Y PWYLLGOR DATBLYGU ECONOMAIDD A THRAFNIDIAETH

EDT2 12-05 (p5)

Dyddiad: 6 Hydref 2005
Amser: 2:00pm- 5.00pm
Lleoliad: Cynulliad Cenedlaethol Cymru, Bae Caerdydd
Teitl: Yr Ymgyrch dros Wyddoniaeth a Pheirianneg

Ymateb i arolwg Cynulliad Cenedlaethol Cymru ar bolisïau yn ymwneud â gwyddoniaeth yng Nghymru

Crynodeb:

1. Mae'r Ymgyrch dros Wyddoniaeth a Pheirianneg (*The Campaign for Science & Engineering - CaSE*) yn gwerthfawrogi'r cyfle i gyflwyno ymateb i gais y Pwyllgor Datblygu Economaidd a Thrafnidiaeth am dystiolaeth i'w arolwg ar bolisïau yn ymwneud â gwyddoniaeth yng Nghymru. Corff gwirfoddol yw CaSe sy'n ymgyrchu dros wyddoniaeth a thechnoleg yn y DU. Cefnogir CaSE gan dros 1,500 o unigolion a thua 70 o sefydliadau, gan gynnwys prifysgolion, cymdeithasau dysgedig, cyfalafwyr mentro, cyllidwyr, cwmnïau diwydiannol a chyhoeddwyr.

2. Mae CaSE wedi ymrwymo i ymgyrchu dros, a hybu gwyddoniaeth a pheirianneg mewn Cymru ddatganoledig ac ers ei sefydlu (fel CaSE a hefyd o dan ei hen enw o Achuber Gwyddoniaeth Prydain (*Save British Science*)) wedi: trefnu cyfarfodydd polisi gwyddoniaeth rhanbarthol ar y cyd â gwyddonwyr a gwleidyddion lleol yng Nghaerdydd, Aberystwyth a Wrecsam; cyhoeddi agenda pum mlynedd o bolisïau gwyddoniaeth ar gyfer etholiadau y Cynulliad Cenedlaethol yn 2003; cyfarfod â gweinidogion, cadeiryddion pwyllgorau ac eraill yn y Cynulliad; cyhoeddi proffiliau o weithgarwch gwyddonol mewn gwahanol ardaloedd yng Nghymru; cyhoeddi ymatebion Arweinwyr y Pleidiau Gwleidyddol yng Nghymru i gwestiynau yn ymwneud â pholisïau gwyddoniaeth ym maniffestos Etholiad Cyffredinol; cymryd rhan yng Ngŵyl Wyddonol Wrecsam, a chael ei dyfynnu, cyhoeddi llythyron a chynnal cyfweliadau ar BBC Radio Cymru, BBC *Radio Wales*, y *Western Mail*, y *Wrexham Leader*, y *Flintshire Evening Leader*, y *Daily Post*, y *Border Counties Advertizer* a chyfryngau eraill yng Nghymru.

3. Prif gasgliadau a argymhellion:

Mae polisi gwyddoniaeth Cymru yn dioddef o ddiffyg ffocws oddi mewn i'r Cynulliad Cenedlaethol. Dylai'r Cynulliad apwyntio Prif Wyddonydd annibynnol academaidd neu ddiwydiannol, a dylai'r apwyntiad sicrhau grym digonol i ddatblygu agenda wyddonol a fyddai o fudd i ffyniant economaidd, cymdeithasol a diwylliannol Cymru. Rhan o ddyletswydd yr apwyntiad byddai sicrhau bod y trefniant datganoledig dros wyddoniaeth yn eglur, a bod y Cynulliad mewn safle priodol i herio San Steffan ar y polisïau hynny lle nad yw'r grym eto wedi ei ddatganoli.

Y gyfundrefn addysg yw conglfaen polisi gwyddoniaeth effeithiol, a dylai gwyddoniaeth fod yn amlwg trwy'r datblygiad addysgiadol o'r ysgol gynradd i'r brifysgol. Rhaid sicrhau bod y gyfundrefn yn un gydlynol yn hytrach na thameidiog. Dirdynnol yw'r sylweddoliad bod pob dolen yn y

gadwyn gyfredol o addysg wyddonol yng Nghymru (cynradd, eilradd, addysg uwch a phrifysgol, boed academaidd neu alwedigaethol) yn wynebu problemau. Rhaid cyfaddef, bod y mwyafrif o'r rhain yn gyffredin i ganran uchel o wledydd y byd diwydiannol; mae rhai ohonynt yn cyflwyno sialensiau hirdymor anodd iawn, ond gellir gwneud gwelliannau amlwg ar nifer ohononyt o fewn ychydig flynyddoedd, os ydy'r ewyllys wleidyddol yn bod.

