Response to the Consultation Paper on the Successor to the Strategy for Science, Technology and Innovation

Dublin Institute for Advanced Studies

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Introduction

The Dublin Institute for Advanced Studies (DIAS) is a statutory body established in 1940 (under the Institute for Advanced Studies Act of that year, see http://www.irishstatutebook.ie/1940/en/act/pub/0013/index.html#zza13y1940) with the two-fold mission of pursuing research at the frontiers of knowledge and of training advanced students in methods of original research. It does this through constituent schools each of which has an independent Governing Board appointed by the Minister for Education and Skills. Currently there is one humanities school, the School of Celtic Studies, and two science schools, the School of Theoretical Physics which works at the interface between pure mathematics and theoretical physics, and the School of Cosmic Physics which works on non-laboratory physics including Geophysics, Astronomy, Astrophysics and Astroparticlephysics. The first Director of the School of Theoretical Physics was the Nobel laureate Erwin Schroedinger whose lectures on "What is Life", delivered during "the emergency", stimulated Crick and Watson's investigations of the structure of DNA and thus the explosion of modern molecular biology and medicine. Fundamental work on the formation of the North Atlantic by the Geophysics section of the School of Cosmic Physics led to the unexpected discovery that the Rockall basin is in fact part of the Irish continental shelf, with major implications for Ireland's economic exploitation rights under the law of the sea.

It is noteworthy that in establishing DIAS in 1940 the Oireachtas, under the leadership of Eamon de Valera, was clearly motivated by two principal considerations. Firstly, the reputational benefit to Ireland of recognising the strong Irish tradition in mathematical physics and science generally. It was important to demonstrate that Ireland was not just a backward agricultural economy, but was ready to take its place among the scientifically advanced nations. Secondly, and perhaps more importantly, there was an expectation that the Institute would act as a catalyst stimulating research in the universities and by providing a shared neutral space would encourage greater cooperation and resource sharing between the universities. While there was recognition that the work of the Institute might on occasion have direct economic impact, this was not a primary consideration in its establishment.

We believe that these values are still valid today. Ireland has been successfully marketing itself as a scientifically progressive nation which supports advanced research, but there is growing international awareness of the disquiet felt by Irish scientists about the excessively utilitarian implementation of the SSTI, as witnessed in the recent open letter to the Irish government signed by over 900 scientists, http://www.irishscientists.org. Unless this is convincingly redressed in the new strategy we risk significant international reputational damage. More seriously, we have deep concerns about the future strength of the Irish third level educational system unless there is a rebalancing of the policy mix in the new strategy to offer some support to all areas of research on the basis of intrinsic interest and excellence. In particular we worry about the future of pure mathematics, which underpins all of science, but which receives virtually no support at present, as well as our ability to attract and retain the best students into the physical sciences if we are not able to offer them courses on, for example, modern Particle physics and Astrophysics taught by active and engaged researchers. Anecdotal evidence points to a sharp drop in the number of students commencing PhD programmes in mathematics, and all Irish university physics departments now offer some level of astronomy as a means of attracting students.

A common misconception

It is widely believed that the HEA is the major funder of research in Ireland. This is partially true, but it is important to realise that the figure listed in the official statistics, for example in Table 1 on page 7 of the consultation document, represents simply a portion of the base salary of third level academics. Members of the academic staff in Universities are expected to spend roughly a third of their time on administration, a third on teaching, and a third on research. In this sense it is

perfectly correct to count one third of the pay budget as support for R&D, but this simply supports the academic to sit in an office with no students, no research group, and no laboratory or research facilities other than the library and internet access. It is not what is understood as research income in the universities and anyone who listed a third of his salary as such on an application for promotion would be the laughing-stock of his or her colleagues. The HEA contribution should be recognised and counted in the national R&D statistics, but it is not research income awarded on the basis of competitive grant applications and it properly falls outside the remit of this consultation.

Nevertheless there is a point to be made. The allocation, even if it is only nominal, of one third of an academic's salary is a significant investment that is intended to allow all academic staff to be research active. If the national research strategy does not properly support them with appropriate policy instruments, then this is an under-utilised national resource and involves an element of nugatory expenditure. Essentially we are employing highly qualified specialists, and then giving only some of them the tools they need to work. This naturally brings us to consider the relationship between research and education.

