The attached annex highlights issues of concern to the Institute which are related to the questions listed in the call for evidence.

If you need any further information on the points raised, please do not hesitate to contact me.

Yours sincerely

Dr Robert Kirby-Harris CPhys FInstP
Chief Executive

Institute *of* **Physics**

Science Higher Education in 2015 and beyond

1. The nature of the benefits to a student that accrue from studying an STM subject at HE level, whatever their future occupation

The Institute and the Royal Society of Chemistry published the report, *The economic benefits of higher education qualifications*[1], in January 2005, which revealed that physics and chemistry graduates in the UK earn more than graduates from most other disciplines.

Over a working life, the average graduate will earn around 23% more than his/her equivalent holding two or more A-levels, compared with 30% more for physics and chemistry graduates. The figure of 30% compares between 13-16% for graduates in subjects including psychology, biological sciences, linguistics, and history.

According to the report commissioned from PricewaterhouseCoopers, a graduate in physics or chemistry earns between £185,000-190,000 (compared with the average of £129,000) more during their career than someone with A-levels but no degree, whereas history and English graduates earn only £89,000-92,000 more. The report also demonstrates that physics and chemistry graduates pay approximately £135,000 more in tax than those with A-levels and £40,000 more than the average graduate during their working lives.

The report also assessed the costs associated with undertaking a degree, trading them off against the economic benefits. It concluded that the individual rate of return to the average degree holder is about 12% per annum. This compares with an individual rate of return for graduates in physics and chemistry of 15% per annum.

2. The demand for STM graduates from the economy and wider society, and how this demand is changing

<u>Physicists into industry</u>

The flow of high-quality professional physicists into industry is an issue of concern. Physics graduates are particularly well suited to the needs of industry and business. However, many of those with a four-year MPhys qualification have accumulated debts during their undergraduate study, which will be exacerbated by the introduction of tuition fees. They appear to be attracted by the salaries and conditions in the City and other sectors, where their intellectual strengths are recognised and rewarded. The result is that too few are staying in research/academe, teaching and industry. The problem, primarily, requires attention to the salaries, status, conditions and prospects pertaining to careers in research/academe, but particularly in industry.

[1] www.iop.org/Our_Activities/Science_Policy/Publications/file_4149.pdf

Views of employers

As part of the Institute's Undergraduate Physics Inquiry[2] (UPI) of 2001, a survey was undertaken of the views of employers of physicists. The following views, which are still worth consideration, emerged.

There was a high demand for good physics graduates, with some employers having difficulty recruiting. Physicists find employment in a wide range of sectors, often far from what would conventionally be attributed to physics. What is frequently sought is a combination of good technical and analytical skills combined with good team-working and communications skills.

Employers value the following attributes of physics graduates:

- flexibility and versatility to tackle a wide range of technical and non-technical subjects;
- good analytical and problem-solving skills;
- good mathematical and IT skills;
- a good breadth of technical interest and ability;
- a good understanding of fundamentals from which to approach new situations where traditional approaches do not work;
- analytical problem-solving capabilities (in some sectors, including the financial sector, emphasis is put on the advantages of a research training in enhancing these skills);
- an ability to grasp concepts quickly and in a quantitative way (more important than knowledge of a particular specialism); and
- an ability "to argue on one's feet".

Employers would also like to see:

- improved social, interpersonal and team-working skills;
- better communication skills, particularly written skills;
- a less academic and more pragmatic approach;
- improved business awareness; and
- a greater awareness that not all problems can be solved by logic alone.

The general view from the survey was that after graduates have been with a company for a few years there is little to distinguish between graduates in physics, electrical engineering, other engineering, mathematics or (to a lesser extent) chemistry. The key issue for employers of physicists appears to be in combining the technical, analytical and problem-solving skills (in which physics and engineering graduates tend to be strong) with the 'softer' communication and team-working skills (in which they tend to be weaker). Whereas graduates were more frequently employed on the basis of their skills rather than specific knowledge, some employers regard PhDs as vocational and recruit on the basis of the particular specialism. Others anticipate having to train PhD graduates as they do those with first degrees, but appreciate the additional skills they have acquired through research. The research experience of the PhD provides recruits with a greater independence of vision. This important attribute is shared, albeit in a somewhat attenuated form, by MPhys graduates and is believed to arise as a consequence of the degree's research component.