Mae gwaith ymchwil gwyddonol Cymru o gystal safon ac unrhyw genedl arall drwy'r byd, ond mae'r sector cyhoeddus yn dioddef o brinder cyllid. Canlyniad anochel y fath brinder yw gostyngiad safonau. I ymelwa ar botensial gwyddonol Cymru rhaid gwella'r berthynas a'r rhyngweithiad rhwng byd busnes â'r byd academaidd. Gall Cynulliad Cenedlaethol Cymru gataleiddio'r berthynas hon trwy ddatblygu posibiliadau a chyfleon arloesol i hyrwyddo cydweithrediad diwydiannol.

Annhebyg bod y ddirnadaeth wyddonol a pheiriannol yn is yng Nghymru nag mewn unrhyw ran arall o'r DU, ond gall y traddodiad Cymreig o ddathlu ac ymfalchïo yn yr etifeddiaeth ieithyddol, gerddorol a chelfyddydol gysgodi agweddau eraill o fywyd cenedlaethol, gan gynnwys gwyddoniaeth. Nid gwaith gwleidyddion yw newid y fath agweddau cymdeithasol, ond gall y Cynulliad gynnig arweinyddiaeth yn y cyd-destun hwn trwy sicrhau gwerthfawrogiad mwy amlwg nid yn unig o sefydliadau ac unigolion sy'n llwyddo mewn meysydd gwyddonol, ond hefyd o ymdrechion gwyddonol y rheini sydd heb fod mor amlwg wyddonol-bwysig.

Part 1. The science portfolio in the Assembly

4. The Campaign for Science & Engineering (CaSE) wholeheartedly supports the efforts of the Economic Development & Transport Committee to examine all aspects of science policy in Wales. In the past, Wales has shown that sections of its economy can be extremely powerful – the first ever cheque for £1 million was signed in Cardiff. That historical economic growth relied on natural resources and cheap labour. No part of the UK will compete on wages in the 21st century, and while Wales continues to enjoy some natural resources (it is, for example, an ideal place for wind-generated alternative energy supplies), its economy in the coming decades, like that of most of Europe, will depend on education, science, engineering and technology.

5. Under the current arrangements, however, it will be difficult to create an overarching strategy for science in Wales. This is partly because of an untidy devolution settlement and partly because there is no focus for science policy in the Assembly. The messiness of the devolution settlement was and remains inevitable, and while it may be possible to improve it, the underlying imperfections cannot be abolished. Bigger problems, however, will remain until the Assembly rectifies its failure to create an Office of Science, with a Chief Scientist, and a focus on science, engineering and technology policy.

<u>The devolution settlement for science in Wales</u>

6. The devolution settlement for science is complex. Technically science policy is reserved to Westminster, but in practice this means merely that the Office of Science & Technology (and the Research Councils within it) continue to have a UK-wide remit. Under the Government of Wales Act 1998, other bodies with scientific functions are devolved; these include the Welsh Development Agency and the Further Education Funding Council for Wales. Yet more bodies have a strange hybrid settlement, in which the Assembly can give them new powers and duties but cannot remove their existing functions; the Higher Education Funding Council is the best example of this category. Other public bodies, such as the National Biological Standards Board, may not have their functions altered by the Assembly, but are still answerable to it, in the sense that they can be required to produce documents and members of their staff may be required to give evidence to inquiries undertaken by committees of the Assembly.

7. In education, many functions are devolved, but much power remains in London, and from time to time ministers in London, discuss in vague and general terms the possibility of devolving more powers[i].

8. Many aspects of the way in which economic growth is generated from science are reserved to London because they relate, for example, to tax policy, while the ways in which scientific advice is shared on policy issues such a BSE or railway safety appear to vary according to which departments are involved.

9. The lack of coordination and communication of scientific advice on agricultural issues highlights the degree of problem. After the epidemic of mad cow disease (or BSE) which caused huge difficulties for the farming community in Wales in the 1990s, the BSE Inquiry made fifteen separate findings in relation to scientific advice in the devolved administrations. Most notably, the Inquiry found 'weaknesses in the system for joint policy-making between London [and] Cardiff'. Moreover, it criticised 'poor liaison arrangements' between Whitehall and the devolved parts of the UK[ii].

10. At the time, both the National Assembly for Wales and the UK Government pointed out that the problems had in fact occurred before devolution. While this clearly exonerated the Assembly from blame, it amounted to an admission from the UK Government that at the time, its Welsh right hand had not known what its English left hand was doing. However, it was said that 'formal arrangements have been put in place to promote a synchronised approach'[iii]. Within a few years, when an epidemic of foot-and-mouth disease broke out in 2001, the inquiry once again criticised the level of communication between the UK Government and the devolved administrations[iv].

