

ECONOMIC DEVELOPMENT & TRANSPORT COMMITTEE

EDT(2) 14-05 (p3)

Date:	2 November 2005
Time:	9.00 am to 12.30 pm
Venue:	National Assembly for Wales, Cardiff Bay
Title:	Swansea University

Science Policy for Wales

Response from Swansea University to the invitation to comment on the Science Policy in Wales

0.1 Swansea University welcomes the decision of the Economic Development and Transport Committee of the National Assembly of Wales to consider a Science Policy for Wales. Furthermore, the University welcomes the opportunity to present its views and comments.

0.2 Swansea University is a research-led institution with a mission that clearly states that it wishes to enhance its status as a Centre of Excellence in research and scholarship and to enjoy international esteem for the quality of its work and also to facilitate regional economic growth to contribute towards wealth creation. As such, it has a great interest in a science policy for Wales.

0.3 The University is aware of its position to make a major contribution to the Welsh Assembly Government's Vision for Swansea Bay as 'An area of planned sustainable growth and environmental improvement, realising its potential, supported by integrated transport within the area and externally, and spreading prosperity to support the revitalisation of west Wales', as envisaged in the Wales Spatial Plan.

0.4 The University is already driving economic growth in the regional economy through such initiatives as Technium, the Institute for Life Science, the Institute of Advanced Telecommunications and

Aquaculture Wales. In addition it is active through the CETICs in linking with SMEs and has a successful track record in creating spin-outs. Its collaborative links with industry both within and outside Wales are impressive, and these links are directly benefiting the region. Underpinning all these activities is a firm base of science and engineering excellence that is essential and critical to knowledge transfer activities.

1. Introductory Comments

1.1 The notion of national government supporting scientific research and steering its strategic development has existed for a number of centuries. The political consensus necessary to build today's science and engineering enterprise was founded mainly by the needs and priorities of a nation. Clearly, a major priority for Wales is the need to ensure economic strength through continual technological innovation generated by the pursuit of scientific understanding and application of engineering solutions. Swansea University firmly believes that it has a major role to play in this endeavour.

1.2 The role of the private sector is just as important in maintaining the overall scientific and engineering enterprise as the role played by Government. It is essential that technology based industries operate in as conducive a manner as possible to advance science technology and hence promote economic growth.

1.3 Of critical importance is our system of education from the early age through to research at universities. Without doubt, this must be strengthened. Not only must we ensure that we continue to produce world-class scientists and engineers but we must also provide society with an adequate grounding in science and mathematics if we are to seize the opportunity to succeed in the technology based world.

1.4 It is interesting to consider America's background in science and its development into productive technology. Much of the Science Policy of the United States over the last 50 years has been based on the writings of Vannevar Bush. Bush implied a linear relationship between basic research and applied research and product development. This theory makes for an appealing simple policy prescription. Using this simple model the federal government has funded an increasing share of research in US universities. These universities, over time, have become centres of research excellence and the training grounds for future scientists and engineers. They have attracted industry and R&D investment and there are some spectacular examples of success.

1.5 In the March 2004 budget announcement, the Chancellor reiterated his commitment to science and innovation as key economic drivers and the need to ensure adequate funding levels. He committed to grow public investment in the science base faster than the trend rate of GDP growth over the next Spending Review period 2005/6 – 2007/8.

1.7 We believe it is essential to understand the workings of the overall scientific and technology enterprise. We have to understand that science is fundamentally an enquiry-driven process with curiosity

at its core. Technology is a product of scientific research and is often pursued out of necessity rather than curiosity. However, technological development requires no less resourcefulness and creativity in its pursuit than pure scientific research.

1.8 This difference between curiosity versus need must be understood if we are to put a science policy in place that will produce substantial benefits. It is often thought that basic research is performed by academic researchers in search of knowledge, and applied research is carried out by inventors or industry researchers in pursuit of new and better products. These are artificial distinctions, artificial barriers which must be removed if we are to have a truly scientific entrepreneurial culture.