In addition to the very strong national demand for physicists with the traditional skills of quantitative analysis, data handling and experimentation, employers are requiring

[2] www.iop.org/Our_Activities/Science_Policy/Projects/Archive/page_6337.html

scientists with interdisciplinary skills. Increasingly, technically skilled graduates will be employed in sectors that previously have not recruited such employees. Such employees will include technical sales staff, technicians, communications and IT engineers, environmental monitors and regulatory officers.

3. The quantity of those graduating at all levels of the higher education system, and the quality, depth and breadth of their educational and training experiences

The table below shows the number of first degree and higher degree qualifications obtained by students at universities in the sciences and mathematics from 1994/95-2004/05 (source USR and HESA)[3].

Subject/ Year	Physics (incl Astro)	Mathematics	Chemistry	Biology	Total All Subjects
1994/95					
First	2551	3435	4110	3712	237798
Higher	849	386	1156	532	46968
1995/96					
First	2070	3383	4144	4066	251248
Higher	970	501	1323	719	56252
1996/97					
First	2530	3114	3753	4398	255260
Higher	938	496	1291	731	59002
1997/98					
First	2428	3372	3393	4104	258753
Higher	944	466	1354	833	64968
1998/99					
First	2439	3638	3624	4035	263671
Higher	896	493	1282	743	67175
1999/00					
First	2400	3550	3420	4230	265270
Higher	790	520	1270	780	71910
2000/01					
First	2600	3720	3285	4405	272665
Higher	925	570	1380	1055	86530
2001/02					
First	2330	3725	3215	3915	274440
Higher	915	630	1270	1120	90370
2002/03					
First	2480	4390	2955	4430	282380
Higher	985	685	1380	1265	98885
2003/04					
First	2410	4655	2735	4485	292090
Higher	970	785	1490	1175	110710
2004/05					
First	2525	4575	2710	4585	306365
Higher	1000	975	1455	1255	119445

The number of physics graduates (data includes astronomy) has stayed reasonably constant despite a steady increase in the overall pool of university graduates on a year by year basis. This at first glance may indicate stagnation in the output of physics graduates in an expanding higher education market, but closer inspection reveals a significant achievement by the physics departments to have gained stability in their graduate output in light of the closure of several UK physics departments over the years.

Since the abolition of the binary divide between the universities and polytechnics in the early 1990s, over 30% of physics departments in the UK have either merged or

[3] www.iop.org/Our_Activities/Science_Policy/Statistics/Education%20Statistics/page_2672.html

closed (at present, there are only 47 UK universities out of 125 offering a provision for undergraduate physics). One of the consequences of these closures has been the creation of physics "deserts" - regions with no convenient access to a physics department, such as East Anglia. The government expects more and more students to live at home to reduce living costs. As the proportion of students living at home increases, as industry becomes more dependent upon high-technology knowledge and as the links between schools and universities become stronger, these regions will suffer from a lack of proximity to university physics. There is also concern that these closures are cost driven and random, with no sense of a national strategy or of regional needs. The Institute's latest report, *Study of the Finances of Physics Departments in English Universities*[4], confirmed that the large fixed costs involved in the delivery of the physics undergraduate programme, particularly in maintaining and servicing teaching laboratories mean that sustained recruitment is vital to the financial health of the physics departments surveyed in the study.

As students see closures occurring, they will be concerned about taking physics at some institutions due to the uncertainty of future closures. A continuation of this trend would threaten the UK's ability to produce the volume of physics graduates needed for it to compete on an international basis.

Furthermore, the problem also stems from what is happening at A-level. Over the last decade or so, the number of pupils taking A-level physics has fallen by around 20% whereas the total number of students taking all A-levels has risen by around 7%[5]. Falls of around 8-9% have occurred in both chemistry and mathematics.