Public goods and the impact on Education

State support for any activity should result in the production of national public goods and scientific research is no exception. Another common misconception is that the primary public good resulting from scientific research is patentable technology and innovations. Of course our modern high-tech industries are built on scientific knowledge, but the connection is not as simple and linear as is often assumed. High-level scientific knowledge is a global public good, available to all, and a scientific break-through made in Ireland is as likely to lead to technological innovation in India as vice-versa. There is of course research that is close to market where intellectual property rights can be asserted, however this is not the case for most scientific research and arguably such research should in any case be funded by industry and not the state.

In our view the main public good resulting from support for research in a small and open economy is the human capital it produces. It does this in two main ways. Firstly, through its impact on the quality of our higher education system and our ability to attract and retain the best students. Secondly, in the case of big science, through the technological challenges it poses to industry. Similar conclusions were reached some time ago by A. J. Salter and B. R. Martin in 'The economic benefits of publicly funded basic research: a critical Review', Research Policy 30 (2001), 509–32. They identified six channels through which publicly funded academic research benefitted the British economy and concluded that the most important factors were those related to human capital and social networks. As the president of Stanford pointed out a few years ago in an address at the American Embassy in Dublin, by far the most effective form of tech transfer undertaken by universities is that each year they send the bulk of their fresh graduates out to work in industry. Of course, this presupposes that the students have been taught by research-active staff and understand both the content, and more importantly the methods, of cutting-edge research.

Thus the impact on education is very important. Young people are curious and idealistic. They want to study the big questions they have heard about from Brian Cox, Stephen Hawking and others. They will not be attracted into the hard sciences by the idea of making a better widget even if that is what most of them will end up doing. They want to learn about black holes and extra dimensions, about the origin of the universe and the ultimate constituents of matter. They rightly expect that they will be taught these topics by research-active lecturers who are contributing to their field. What they do not want is the tired regurgitation of out-of-date textbook material, exacerbated by under-resourced instruction in run-down and out of date facilities, and if this is all that they are offered they will go elsewhere, if necessary studying abroad to do so.

However if they are offered the chance to study some of the most difficult open questions in modern science, and to train their minds on such challenges while studying in Ireland, then we will produce a generation of graduates able to think for themselves, trained in the scientific method, and rooted in Ireland. They will bring these habits of mind to whatever jobs they take up after graduating to the benefit of Ireland. This will require the restoration of national support for curiosity driven research as well as access to "Big Science" facilities through membership of appropriate international research organisations such as the European Southern Observatory and CERN.

Although the focus in this submission and in the consultation is clearly on the natural sciences, we wish to observe that the humanities and the social sciences are also of great importance and need research support. Arguably the challenges faced by modern industry, particularly in the rapidly growing services sector, are as much in the user interface and human experience as in the hard technology, areas which require the analytic skills and specific expertise developed in the social sciences and the humanities.

There is a further factor which greatly amplifies the educational impact. For better or worse, a key question nowadays in academic appointments and promotions is one's track record in raising research income. If one works in a field which has very limited opportunities for grant funding, one is automatically disadvantaged in terms of career progression and peer respect. Thus it is not just that teaching in these fields loses contact with cutting-edge research; they become seen as dead-end career choices unable to attract competent and ambitious people. The funding crisis in the universities is further exacerbating this by placing a premium on the ability to generate research income.

In addition to the educational impact, advanced scientific research, especially the so-called big science projects, play an important role in improving industrial expertise by providing technically challenging contracts to Irish firms. This has been well documented in the case of the European Space Agency, and similar effects could be expected from membership of the European Southern Observatory and CERN, the European Laboratory for Particle Physics.

Basic science is just that, the base on which applied science is built. To attempt to build world-class centres of excellence in specific applied areas without such a base is like erecting a tall tower without proper foundations. It will inevitably fail. It is basic science that attracts the brightest minds, that yields the disruptive technological breakthroughs, and that brings the greatest intellectual and cultural rewards. All science is interconnected, often in surprising ways, and a weakening of any one part weakens the whole system, especially if it is in basic areas.