1.9 The continued health of the scientific enterprise is a central component in reaching economic growth. There is no singular sweeping plan for doing this, it is clear that to keep and establish a healthy scientific base requires numerous actions and multiple steps in this highly complex enterprise.

1.10 Science, including an understanding of research, targeted basic research and mission directed research, must be given the opportunity to thrive as this is clearly a precursor to new and better understanding and is the basis of technological advances.

1.11 An additional role and responsibility for science is to help society make good decisions. It is envisaged that this role for science will take an ever-increasing importance, particularly as we face difficult decisions related to the environment and future energy requirements. It is essential that science maintains a solid relationship with society in general; after all, it is society that funds science.

1.12 Science, engineering and technology are not only the key drivers of a successful, knowledge-based economy but also contribute to the quality of life generally. The Strategy, therefore, must also seek to maximise the impact on other sectors such as business, health, education and community.

2. Generating the ideas and knowledge base

2.1 We must facilitate and encourage advances in fundamental research.

2.2 Investment in basic research involves a willingness to take risks for eventual gain.

2.3 New discoveries that will lead to important future breakthroughs are presently being researched. It may take 5, 20 or even 50 years before society derives the pay-offs from some of this research. Not even the greatest scientists can consistently pinpoint the most profitable directions for research or predict the implications of their own discoveries.

2.4 The issue of funding this basic research within Wales is a major challenge; however, it is worth noting the possible returns from such investment. In the United States a report from the Committee of Economic Development estimated a rate of return to private firms from investments in basic research at 20-30%. The Congressional Budget Office concluded that the public rate of return from research ranges

from 30-80%, and a study undertaken in 1992 indicated that nearly 50% of economic growth could be attributed to technological progress. Clearly, then, funding of basic research today would be a major determinant of future economic strength and growth.

2.5 We accept that industry cannot be expected to fund research that has no guarantee of practical applications, therefore, major funding for basic research must fall upon national governments.

2.6 It is, therefore, in the best interest of Wales to enable our scientists to continue to pursue fundamental ground-breaking research and they should be supported in these endeavours.

2.7 We therefore recommend that a stable and substantial funding stream for fundamental scientific research is given a high priority.

2.8 It is critical to stimulate innovation in basic research. If limited funding, and thus intense competition for grants, causes researchers to seek funding only for safe, that is, incremental research instead of research that challenges the status quo and pushes at the boundaries of conventional wisdom, then the research enterprise as a whole will suffer.

2.9 We recommend that the Welsh Assembly Government should consider allocating a certain fraction of grant funding specifically for the pursuit of particularly creative ground-breaking research.

2.10 The practice of science is becoming increasingly inter-disciplinary. Scientific progress in one discipline is often propelled by advances in other, often apparently unrelated, fields. Any science policy must recognise this, and it is important, therefore, that the government funds basic research in a broad spectrum of scientific disciplines and resists over-emphasis in particular areas.

2.11 It is essential that the Science Policy takes full account of research partnerships. Effective partnerships should be a mechanism for leveraging significant research investment from government. Partnerships should have a number of components. First, participants should have common goals and complementary skills, and should understand and accept the other's priorities. Second, the partnership must be based on a shared interest in the research that will be performed and provide each participant with meaningful results. Finally, participants must set explicit outcomes and procedures before collaboration begins. Trust and communication between partners is critical to success and must be cultivated.

2.12 A Science Policy for Wales should encourage and support major research universities within Wales that can help secure the flow of new scientific ideas that will, in time, contribute to the economic health of Wales.

3. The Private Sectors Role in the Scientific Enterprise

3.1 The most recent figures available indicate that the UK spends 1.8% of its GDP on research and

development, which places it behind Sweden, Finland, Iceland and Japan where expenditure exceeded 3%. In comparison, the USA spends 2.7% whilst Wales spends just 1.1%.

3.2 We must ensure that the discovery of new science is not allowed to stagnate. We must draw upon these new ideas continually and apply them to the development of new products or processes.

3.3 University industry partnerships are fundamental. Universities seek to lever research funds from government and companies look for opportunities to capture basic research results without building up expensive in-house research programmes. Partnerships between university researchers and industrial entities have become more prevalent and these are to be further encouraged.