Ethnic minority participation

The Institute and the Royal Society of Chemistry recently published the report, *Representation of Ethnic Groups in Chemistry and Physics*[6], which charted the progress of all ethnic groups from GCSE to postgraduate level. The report found that with the higher education system, within SET subjects there is a general bias found amongst ethnic minority students against traditional areas of science, such as the physical sciences, the biological sciences and mathematics. In contrast, ethnic minority groups in general tend to be over-represented in ICT and computer science, compared with their white counterparts.

In terms of achieving a first or upper second class degree, there is strong evidence of significantly different patterns of achievement in chemistry and physics by ethnic group. White students have much higher rates of success in terms of achieving a first or upper second degree, and hence are in a better position to access postgraduate chemistry, physics or related science courses. This differential achievement by ethnic group is found not only in chemistry and physics, but across most subject areas. However, there is evidence that most of this differential achievement may be explained by subject choice and because many ethnic groups are over-represented in the undergraduate population relative to their white counterparts.

Amongst students who achieve high standards at undergraduate level, ethnic minority students are less inclined to study chemistry or physics at PhD level than their white counterparts. This is made more interesting as ethnic minority graduates in chemistry and physics are significantly more likely to go on to some sort of further study than their white counterparts. From this it can be inferred, that ethnic minority

[4] www.iop.org/Our_Activities/Science_Policy/Publications/file_6598.pdf
[5] www.iop.org/Our_Activities/Science_Policy/Statistics/Education%20Statistics/page_2620.html
[6] www.iop.org/Our_Activities/Science_Policy/Publications/file_5726.pdf

students tend to study subjects outside chemistry and physics at postgraduate level. This apparent drift away from chemistry and physics by ethnic minority students presents an interesting avenue for future research.

4. The length of time HE studies should take, and how that time should be broken down (with reference to the Bologna proposals to standardise the structure of HE across Europe).

The Institute strongly supported the introduction of the undergraduate four-year MPhys degree, which in many university physics departments is offered alongside the traditional three-year BSc in physics or physics-related degree[7]. Hence, the length of time taken to undertake a first degree followed by PhD study traditionally will be 4+3 years, unless a student wishes to take a Masters degree, which is either one or two years in length.

The Bologna Declaration has proposed the implementation of 3+2+3 model across Europe, which the Institute has been active in discussing with its community and lobbying the government to acknowledge as a concern[8].

The Bologna Process for the reform of higher education in Europe poses potential problems for the international recognition of UK Masters level degrees since this level is reached after four years in England and Wales rather than the five years expected in most other European countries. This particularly affects science and engineering because of their international nature and because the Masters level is regarded as the minimum for professional practice. There are risks for the employment of such graduates in international companies since such companies could well prefer graduates educated in other European countries.

The main concerns are for the recognition of the four-year UK integrated Masters degrees (i.e. MPhys/MChem/MEng/MSci) as second cycle qualifications, although there are also concerns for one-year MSc degrees. If the four-year integrated Masters degrees are recognised, it may mean that the final year would have to be a full calendar year, rather than an academic year, with obvious funding implications. It is essential that these four-year qualifications are maintained and recognised as second cycle qualifications throughout Europe, as these degrees are crucial for the training of UK scientists and engineers. Doubts on their international recognition would also endanger the important overseas student market in science and engineering. In addition, many UK universities will continue to adopt the three-year BSc route to PhD level, which will seriously undermine the recognition and acceptance of the PhD as a 3rd cycle qualification in Europe.

The response of the UK government to these concerns appears to be that there is no problem and that no consideration needs to be given to any possible modifications in the light of the Bologna Process. This contrasts with the view of the UK science and engineering academic community actively involved with discussions with colleagues in other European countries on the implications of the Bologna Process. It also contrasts with the view taken by other European governments. The Bologna Process is not static and continues to evolve. The UK government needs to consult more with those in universities actively involved in European developments in the Bologna Process, particularly in science and engineering, and should consider what response is needed. The views of employers also need to be sought.