11. It was disappointing that the Richard Commission Report on the Future of Devolution in Wales, published in 2004, did not make a clear-cut recommendation about something as important as science policy. However, it did recognise that the devolution settlement on some scientific issues (such as foot-and-mouth disease and the development of wind farms) was unsatisfactory.

12. The likelihood of the Assembly being a position to engage with, or challenge, Westminster on such issues in future appears to be compromised by a fudge in the devolution settlement. When asked about the funding of science to inform agricultural science, Assembly officials replied that: 'The position is that DEFRA holds the agricultural research budget on behalf of Welsh Assembly Government, to cover aspects of work required for Wales. There is liaison with DEFRA on direction and content of the programmes, but not on specific selection of bids'[v]. While in principle this may sound reasonable, it is not clear what happens if, after 'liaison,' civil servants and ministers in Westminster decide they disagree with Welsh politicians and officials about the most useful areas of study and decide that the content of programmes will not include areas of particular interest to Wales? It is perfectly possible that priorities for funding in Wales may, on some issues, differ from those decreed in Westminster, which quite properly have an English bias.

One of the key areas for the Assembly in devising a strategic science policy is to be clear about the boundaries of its power and about those areas where it needs to lobby Westminster for changes that will benefit science in Wales. The Assembly must also identify areas where it cannot rely on Westminster to carry out research or actions necessary for the strength of science in Wales.

<u>The need for a coordinating office</u>

13. The remit of the current inquiry demonstrates the need for a more coordinated approach to science policy. Thus, while the Economic Development & Transport Committee can refer in general terms to "skills provision" and "HE excellence," the educational chain from primary schools to universities remains outside its jurisdiction. The Committee can hardly be blamed for that, but as we explain in Part 2 of this memorandum, educational issues are key not only for their own sake, but for the supply of scientists in research and development.

14. An Office of Science, headed by an independent scientist or engineer with a distinguished background in industrial or academic research, supported by dedicated civil servants, could ensure both that the best could be obtained from the devolution settlement for science and that scientific policy issues within Wales were coordinated effectively. There would be no need to copy the Westminster model. The Scottish

Parliament, for example, has appointed a Chief Scientist who is in effect the Chair of a panel of experts that provide timely and authoritative advice on issues such as science education and the use of scientific advice in policy-making.

15. Figure 1 embodies the mismatch between good intentions and overall performance in science policies in Wales. The data show the changes in investment in research and development to inform policy-making since 1999 in Wales and in England. The positive aspect is that investment in Wales has risen by two thirds since 1999, while in England it is actually marginally lower now than it was in 1999. The negative aspect is that the absolute level of investment is Wales is still only about three quarters as great as in England.

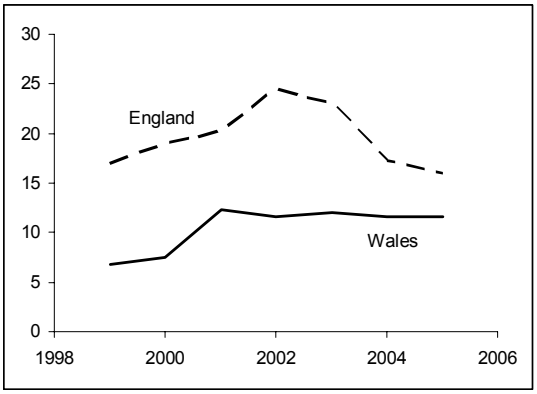

Figure 1. Investment in research and development via the civil ministries in England and via the Welsh Assembly (and formerly the Welsh Office) in £ per head of the population per year [Source SET Statistics, Table 3.2, http://www.ost.gov.uk/setstats/3/t3_2.htm].

Unless Wales creates a post of an independent Chief Scientist, with an Office of Science & Engineering that acts as a focus for scientific issues, and which has resources to back up his or her work, it will continue to underperform in terms of science policy.

Part 2 The chain of scientific education in Wales

16. A good system of science education is essential to all aspects of a science policy. We cannot have a skilled workforce, word class researchers or technological entrepreneurs if children and young people are not exposed to science in a positive and meaningful way from primary school upwards.

17. Although this area is not strictly within the remit of the Committee's inquiry, it cannot be ignored in reviewing overall science policy. There are many problems with the educational systems throughout the UK, which is why the current Prime Minister was so keen to assure the electorate of his focus on 'education, education, education'. Many of those problems are not unique to the UK, and certainly not to Wales, but in a globally competitive economy, Wales must strive to be ahead of the game, and its traditional emphasis on education should leave it well placed to lead the way.