The case for and against Prioritisation

It is important to note that we are not opposed to a considerable level of prioritisation in research funding. It is perfectly proper for the state to decide that there are specific areas of research which it regards as of particular social, medical or economic importance and to prioritise there. However such prioritised funding must be balanced by support for excellent research across all academic disciplines (in the language of the SSTI "research for knowledge"). As argued above this is vital for the health of the higher education system, and ultimately for the viability of the prioritised research programme itself.

The argument is sometimes made that we cannot afford to fund everything, and that therefore we have to prioritise, but again this is a misconception. A well run competitive programme of small to medium sized research grants awarded on the basis of excellence is potentially open to everything, but in reality areas of strength will spontaneously emerge through natural selection. Good proposals do not normally come from nowhere. Clusters of excellence will emerge spontaneously as successful research groups expand in such an eco-system. Experience from

evolutionary biology and market economics shows that such bottom-up self-organising systems tend to be more agile and productive than top-down solutions imposed by committee.

In our view the optimal policy mix should complement prioritised funding in certain selected areas with such an open competitive funding scheme supporting in particular small to medium sized research projects across all disciplines. We point to the old Research Frontiers Programme as an example of such a scheme. While this only consumed about 7% of the SFI research budget it was of vital importance in supporting areas such as pure mathematics and astronomy. Such a scheme would naturally fit within the Irish Research Council's remit and we would strongly support an uplift in the IRC budget to allow it to play this role. An alternative would be to explicitly broaden the remit of SFI, however as the major public good resulting from such a programme is an improved higher educational system it seems logical that the programme should be administered by an agency under the aegis of the Department of Education and Skills.

Counterfactual considerations

Let us suppose that we continue with strict prioritisation for another decade, what will happen? Inevitably the higher education system will become highly distorted. The universities will find it impossible to recruit competent staff in areas such as pure mathematics, palaeontology, taxonomy, astronomy, particle physics, theoretical physics etc. Computer science departments will no longer be able to call on the expertise of pure mathematicians in teaching cryptography, geology departments will struggle to teach basic stratigraphy, in the life sciences we will have experts on molecular signalling, but no botanists or zoologists expert in the basics of the Linnean classification, and in physics we will have lost touch with all the exciting developments at the frontiers of knowledge. Our brightest students will travel abroad, many never to return, because they will see the intellectual poverty of our universities and the lack of promising careers for scientists in Ireland. Our universities will plummet in the world ranking tables and our once proud boast of having the best educated work-force in Europe will be exposed as a hollow lie.

Conclusions

1. There is an urgent need to rebalance Irish research policy if lasting damage is not to be inflicted on the higher educational system and the country's international reputation.

2. This rebalancing must complement prioritised funding of specific areas, identified on the basis of social, medical or economic grounds, with an excellence-based system open to all areas of research, including the humanities and the social sciences.

3. Participation in "Big Science" should be included in the mix and we refer to our separate submission on membership of international research organisations made to the CIRCA group consultants.

4. The Dublin Institute for Advanced Studies has championed the value of advanced fundamental research and scholarship for three quarters of a century and will continue to do so.

Specific Responses to Questions in the Consultation Paper

Pillar 1 - Investment in STI

- What should Ireland's ambition be in STI?

The main emphasis of STI investment in a small and open economy has to be on the development of human capital and skills through a research-active educational system and a technically challenged industrial sector. Scientific knowledge itself is very "leaky", but people are much less mobile.

- Ireland is currently an innovation follower and lags other small developed countries in R&D intensity. Should we have more ambitious targets for investment?

Yes of course. We should participate in "Big Science" projects which bring the immediate benefits of technically challenging contracts to Irish industry, have a proven positive impact on student attraction and retention into STEM areas, and improve Ireland's international reputation. This is well attested in the case of ESA and similar benefits would accrue from membership of ESO and CERN, or on a smaller scale LOFAR and CTA.

- How can that level of ambition be justified? Where would we target increased funding and how could this be justified?

Two complementary areas need to be funded - an excellence-based system similar to the European Research Council supporting small to medium-scale projects and open to all disciplines, and mechanisms to participate in "Big Science" though international partnerships. The justification is that this is essential to sustain a high-skills educational system and industrial base.

Pillar 2 - Prioritisation

- How can research prioritisation better serve our national objectives of a strong sustainable economy and a better society?