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[7] www.iop.org/Our_Activities/Science_Policy/Publications/page_4144.html
[8] www.iop.org/Our_Activities/Science_Policy/Publications/file_4156.pdf

In November 2005, an International Panel of international physicists and astronomers undertook a second Review of UK Physics and Astronomy Research, reporting on the quality, distribution of effort and future potential of research in physics and astronomy in the UK. The Review aimed to indicate areas of strength, weakness, improvement, decline and growth with respect to the preceding review. In their report, *International Perceptions of UK Research in Physics and Astronomy 2005*[9], published in January 2006, the International Panel expressed the following concerns about the length of the UK's PhD programmes of study:

"…a three-year programme of study, despite its advantages, for example the efficient flow of graduates into the employment market at an earlier age, is undermining the ability of UK PhD graduates to compete with their international counterparts for postdoctoral fellowships, both at home and abroad. Alarmingly, this view was shared by a number of PhD students questioned by the Panel. In addition, many of them indicated that they felt inadequately prepared in secondary school and that, even after four years of undergraduate training (i.e. MPhys/MSci degree programmes), they felt less trained than many PhD students from other EU countries."

"The Panel is of the view that UK PhD students are well trained in their narrow sub-fields, but lag behind their counterparts in countries like Germany in their broad set of skills. This problem is exacerbated by the lack of graduate advanced courses, coupled with little or no credit allocated to these courses by university departments."

"The Panel was encouraged to note that PPARC are funding some PhD students for up to four years, and EPSRC for three and a half years with the flexibility within a university to use the funds to provide four years of support, but would like to see both research councils fund PhD studentships for four years."

"… the Panel recommends that the UK needs to make an informed decision about the future of its graduate training programme. In order to do this, it should commission an in-depth review of graduate level education, which needs to incorporate comparisons with its leading scientific competitors, and address the implications of the Bologna Process..."

5. The current discipline boundaries, and whether a general science first degree option could be appropriate.

Interdisciplinary science is increasingly important in research. In practice, the work is done by multi-disciplinary teams where individuals bring their specific set of skills (i.e. physics, chemistry or biology) to the table. General science degrees, in many cases, would provide insufficient depth and coverage of the individual core sciences to prepare students for a career in research. In addition, physics is unique in its reductionist approach, using mathematics to understand problems at their most fundamental level, and there would be a real danger of this element (often seen to be harder than the rest of science) being omitted from a general science degree. An MPhys or BSc in physics provides students with a vigorous grounding of the subject.

However, there is an untapped market of talent who might be attracted to a broader based degree which still has a rigorously defined physics element to safeguard that side. Hence, the Institute as part of its Stimulating Demand for Physics project[10],

[9] www.iop.org/Our_Activities/Science_Policy/Projects/International_Review/index.html
[10] www.hefce.ac.uk/News/HEFCE/2006/physic.htm

funded by HEFCE as part of its remit to support strategic subjects of national importance[11], is running the following pilot project:

New Degree Structures:

The Institute will be working with university partners to develop a new brand of physics-based, interdisciplinary degree programmes that will appeal to non-traditional entrants. The programmes will be attractive in their own right to both employers and students but will also enable students to continue with further study in a specialist physics programme if they so wish. The courses will have different flavours, depending on the host university, but our chosen partners allow us to cover, for example, the problem of physics deserts and non-traditional entrants.

6. The changes to the skills, knowledge and experience of those entering the HE system and how the HE system can accommodate such changes.

The International Panel in their report stated:

"Both the methods and results of physics and astronomy research have an impact on society that clearly transcends the confines of academic research. However, a society can only value the importance of such research if secondary schools offer a basic education in mathematics and the core sciences, i.e. physics, chemistry and biology. As was the case in 2000, many of the individuals that the Panel encountered expressed serious concerns about the level of science education and, in particular, about the inadequate training in mathematics. In fact, many schools no longer provide the level of training in physics and mathematics that is required to enter a university programme in physics. As a consequence, a substantial fraction of those who enter university are, effectively, barred from taking up physics. This has created an unhealthy situation for a country with an increasingly knowledge-based economy."