Primary school level

18. Most primary school teachers are not trained scientists (for example, 47% across the UK have no physics qualification of any kind). Partly as a consequence, they lack confidence in their own ability to engage children with scientific topics. Only about half of primary school teachers say they have 'a lot of confidence' in teaching

science, appreciably lower than the two thirds who are self-assured in teaching English[vi].

19. Moreover, some aspects of primary-level science may be worse in Wales than in England. For example, a very recent survey shows that while only 50% of primary school teachers in England and in Scotland believe they have 'good resources' for teaching science, in Wales the figure was even lower at 42%[vii]. A third of primary science teachers lack the confidence to relate scientific material to everyday life. More needs to be done to support science at primary school level if young people are to be given the best start in contributing to science-driven economy of the present and the future.

Secondary school level

20. Across the UK, the single biggest problem with secondary school science is the shortage of qualified science and mathematics teachers. In mathematics alone, even if 40% of all British mathematics graduates were to become teachers for each of the next few years, there would still be barely enough to provide a good mathematical education for all pupils[viii].

21. Two-thirds of those who teach physics to 15- and 16- year olds do not have a degree in physics, and one third do not even have the equivalent on an A-level[ix]. One in ten of the people who teach chemistry to students between the ages of 11 and 18 do not have any qualification in chemistry. Nine per cent of biology teachers have no biology qualification[x]. Only 64% of secondary school lessons in general or combined science are taught by people who claim to have a degree in the subject. 74% of biology lessons, 78% of chemistry lessons and 72% of physics lessons are taught by people with a relevant degree, but these figures include teachers with general science degrees[xi].

22. We have insufficient hard evidence to say whether these figures fully represent the picture in Wales, but it is certainly the case that a rising proportion of unfilled teaching vacancies are in the sciences. In 1991, about one in every ten vacant teaching posts in Wales was in mathematics and by 2003, this had risen to about one in every six, an increase of 59%. In physics, the rise was 62%. By comparison, as a proportion of the total, unfilled jobs in music and Welsh fell by 41% and 22% respectively[xii].

23. Moreover, in preparing this memorandum, a clear message came from many interested parties in Wales that teacher recruitment in some subjects is uniquely difficult because of the need for people who are not only good teachers trained in their discipline, but who are also able to teach through the medium of Welsh. Since many children require science to be taught in Welsh, the Assembly will need to do even more to attract good teachers than will be required in England.

Recruiting more qualified science and mathematics teachers into Welsh secondary schools would have as large an effect on the overall strength of science and engineering in Wales than almost any other single change.

Further and Higher Education

24. Further education and vocational training are crucial parts of a technological economy. When CaSE consulted lecturers in further education colleges, we found some truly shocking problems[xiii]. For example, the burden of coursework marking

falls far too heavily on teachers and lecturers. They are required to mark coursework on behalf of the exam boards, but are not paid for doing so. Moreover, the exam boards remark papers in order to verify the teachers' assessments, rendering the teachers' work pointless anyway. Moreover, many of the teachers and lecturers are not properly trained in how to assess coursework, and in some cases the examining boards actually expect the teachers to pay for training.

25. Even more bizarrely, the ratios of public funding for students in different subjects in no way reflects the importance of those subjects or indeed the true costs of teaching them. Using figures for England, we established that colleges receive just 12% more funding for most science students than they do for humanities subjects, despite all the extra costs associated with laboratory and other practical work. But they receive 30% more for students of interior design, and even this is dwarfed by the 72% premium they receive for those studying floristry. We apologise that we have not been able to establish the precise official figures in Wales, but in consulting lecturers in Welsh colleges, it is plain that the broad pattern is the same. Funding for science and engineering students in Welsh colleges, relative to that for other disciplines, does not reflect either the actual cost of teaching these subjects or their importance to the economy. One lecturer reeled off a list of engineering departments in Welsh colleges that he believed were under threat of closure, at least in part because of underfunding.

26. This highlights a lack of strategic preparation in shaping the education system. Departments close because of local decisions based on current economic conditions, and in each case, colleges and universities make independent decisions based on their own financial and strategic constraints and objectives. But the overall effect - the sum of the individual decisions – may not add up to the educational landscape that is in the best interests of students or of the Welsh economy as a whole. This is yet another reason for a greater level of strategic coordination by an Office of Science in the Assembly headed by an independent academic or industrial scientist.

27. The industrial relevance of some vocational training (both in higher and further education) was brought into question by some of the groups to whom CaSE spoke in preparing this memorandum. For example, although the pharmaceutical industry requires people trained in pharmacy, the available courses tend to include relatively few opportunities for industrial placements. Some within the further educational sector felt that this problem could at least in part be laid at the door of industry itself, which failed to engage. While there is a world shortage of trained aerospace engineers, one important aerospace company had withdrawn from an apprenticeship scheme.