3.4 There are significant challenges facing these types of partnerships. First, universities must not lose sight of their ultimate aim of teaching students and performing basic scientific and engineering enquiry. Universities should work synergistically with industry, they must not be industry. Unless universities retain their culture, based on fundamental research and educational mission, they will not have value to bring to the partnership.

3.5 In turn, the private sector, that partners universities, should not view their university partner as fully fledged substitutes for their own research programme.

3.6 The partnership between industry and university is a key issue for Wales. The Lambert Report provided some data which gives cause for concern. The involvement in Welsh-based industry in investment in universities is well below what can be reasonably expected.

3.7 For basic research to have an impact, it is necessary to have a private sector capable of translating scientific discoveries into products, advances and other developments, and must be an active participant in the overall science and technology enterprise.

3.8 We strongly support a Science Policy that encourages technology-based companies not to question whether research is important but to consider how much and what kind of research should they focus upon. We are concerned that many companies focus their efforts on technologies that are closest to being marketable and hence are likely to be profitable sooner, instead of on projects which will require a more substantial research investment, but that could have significant returns. A balance must be obtained.

3.9 There exists a strong correlation between the presence of major research universities and a flourishing technology enterprise within a given geographical area. Examples range from California, Silicon Valley, Massachusetts Route 128 and North Carolina's research triangle.

3.10 Inward investment is an obvious measure of a successful science policy and the ready availability of a skilled, graduate workforce is a key factor. Unless suitable high-quality jobs are available locally, these individuals will seek employment elsewhere and be lost to the Welsh economy. In addition, there

is also a requirement for skilled technical research support, of which the FE sector is a prime provider.

4. The Importance of Education

4.1 We must strengthen our education system to ensure that we not only produce scientists and engineers who are creative and can develop these ideas, but we must also produce technologically proficient workers and informed members of society who can draw upon the wealth of knowledge created through scientific discovery.

4.2 We must continuously and diligently nurture succeeding generations of people talented and dedicated in science technology and its development.

4.3 We are disappointed that young, able students domiciled in Wales cannot participate in the high-profile activities of the Gifted Children Academy recently set up, using UK government funds, at Warwick University. Is this not the type of initiative to which Wales should be participating? Is this not the sort of initiative that could be created within Wales?

4.4 So critical is the nurturing of young, able students, that should not the Science Policy for Wales address itself to the creation of new initiatives that we see elsewhere around the world? The United States has its JETS (Junior Engineering Technology Society) and FIRST (For Inspiration and Recognition of Science and Technology). Similar activities are on offer in other knowledge-based economies around the world, eg South Korea and Singapore.

4.5 We must ensure that for every scientist who makes a potentially useful discovery there is an individual in the private sector who recognises the significance of the finding and is able to act. People with the skills to link between the scientist and the market place are limited in their availability and this must be addressed through the science policy. For Wales, it is important that once a new product is ready for market, other workers are able to produce these goods, often in factories and in turn, these factories must themselves be driven by technology.

4.6 We wonder whether our present educational system from pre-school to research universities is currently up to this challenge. There is much work to do in this area, and we strongly recommend that the science policy addresses this fundamental issue.

4.7 Welsh HEI's have a reputation of producing high quality scientists and engineers, many go on to become high-profile researchers and managers and developers within industry. However, do our present curricula create the skills that provide the essential linkages between research, development, production and the market place? We look to the Science Policy to link with the education policy to provide the necessary impetus for change.

4.8 In a technology driven economy, jobs that require a scientific or technological background will gain increasing importance for our economy. We must ensure that we instil in younger generations the

motivation and desire to obtain those jobs as well as the fundamental schools and knowledge to be able to perform them. A Science Policy must address this issue.

4.9 The recruitment and retention of teachers who have the necessary skills, commitment and enthusiasm to science is critical. How can these teachers be given further insight and training into scientific research and technological development? Can the Welsh Assembly government, through its science policy, go further than the UK government and establish infrastructure where a dialogue can be achieved between teachers, researchers and technologists?