Furthermore, *"Obviously, the problems with secondary school education have consequences for the undergraduate curriculum of physics and astronomy departments: the transition to a four-year undergraduate programme is widely perceived as a necessary change to include "remedial" teaching in the first year. Hence, the physics proficiency of the new four-year graduates is barely equal to that of the three-year graduates of 20 years ago."*

In addition, the UPI survey unearthed some interesting findings:

Respondents were asked to comment on whether they had obtained evidence of changes to the nature of entrants to courses. All departments monitored student performance carefully through course work and tutorials, as well as diagnostic testing; other respondents were considering the introduction of such tests. Many respondents said that prior knowledge tests provided evidence of a change within the students' level of preparation. Many departments worried about the mathematics preparation of new entrants and had modified their courses to address this issue. Respondents commented on the absence of mathematics in A-level physics; they said that students find it hard to use their mathematics in a physics context. Several respondents were concerned about the lack of depth of the mathematics syllabuses and wished to address these deficiencies but without de-motivating the students.

[11] www.hefce.ac.uk/aboutus/sis

1096 undergraduates from 55 UK universities also responded to the UPI survey, with the following results:

• 87% of undergraduates believe their courses to be up-to-date and not to have too much laboratory work. About half believed the choice of final-year modules to be adequate.
• 82% agreed that the teaching of physics was good, with 61% and 68% respectively agreeing that school physics and mathematics had enabled them to tackle university physics with confidence.
• Significant numbers of undergraduates obtaining an A or B grade in mathematics and/or physics at A-level did not believe that school had prepared them for their university course.

7. The need to allow students to be flexible in their choices of occupation as they gain their qualification and afterwards.

Looking at the issue of attracting students to science and engineering, the problem starts at school. The supply of scientists and engineers is dependent on the choices young people make between the ages of 12-15, and these in their turn are determined by the nature and quality of science teaching earlier in their schooling. The woeful lack of science teachers, particularly in the physical sciences, is of utmost concern, as only those with confidence and competence can teach a subject well, engaging and enthusing pupils, and motivating them to pursue science and engineering careers.

The Institute is very concerned that students are not being given accurate careers advice at a sufficiently early age to allow them to make informed choices. Currently, careers advice tends to be reactive and does not provide students with a full picture of the consequences of subject choices. This is exacerbated by recent changes to the structuring of the careers service where insufficient attention has been paid to the skills and knowledge of those required to give useful and accurate careers advice.

In addition, most careers advisors are not knowledgeable about physics. In order for careers advisors to be able to persuade more people to continue with physics post-16, they need to be able to inform children and their parents about the contribution of physics to daily life as well as be knowledgeable about the fact that physicists are very flexible employees because of the widespread applicability of their skills.
The wide range of career opportunities that a physics degree can provide needs to be proactively disseminated to ages 11-15, before they choose their GCSEs, if it is to have any impact.

It is common knowledge that one of the problems of tracking the long-term career destinations of graduates (to inform careers material) has been the lack of reliable data. HESA data on first destinations is inadequate as the first job after graduation for a number of graduates may not be linked to their academic qualification or their career aspirations, for example, a short-term tenure at a fast-food restaurant while they apply for jobs in the City! This is something that needs to be addressed.

In an attempt to gather such data, the Institute has launched a longitudinal study of the long-term career paths of a cohort of UK physics graduates. All final year undergraduate students of physics in 2006 were asked to fill in a detailed questionnaire. All participants (around 1,100) will be contacted at yearly intervals via e-mail, to build up a picture of their earnings and careers over a five-year period. In addition, the Institute aims to enlist a new cohort of participants each year.

8. The increasing number of students who choose to study later in their lives, and/or part-time, and/ or have geographic limitations on where they can study

This issue is exacerbated by concerns relating to physics "deserts". Students irrespective of age/location should have the opportunity of studying science at any university for which they are eligible (based on their entry qualifications and aptitude), but in physics and chemistry, in particular, may not be able to do because there may not be a university in their region with a provision for undergraduate physics and/or chemistry.