28. It is obvious that neither industrialists who criticise the colleges nor the educationalists who berate industry is entirely right. Whatever the causes of the friction, the Welsh economy would be better served if it could be overcome. The manner in which this might be achieved is far from clear, but it should be priority both for industry and for the education sector.

29. The introduction of the Welsh Baccalaureate is both an opportunity and a threat for science. CaSE has always supported a broader curriculum for post-16 education, thinking it bizarre that at that age, children have traditionally been asked to decide between specialising in science or cutting themselves off from science for the future.

A baccalaureate is demonstrably a good way of dealing with this; other countries, especially in Europe, have had such systems for decades.

30. There remain some concerns. First, in the initial stages, it is important that the Welsh Baccalaureate has credibility with employers and universities. We have heard of examples of students applying to universities in England being told that the institution will not recognise the Welsh Baccalaureate. This may be a teething problem, associated with the fact that the Baccalaureate does not yet have a track record. For the future, it will be essential to ensure that the Baccalaureate earns respect as a qualification with the same rigorous in-depth study of academic disciplines embodied in A-levels as well as giving the advantage of a more rounded education, including both some arts and some science subjects.

Funding university education

31. In terms of public investment in each university student, Wales has committed to maintaining a 'unit of resource' equal to that in England. By international standards, however, that investment per student is low, with Scotland, Denmark, the USA, Sweden, Australia, the Netherlands and Canada all investing more[xiv].

32. Moreover, after a great deal of bitter political wrangling, English universities will now be charging fees of £3000 per year for undergraduate students. The precise effect that this will have on the overall financial situation remains unclear, but it is obvious that English institutions will now be better funded than Welsh ones. We believe it to be obvious and universally-accepted that universities are massively underfunded at the moment, so do not provide a detailed analysis of the funding situation here.

33. It is perfectly possible for the Welsh Assembly to take the view that top-up fees are politically unacceptable in Wales, in which case it must decide whether it wants Welsh universities to be worse funded than those in England or whether it intends to find alternative sources of funding. If Welsh universities, however, are to continue to offer a world-class education, and to compete with the rest of the UK, let alone the rest of the world, it is essential that some positive steps must be taken to redress the funding imbalance that will be caused by the introduction of top-up fees in England.

34. This problem will not go away, is likely to get worse rather than better, and must be addressed immediately.

35. The funding of post-graduate students is also an area where policies decided in London may have unintended consequences that happen to be severe in Wales. For example, the Engineering and Physical Sciences Research Council has recently decided that it will only award Doctoral Training Accounts to departments that already receive more than a certain level of grant funding from the Council. This is supposed to ensure that only those departments that can be shown to be doing high quality research are in a position to use public money for training the next generation of researchers. But it hits particularly hard on small departments, or those in which research can be done cheaply and does not require large grants. The Department of Mathematics at Swansea University is a case in point. It was awarded a Grade 5 (the second highest) in the last Research Assessment Exercise and is so successful that, unlike most university science departments, it currently has a financial surplus. But the research in the department is of the kind that can be caricatured as requiring only a sharp pencil and some paper, so it does not tend to attract large research

grants like those that might be awarded to a chemistry department. The mathematics department at Swansea is likely to lose its doctoral training account despite manifestly being a highly suitable place to train mathematicians (of which the country cannot produce enough even to supply the teaching profession let alone the many other areas in which mathematics graduates can make a contribution)[xv].

Part 3 The research base and its interaction with business

36. As we have shown elsewhere[xvi], the Welsh science base has increased both its productivity and its quality faster than that in England in the past two decades. This analysis is encapsulated in Figure 2.

37. The numbers of scientific papers published from Welsh addresses has grown faster than the number from English addresses, particularly since the mid 1990s. At the same time, Welsh papers have gone from being cited only about three quarters as frequently as English ones to being cited at least as often. Because of the nature of the data and the difficulty of performing the analyses, these graphs are valuable for the trends they reveal rather than absolute figures.