4.10 Courses on offer at higher education institutions should also be viewed from the point of view of attracting and retaining able students to pursue a career in scientific research and technological development. Demands placed particularly in engineering by the Engineering Council by accreditation bodies fill the curriculum with highly technical and relevant material. However, how much room is left for students to pursue creative projects that develop entrepreneurial skills where the possible outcome may be in question, and which, to a large extent, flies in the face of QAA speak and requirements?

4.11 Graduate education in the sciences and education must strike a careful balance between continuing to produce high quality premier scientists and engineers and offering enough flexibility so that students with other ambitions are not discouraged from leaving the profession and taking up jobs outside science and engineering.

5. The fractured nature of Science Policy within Wales

5.1 Research and innovation policies are based on visions of the future of science technology and society. Science policy for Wales must address what the Welsh vision is for the future of science technology and society within Wales. However, Wales cannot act alone.

5.2 How will the Science Policy take account of all relevant aspects of other national UK and EU policies?

5.3 Critical is how the Welsh Science Policy will complement existing science policies and the co-ordination of national research activities and policies which account for most of the research carried out and financed in Europe.

5.4 The Heads of States and governments of EU member States decided in Lisbon in March 2000 on a long term strategy to make the European Union by 2010 "the most competitive and dynamic knowledge-based economy in the world, capable of sustaining economic growth with more and better jobs and create a social cohesion."

5.5 The move towards a European Research Area is a key dimension of this ambitious strategy. Open co-ordination of national and EU research and innovation policies are on the agenda. The proposed Science Policy for Wales must address the role of Wales in this agenda. It must also address how Wales can

influence the agenda.

5.6 How will Wales and its Science Policy fit with the vision expressed in the concept of a European research area?

5.7 The idea of a European Research Area grew out of the realisation that research in Europe suffers from 3 weaknesses:

- insufficient funding
- lack of an environment to stimulate research and exploit results

and

- the fragmented nature of activities and the dispersal of resources.

Are these weaknesses also common to Wales?

5.8 How will the Science Policy contribute to the meeting of the targets set out by the Lisbon-European Council? (How will Wales meet the aim of achieving 3% of GDP investment in research and development by the year 2010?)

5.9 How will the Science Policy address the need for excellence recognised by the Barcelona-European Council in its call for European systems of education to become a world reference by 2010.

5.10 Will the Science Policy encourage Welsh HEIs to engage in the Bologna Process?

5.11 How will the Science Policy of Wales complement such UK-wide activities as Foresight? Foresight is aimed at horizon-scanning to provide a view on challenging visions of the future and to ensure effective strategies are in place to address them?

5.12 The ten year Science and Innovation Review by the UK Government outlines a broad range of investment and policy priorities including:

- world-class research at the UK's strongest centres of excellence;
- sustainable and financially-robust universities and public laboratories across the UK;
- a continuing step-change in the responsiveness of the research base to the needs of the economy and public services;
- increased research investment in R&D and increased business engagement in drawing on the UK science base for ideas and talent;
- a more responsive supply of science, technology, engineering and mathematical skills to the economy, and greater flexibility within schools and universities to attract the skills they need;
- confidence across UK society in scientific research and innovation applications.

Will the Science Policy complement these priorities?

5.13 Swansea University would like to see a more co-ordinated approach by Welsh industry in the investment and research in the HE sector. This may involve club funding of research in universities, sharing research output, including intellectual property.

5.14 There is a desperate need for a forum where higher education can discuss important issues on collaboration and partnership with business. The lack of willingness for business to participate in collaborative funding with HE is one of the big differences we see between R&D investment by industry in the UK and R&D investment by industry in the US.

5.15 For scientific researchers working within Wales, decisions about science policy are made in a number of different areas. We have Science Policy for Europe, we have a central UK government producing Science Policy documents. These are then reflected in the policy documents of, for example, government departments such as the Department of Trade and Industry and through the Office of Science and Technology to the UK Research Councils. These policies either at European or UK government level are translated into financial support. Researchers bid for funds within their area of expertise, but many are also opportunists who will successfully bid for research funds to ensure they receive external research income.