The Institute noted a survey conducted by the THES (23 April 2004) that revealed that more students are staying at home when they enter higher education. The survey found that a quarter of students live at home while studying, a higher proportion than estimated for previous years. If more and more physics departments are forced to close, regional deserts of physics provision are likely to appear all over the UK.

The UPI survey discovered that many UK physics departments were of the view that they stood to benefit from increased participation rates in higher education, although they were concerned about the ability of mature students and others to handle a traditional physics degree, and of departments to teach them. Physics, unlike many degrees, requires specific skills and knowledge on entry, not just ability, which has a great effect on its appeal to mature students. As mentioned earlier, the Institute's New Degree Structures project will look at developing a new brand of physics-based, interdisciplinary degree programmes that will appeal to non-traditional entrants, such as mature students, and that perhaps could be offered at universities that currently do not have undergraduate provision for physics.

9. The financial impact upon students who undertake HE study

Anecdotally we know that the average student graduates with a debt in the region of £10,000-15,000. This will be exacerbated by the introduction of tuition fees from 2006/07, which may have a bearing on the number of entrants to physics under- and postgraduate courses, especially from under-represented groups. A significant fraction of the undergraduate cohort for physics is enrolled on four-year courses, hence further financial pressures exist, which may affect their choice of course. Such pressures also exacerbate recruitment into postgraduate courses. An already fragile population of physics degree applicants could be driven away to cheaper options. This would not be in the national interest, as at the employers' level, there is high market demand for graduates in these areas. (The financial rewards are there for physics graduates, but potential students are not aware of this. They might be more inclined to choose physics if they did.)

In response, the Institute aims to provide bursaries of around £1000 per year to selected undergraduates studying physics in the UK and Ireland with the objective of increasing participation in the subject. The Institute's Undergraduate Bursary Scheme[12] will be operational from the academic year 2006/07 and will involve the allocation of a quota of bursaries to participating university physics departments. The scheme will be restricted to accredited degree programmes and to UK and Irish nationals.

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12 www.iop.org/aboutus/The_Institute_of_Physics/Support_And_Grants/Undergraduate%20Bursary%20Scheme/page_5602.html

10. The impact, on the UK, of international flows of students and STM professionals

The Institute endorses the following comments made by the International Panel in their report:

"Since the 2000 review, the Panel has noticed an increased internationalisation of the people involved in physics and astronomy research at all levels. The Panel believes that this is a positive development, which reflects the increased competition for the very best people independent of nationality. However, this does not appear to be the case for non-EU nationals at the graduate level. The Panel wonders whether there are funding barriers to recruiting non-EU students and, if so, would urge the appropriate agencies to review the regulations."

Furthermore, *"As highlighted in the 2000 report, the UK still needs to review its policy of charging higher tuition fees to non-EU students, which is resulting in it profiting less than other EU countries from the influx of intellect from countries outside the EU (in particular, south and southeast Asia).The possibilities for covering these expenses are, at present, very limited. For EU students, tuition can be waived and more possibilities exist to fund subsistence, although apparently not all of the research councils treat EU students as equals with their UK counterparts. Overseas students should be seen as an investment to the UK."*

However, the Institute's finance study showed that the numbers of non-EU students studying physics in the sample of departments surveyed is very low compared with home and EU students, with only two out of 10 departments taking more than 10% of their undergraduate students from outside the EU (who are not supported from public funds). Students from outside the EU were a higher proportion of postgraduate research student numbers, but the absolute numbers were modest in relation to total student numbers. This is a concern as non-EU students are an additional source of income, and physics departments appear to be missing out.

The finance study also revealed that overall, the physics departments in the sample were heavily dependent on public funding for their student related income. In 2003/04, across all UK physics departments, 290 full-time physics undergraduates were non-EU domiciled, representing 3.1% of the total full-time physics undergraduate numbers of 9400. For a comparison for all subjects in 2003/04, just over 7% of full-time undergraduates were domiciled outside the EU and for full-time undergraduates in business studies, 13.6% were from outside the EU.