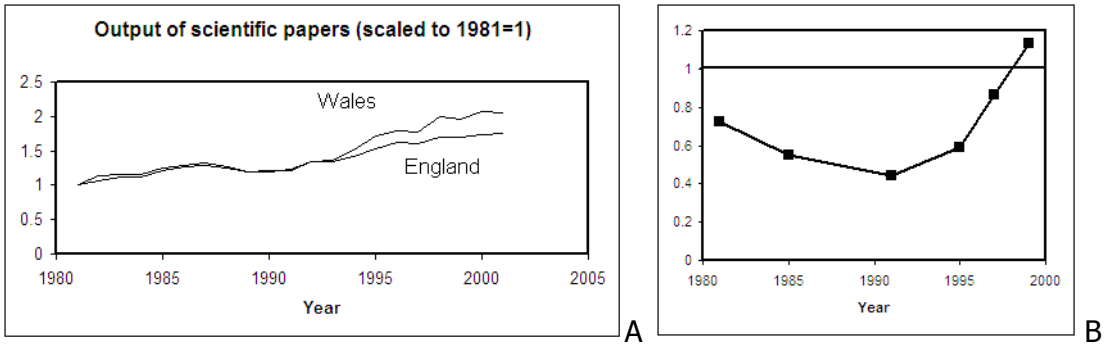

Figure 2. A. The number of scientific papers produced each year in England and Wales (scaled so that 1981=1). B. Average number of citations per paper for research papers published from Welsh and English addresses, relative to the number for English papers, scales so that English average is 1 for all years [Source ISI Web of Science].

38. This suggestion that Welsh science is now of equivalent quality to English science is confirmed by the fact that in the last Research Assessment Exercise, Welsh researchers gained higher average scores than those in the rest of the UK in ten out of the 21 scientific and engineering disciplines in which they made submissions. These subjects included civil engineering, pharmacy, earth sciences and physics. What is particularly healthy about this mix is the fact that it spans more applied and more theoretical subjects[xvii].

39. This is enormously important. Wales is a small country, and even if it invested in science at the highest levels shown by any country (about 3% of GDP in the USA, Japan and South Korea), it could not hope to carry out even half of one per cent of all the research in the world. In other words, it cannot do everything and cannot be active in all subjects. That is reflected in the fact that Welsh researchers were entered into about only 21 scientific subjects in the last Research Assessment Exercise, out of a total of more than 30 possible such disciplines.

40. A strong emphasis in our consultation with scientists in Wales is the contraction of the number of departments undertaking research in core scientific disciplines in Wales. For example, physics has gone from Bangor and chemistry from Aberystwyth. It would be a perfectly justifiable argument to say that Wales can only

afford one university, and to divert the vast majority of resources to Cardiff. CaSE disagrees with this assessment, but recognises its intellectual value. But if that is what the elected Assembly wants, it should do it properly, not by default and the slow attrition of science and mathematics outside Cardiff.

41. In deciding what Wales can achieve, it is a bad idea to try to predict what will produce the most exciting scientific results or the most economically valuable pay offs. By far the strongest complaint from CaSE's members in Wales is that too much funding comes ring-fenced for areas that are politically fashionable, leaving it relatively hard to obtain funding for areas that the scientific community knows to have exciting seams to be mined at the moment, but which happen not to have caught the attention of politicians.

42. So, while politicians tend (rightly) to stress the importance of interdisciplinary research, many in the scientific community feel that they do not always appreciate what is necessary to sustain the strong disciplines that underpin such work. Most difficult of all is to ensure that a nation continues to support a broad base of 'blue-sky' research, with no obvious future or immediate application, but such work is important for a number of reasons. First, it is the seed corn from which future applications grow, and second, since we cannot predict what field will generate the next important breakthrough, it is important to retain expertise across as broad a range of basic disciplines as possible.

43. Deciding what science to fund will always be a competitive game, and where the money comes from the taxpayer, politicians are entitled to take a strategic interest in what is being done with it. By far the most important lesson politicians can learn, however, is that, on average, they will never make as good a job as the scientific community. The scientific community is a worldwide network, and in assessing or peer reviewing applications for funding, it may prove difficult for a small, closely-defined network (such as researchers in Wales) to find enough suitable experts. If the Assembly creates new pots of funding (as it has with WORD, the Welsh Organisation of Research and Development), which are available only to researchers in Wales, then incentives will need to be given appropriately to encourage the best external reviewers to assist in deciding allocations.

<u>Levels of public funding for university research</u>

44. Although the quality of science in Wales remains high, as Table 1 shows, investment in the Welsh science base is lower than it is in other parts of the UK

	Annual investment per head via the Higher Education Funding Councils	Annual investment per head via the Research Councils
Scotland	£36	£51
England	£29	£45
Wales	£28	£10

Table 1. Investment in the science and engineering research base in the constituent parts of the mainland Britain [Sources: *Forward Look: Government Funded Science, Engineering and Technology,* OST, 2003 and *Hansard* [House of Commons] 12 June 2000.

45. The biggest difference between Wales and rest of the UK is that although Wales has about 4.9% of the total population, it receives only about 1% of the Research Council investment in science. Partly that is because Wales lacks the number of

research institutes that operate in England and Scotland. This is unlikely to change in the near future (the Research Councils are not in the business of establishing new, expensive institutes). Part of the difference, however, comes from the fact that the base from which scientists apply – the base provided by funding from the Higher Education Funding Councils – is lower in Wales than elsewhere. Indeed, it is barely more than 75% of the Scottish level. Even though the difference with England looks small, if Welsh investment reached the English level, there would be some £3 million extra in the system annually, equivalent to about £2,800 per year for every researcher in a science or engineering subject entered into the 2001 Research Assessment Exercise. Scottish levels of investment would provide more than £20,000 extra research funding per researcher per year[xviii].