5.16 Given the present pressures on University researchers through their own institutions who, in turn, are subject to review such as the Research Assessment Exercise, it is critically important that researchers attract funding. Whether this funding then fits into a grand policy scheme is, to a large extent, irrelevant to many researchers.

5.17 This situation is further exacerbated for researchers in Wales. Do the priorities at a European level and UK-wide level and subsequently through the major research councils reflect the priorities and policies within Wales through the Welsh Assembly Government? There is an implicit assumption that this is the case. However, how well founded this assumption is, is open to considerable discussion and debate.

5.18 Here we see a significant role for the Welsh Development Agency. However, the Agency lacks a clear science policy. It is somewhat disappointing to find that on the WDA website, science and science policy is noticeable by its absence.

5.19 Regional science strategies have already been developed in England and Scotland by the various Regional Development Agencies. The absence of any such strategy for Wales is seen as a major obstacle to leveraging additional funding.

5.20 Given the resources of the WDA, it is critical that the Science Policy provides a clear steer for priority investment to support the science and technology enterprise.

5.21 Hence, it is important for any science policy for Wales to make clear links and connectivity between policy at a European and UK government level.

6. International Collaboration

6.1 Although science is believed by many to be a largely individual endeavour, it is, in fact, often a collaborative effort. Scientists often work without concern for international boundaries.

6.2 There are many reasons for entering into an international science collaboration. On the one hand there is the desire to compete with the very best in the world, on the other hand, there are opportunities to have access to large-scale science projects and expensive scientific equipment that cannot be provided locally. We look for a science policy for Wales that encourages international collaboration.

6.3 The Science Policy must also address the issue of increasing cooperation, stimulating competition and achieving a better allocation of resources within Wales.

6.4 The Science Policy must address the issue of free movement of knowledge, research and technology, not only within Wales and the UK, but within Europe and other leading knowledge-based countries.

6.5 How will the Science Policy promote international standards of research excellence.

7. Communicating Science

7.1 One of the ironies of our modern age is that although our society depends on the sciences more than ever before, what scientists do remains an enigma to most people. The language of science is virtually incomprehensible to the layman. If we are to maintain public appreciation and support for scientific enterprise, a way to translate the benefits and grandeur of science into the language of ordinary people is sorely needed.

7.2 A Science Policy for Wales must address the issue of how science is communicated to the public. It must also address the relationship between science, scientific advances and how these are reported in the media.

7.3 The Research Councils have recently begun to emphasise the public awareness of science. Funding is available for project-driven activity in this area. Are these activities having an impact in Wales? What is the public perception of science within Wales? How will the Science Policy address these issues?

7.4 It is disappointing to visit the website of the National Assembly of Wales and to find no reference to science policy.

7.5 Science and engineering provide more than the ideas for future products. They also provide the basis

for making decisions as a society, as corporations, as governments and as individuals. Science can inform issues and we welcome a science policy that puts this as a fundamental basis.

7.6 We would welcome proposals whereby science, science principles and the scientific procedure are used to inform the decision making process in the WAG and the Welsh Development Agency.

8. Resources

8.1 It is essential that the science policy looks to maximise efficiency of resources. A particular example with a strong base and high profile at Swansea University is that of Computational Science. The rapidly expanding field of computational science represents one area in which the resources necessary to undertake front-line research can be established in Wales. Scientific hypotheses are usually pursued and tested by experimentation, but there are some scientific questions of such large scale that they cannot be adequately broken down into testable components. Computational science is a potential solution to this dilemma. The future opportunities in making significant contribution in science will no doubt be linked to access of massive computational power now available in supercomputers. Such a resource can have a major impact in Wales' position in the scientific community and there is a significant opportunity to take a lead.

9. The Scale of the Research Challenge in Wales

9.1 Relative to England and Scotland, there is significantly less international quality research in Welsh Universities and Colleges. This is particularly serious within science and engineering, clearly the critical drivers for a knowledge based economy. The contrast with Scotland is dramatic with three and a half times the number of academics in top rated science and technology departments in Scotland after allowing for the different population sizes.