However, the International Panel in their report questioned, *"…whether there are funding barriers to recruiting non-EU students and, if so, would urge the appropriate agencies to review the regulations."*

<u>The Research Assessment Exercise</u>

Because of its importance the RAE has the unintended effect of distorting recruitment patterns in science. It has led to many departments hiring star researchers who have an established track record, which sometimes includes staff from overseas, in order to improve the department's rating in the exercise, which limits the number of positions available for up and coming UK researchers. In physics, a recent survey showed that the average age of appointment to lectureship posts is 35. Many persons appointed have been research associates or held a personal fellowship in a different university from the one in which they get their permanent appointment. Thus, to be appointed, a candidate must both have an excellent academic record

from the time of graduation and usually be prepared to move from one area of the country to another and also to leading overseas laboratories. This means that it is extremely difficult for a woman to pursue an academic career unless she is prepared to delay starting a family until her mid-thirties.

11. The developments in HE and economic policy inside and outside the UK and how the HE system can accommodate these changes

The Institute's finance study concluded that in 2003-04 all of the physics departments surveyed were in deficit on a full economic costing (FEC) basis (ranging between 16-45% of their total income). In part this reflected their very heavy dependence on public funding and the metrics used to allocate those public funds. The move to use the FEC for individual research projects; the increased funding of project overheads by the research councils in 2006-07; and the decision by HEFCE to use TRAC based costing data to underpin key elements within its funding of teaching mean that there is a real prospect of an improvement in the financial position of physics departments.

In addition, the move to increase tuition fees in England for full-time home and EU undergraduates to a maximum of £3,000 from 2006 should provide some increase in the funding available to physics departments, as long as they can sustain current levels of recruitment. However, the additional sums available from this source for making good structural deficits will at best be modest because most of the additional income will be used for student bursaries, improved academic pay and investment in teaching facilities.

The Institute welcomes the efforts made by HEFCE, in particular, to engage with it to increase the market share for physics undergraduate degrees, but it must be understood that this is a long-term solution to the demand-side problem that physics will face. In the short-term there are grave concerns that by the time the long-term measures start to take an effect, the UK's physics university base could be suffering with supply-side problems, as a consequence of further physics department closures, forced by forthcoming 2008 RAE, for instance.

Once lost, physics departments are almost impossible to re-establish. It is all well and good to talk about the "dynamism of English HE" and the strategic plans of universities, but the start-up costs of physics (and other) programmes is so great that HEFCE would benefit from preventing short-term closure that will inevitably lead to a long-term lack of provision. HEFCE should also remember that departments carry out research as well as teaching, and that losing departments as a result of demand-side problems in their teaching domain may well have far reaching consequences for the research infrastructure of a whole faculty; for example, the loss of a physics or chemistry department can undermine research efforts in many other science departments.

Hence, HEFCE should reconsider the allocation of its teaching funds for science and engineering subjects, in particular physics and chemistry. As of 2004-05, the weighting for price band B subjects, which includes physics, is 1.7, which is not sufficient.

Finally, the dysfunctional character of the HE market is a concern, whereby university funding is determined by student choice, which is almost entirely uninformed by career prospects or the needs of employers. As a result, the recent huge expansion of graduates has been in subjects such as drama studies, English etc. It is difficult to

see how this arrangement is benefiting either the student or the economy. The International Panel concurred with this in their report stating:

“The Panel is disturbed to find that the financial health of university departments is to a significant degree dependent on undergraduate numbers, which themselves depend on career choices of young people in the secondary system. This is not a good basis for strategic planning of the science base.”

The Institute of Physics is a scientific membership organisation devoted to increasing the understanding and application of physics. It has an extensive worldwide membership (currently over 35,000) and is a leading communicator of physics with all audiences from specialists through government to the general public. The Institute believes in and promotes ethical integrity in all scientific activity, including education, research, publication and the exploitation of knowledge. Its publishing company, Institute of Physics Publishing, is a world leader in scientific publishing and the electronic dissemination of physics

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