Unless science in Wales is to be funded at higher levels than at present, it is difficult to see how the country will be able to compete in the fiercely competitive global economy of the coming decades.

Economic exploitation of research

46. The reason why scientific research can expect the higher level of funding it receives than other areas, such as the arts, is that its results feed more strongly into economic growth.

47. The ways in which it does so depend on a whole raft of policies that are outside the control of the Assembly (such as the way in which university spin-out companies are taxed), but there are certainly areas in which Wales could take a lead.

48. A good deal of money has in recent years gone into a variety of streams through the Development Agencies and others aimed at improving links between universities and business, and at stimulating growth in small innovative companies, many of which spring from the university research base. In Wales, the obvious example is the Knowledge Exploitation Fund.

49. The strategic coordination and direction of these funds is rarely examined critically. For example, much of the money, under the name of 'third leg' funding, is given in various forms to the universities (teaching and research are the first and second legs) with the aim of pushing their research results towards exploitation in industry. But there is no particular reason to suppose that those university researchers interested in obtaining this money are the ones whose results are actually of relevance to challenges that happen to be facing business and industry at the moment. Moreover, since small companies typically have little in the way of spare resources, without financial support they cannot necessarily spare the staff time needed to engage effectively with a university.

50. Almost everyone to whom we have spoken agrees that policies would be more effective if they concentrated more on generating industry 'pull' rather than university 'push'. Experience tends to show that placing an industrial scientist in an academic laboratory generally produces better results (in terms of knowledge transfer between the public and private sector) than placing academic scientists in industrial laboratories. Thus, 'third leg' funding might be better channelled through the companies rather than through the universities.

51. In this way, a small company may be able to finance the staff time needed to talk to a group of researchers for a day or two at an early planning stage, rather

than money being spent on a project which cannot succeed because the such early planning has not happened.

Private sector investment in research and development

52. Wales has the opportunity to reverse the flaws in 'third leg' funding, for example, through the Welsh Development Agency, but its small size might mean that it could also be more flexible than England in attracting private-sector investment. For example, one of the reasons that the pharmaceutical industry is keen to invest in the UK is that the National Health Service provides a unique resources of millions of linked records, with which it would be possible to conduct powerful research. It might be possible, for instance, to conduct a retrospective trial of different drugs, using fully anonymised records to compare patients whose GPs adopted different prescribing regimes. This will only be possible once patients' data are fully entered into the new NHS database, and if Wales wants to be at the forefront of attracting pharmaceutical investment, it will want to keep ahead of England in doing this.

53. Figure 3 shows how Wales's share of the UK's research and development has risen in the recent years, but remains at less than half the level that would be expected for given that almost 5% of the UK's population lives in wales.

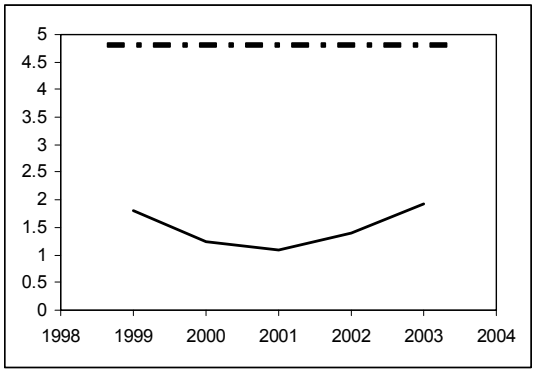

Figure 3. Percentage of the UK's industrial investment in research and development that is spent in Wales (solid line) compared with the proportion of the overall population (4.9%) resident in Wales [Sources: Office for National Statistics *Business Enterprise Research and Development Survey*, Office for National Statistics *Population Estimates*].

54. These figures are reflected in the analyses we carried out at the time of the last Assembly elections in 2003[xix]. Of the 24 Welsh companies then listed on the London Stock Exchange, only one invested enough to appear in the official *R&D Scoreboard*[xx]. In other words, although it has almost 5% of the UK's population, Wales has only 0.3% of the most research-intensive companies.

55. In its document *Wales for Innovation*, the Welsh Assembly Government set a target that industry should invest 1% of the national product in research and development, up from about 0.6%. In the long term, this is not ambitious enough; the most productive economies in the world already invest much more than this.

The admirable public policy aim of universities more with business is failing to achieve its full potential because it tends to be geared towards finding commercial uses for existing university research rather than finding solutions to existing industrial challenges. Wales need to appreciate opportunities for to attract scientific investment at an early

stage in order to take advantage of the flexibility that its relatively small size can bring.