9.2 It is argued that this problem arises both from historic under performance of Welsh HE and the relatively low emphasis within the sector on science and technology. It is hoped that the science policy will look to adopt policies that will address this as a matter of urgency.

9.3 The HEFCW analysis of the last (2001) RAE results praised the progress made by Welsh institutions but was sober in its overall assessment: "Despite the encouraging rates of improvement, the overall weighted average rating for Wales (5.16) remains below that for the UK as a whole (5.42)." (HEFCW document W02/13HE, 26 February 2002)

9.4 The number of academic staff per million population is nearly identical in England and Wales, as is the number submitted to the RAE exercise. However, the figures for Scotland are about 40% higher. In other words, after allowing for the sizes of the populations in each of the countries, the higher education system in Scotland is about 40% larger than that in England or Wales.

9.5 An analysis of the number of staff working in RAE rated 5*/5 departments of science and

technology across Wales as compared with England and Scotland is of concern. England has more than twice as many academics working in top rated science and technology departments than Wales after allowing for population size. But Scotland manages three and a half times as many academics in top rated departments. Again, the discrepancy between England and Wales is not explained by the Oxbridge/London effect.

9.6 This is a difficult time to grow high quality research in Wales. Specifically:

- English HEI's have been given special earmarked funds for salary enhancements to attract and retain the best international scholars;
- RAE ratings have become increasingly influential in attracting research grants, overseas students and funding from the private sector; it is therefore difficult to attract the funding to grow the levels of activity in areas not already ranked as 5 or 5*;
- Decisions on any increase in core funding for research in Wales is conditional on delivering the challenging reconfiguration and collaboration agenda;

9.7 HEFCW has made a start with the research Capacity Development Fund. But substantial additional pump priming investment is required if Wales is to achieve a level of international quality research on a scale similar to England or Scotland. Growing research in science and technology is arguably the top priority because of the need to support the economic regeneration of Wales and compensate for the low levels of industrial R&D.

9.8 HEFCW should either receive additional funding to help build world-class science and engineering, or should be diverting resources to achieve this goal. This diversion may involve channelling resources from non-research active HEIs to those that have internationally recognised research profiles and who can be assured of adding value to economic development.

9.9 We look to the science policy to address these important issues and to ensure that those individuals who are part of the science and engineering enterprise in Wales are not operating in an environment that puts them at a disadvantage when compared with their competitors.

10. Developing a Strategy

10.1 The development of a Science Policy for Wales, will require the following issues to be discussed

- Where is Welsh science now?
- Where is Welsh science going?
- Where should Welsh science be going?
- How does Welsh science get there?

10.2 The Science Policy for Wales must:

- take account of central Government initiatives;
- interact with other relevant National Assembly initiatives e.g. the recent Knowledge Transfer Nexus Report;
- be long-term (10 – 20 years); and, most importantly,
- build on the particular international strengths in Wales and ensure that there is a sustainable and dynamic science and engineering base with sufficient investment to provide a high quality infrastructure and support for world-class scientists, engineers and technologists.

10.3 The Strategy, of necessity, will be a ‘living document’ and be subject to regular updating and review. If it is to succeed, however, all stakeholders must be involved from the outset to ensure understanding, ownership and partnership. Identification of the key partners will be an essential first step and the key players will include the WDA, National Assembly for Wales, the HE Sector, regional economic fora, DTI, CBI etc.

11. Current range of research and development carried out by Swansea University

11.1 We have chosen not to include a list of areas of current activity in science and engineering on the grounds that this would be a very lengthy and extensive submission. However, we would be delighted to submit details when this is required.

11.2 Further information can be obtained from our web site www.swansea.ac.uk .

11.3 The Swansea University ‘Directory of Expertise’ can be downloaded from the web site.

This response was compiled by Professor Nigel Weatherill Pro-Vice-Chancellor (Research) to which any questions or queries should be addressed.

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