Part 4 The overall perception of science in Wales

56. Among the many interested parties CaSE consulted in preparing this memorandum, a strong theme has been about the overall perception and awareness of science in Wales. Wales has an enviable tradition of celebrating its poetic, musical and other artistic achievements. The unique tradition of eisteddfodau at local and national level is both loved in Wales and admired by others.

57. But there is very little celebration of Wales's scientific achievement. In fact, Wales has produced some truly impressive scientists and engineers, from the thinking of Robert Recorde, who invented in the 'equals' sign (=) in Pembrokeshire in the sixteenth century, to the practical attainment of Monmouth-born Henry Royce as one of the founders of Rolls-Royce. As Part 3 of this memorandum shows, Wales has an impressive scientific present.

58. Children in Newport, however, are barely taught about the contribution of Alfred Russel Wallace, the man who put forward the theory of evolution by natural selection simultaneously with Charles Darwin, although he spent much of his life in nearby Usk.

59. Politicians cannot make the people of Wales value their scientific past and present as much as they love their language, literature and music. But they can show leadership in the way science is dealt with. With this in mind, the debacle over the lack of funding for the National Botanic Garden of Wales is a salutary lesson. The Botanic Garden is valuable for a range of scientific reasons, including the fact that it engages people with science in a way to which they can relate and the more practical and economically-relevant fact that studying plants has proved a reliable way of uncovering chemical compounds with novel uses, for example as drugs. The National Assembly of Wales, however, chose to see the Garden as commercial a tourist attraction, and treated it on that basis, while the Royal Botanic Gardens in England receive more than £16 million a year in funding for science-related activities[xxi]. The latest Quinquennial Review of the Royal Botanic Garden Kew[xxii] noted that grant-in-aid was essential to ensuring its core functions and the Royal Botanic Garden in Edinburgh has received a major boost to its wide-ranging scientific, horticultural and visitor initiatives, with the news that the Scottish Executive will enhance its annual financial support by £1.7 million over the next three years[xxiii].

If the National Assembly as a whole were to demonstrate a better appreciation of scientific endeavour in Wales both in institutions which are obviously scientific and those where the science is less obvious, it would show leadership for the rest of the country to appreciate more fully its scientific heritage, current research and future potential.

Notes and References

[i] e..g. *Hansard* [House of Commons] 20 January 2003, column 311.

[ii] *Report of the BSE Inquiry,* Volume 9, The Stationery Office, 2000.

[iii] *Interim response to the Report of the BSE Inquiry,* HM Government and the Devolved Administrations, 2001.

[iv] *Foot and Mouth Disease: 'Lessons to be Learned' Inquiry*, House of Commons, 2002.

[v] Email message to a member of CaSE, April 2004.
[vi] *A study into the professional views and needs of science teachers in primary and secondary schools in England,* Council for Science & Technology, 2000
[vii] *Primary Horizons: Starting out in science,* The Wellcome Trust, 2005.
[viii] *Making mathematics count,* Stationery Office, 2004
[ix] A *study into the professional views and needs of science teachers in primary and secondary schools in England,* Council for Science & Technology, 2000
[x] *Secondary schools curriculum and staffing survey,* DfES, 2003
[xi] DfES, Secondary Schools Curriculum and Staffing Survey [SFR 25/2003]
[xii] *Schools in Wales: General Statistics 2004,* Welsh Assembly, 2004.
[xiii] *Opinion Forum: Science and Engineering in Further Education*, CaSE, 2005
[xiv] *Education at a Glance, OECD Indicators,* OECD, 2002.
[xv] Information supplied by the Head of Department.
[xvi] *Science Policies for the Next Welsh Assembly: Agenda for the Next Welsh Assembly,* Save British Science, 2003.
[xvii] In Northern Ireland, the nearest comparison with Wales, scientists outperformed those in the rest of the UK primarily in applied subjects, such as various engineering subjects, nursing, food technology and agriculture, but in almost none of the subjects that also include more fundamental research, such as physics, chemistry, pure mathematics or biology.
[xviii] *2001 Research Assessment Exercise: The Outcome,* HEFCE 2001; science and engineering subjects are defined as Units of Assessment Numbered 1 to 33.
[xix] *Science Policies for the Next Welsh Assembly,* SBS, 2003.
[xx] *R&D Scoreboard 2002,* Department of Trade & Industry
[xxi] *Forward Look 2003: Government-funded science, engineering and technology,* Department of Trade & Industry, 2003.
[xxii] Quinquennial Review of the Royal Botanic Gardens Kew, DEFRA.
[xxiii] Scottish Executive Environment and Rural Affairs Department, Press Release, 14 April 2005.