Priority areas need to be kept under constant review and care must be taken to match investment against the absorptive capacity of industry and society. More attention also needs to be paid to the need for investment in under-pinning basic science. Prioritisation must not mean that only the priority areas have any prospect of funding, or the educational system will become badly distorted to the ultimate detriment of the priority areas themselves.

- How best do we identify emerging areas of opportunity and challenge i.e. horizon scanning?

There is a pool of under-utilised expertise available in bodies such as the Dublin Institute for Advanced Studies and the Royal Irish Academy who would be pleased to help with such horizon scanning exercises on a pro bono basis.

Pillar 3 - Enterprise-level R&D

Industrial R&D policy is not an area where DIAS has any special competence, but we support the importance of enhanced interaction between the industrial and academic sectors and suggest that this is best done as the level of the individual researcher through exchange programmes and social networking events aimed at increasing mobility between academic and enterprise research groups.

Pillar 4 - International Collaboration

- How can we further increase/strengthen the effectiveness of our international collaboration and engagement across all areas of STI investment in pursuit of economic and societal goals?

There is a need for national funding agencies to support participation in medium-scale international projects below the level of inter-governmental treaty organisations. Such programmes are standard in most European countries and Ireland is quite anomalous in this regard. CTA and LOFAR, for example, only cost of order an SFI investigator award and should be decided at agency level. We would also recommend increased participation by research bodies in trade missions, as well as further harmonisation of taxation, pension and visa rules to enable greater international mobility of researchers into Ireland,

- What additional measures can be taken to maximise the engagement of industry as a partner in this regard?

Irish industry needs to be made aware of the contract possibilities opened up by membership of international research collaborations and encouraged to bid for them. The work of EI in the case of ESA shows how this can be done. The technical challenges of many of these contracts would lead to a valuable up-skilling of the workforce in successful bidders with in consequence a significant multiplier effect.

- What additional measures could be taken to enhance Ireland's participation in Horizon 2020 and other EU Programmes – industry, academia, SMEs and MNCs?

There is an urgent need to broaden the research base outside the priority areas to better align it with the objectives of Horizon 2020 (including the humanities and the social sciences which are important also for the services sector of the economy).

- Are there research policy or programme developments taking place at EU level where enhanced engagement by Ireland could provide opportunities for research collaboration and ultimate economic or societal benefit?

We wish to draw attention to the benefits accruing to Ireland from the technology transfer activities of the Irish Centre for High-End Computing (ICHEC) which DIAS helped establish. ICHEC represents Ireland within PRACE, the Partnership for Advanced Computation in Europe and Ireland benefits greatly from access through PRACE to Tier-0 supercomputing facilities. Advanced computing is a generic technology supporting a wide spectrum of research and with very significant industrial impact and we strongly support continued Irish membership of PRACE and enhanced participation in its activities.

Pillar 5 - Organisational arrangements

- What could we do to further enhance our landscape and institutional arrangements to maximise the impact of research excellence and deliver jobs?

The Dublin Institute for Advanced Studies (DIAS) occupies a unique position within the Irish Research landscape as the only statutory body charged with a pure research mission. It has a valuable role to play as a trusted discipline-neutral and institution-neutral partner to the rest of the system and an international ambassador for excellence in Irish science and scholarship. This role should be expanded and greater use made of the Institute as a show-case for excellence. We note that additional schools of the Institute can easily be established by simple statutory instrument in areas that the Government considers of particular importance. The international reputation of DIAS, established over three quarters of a century, and the association with such scientific greats

as Schroedinger, is an under-utilised national asset (we draw attention to the parallel with the Max-Planck Society in Germany).

- Is there a need for a complementary market focused research centre structure in Ireland and how should that be organised?

This is not an area that we have any specific expertise, but the Fraunhoffer Institutes in Germany offer an interesting example.

- How can Ireland optimise its strategic advantages of location, scale and environmental quality as a fundamental component of its research infrastructure?

We suggest that green-computing and the hosting of high-performance scientific computing services is an area where Ireland enjoys considerable advantages (cool climate with plenty of renewable energy). As noted above high performance computing is an essential under-pinning technology across a wide slew of scientific disciplines and also an area of great industrial relevance with considerable jobs potential. More generally Ireland is a natural location for "Green technologies" which will certainly be a major growth area in the future.

- How can we further increase/strengthen the effectiveness of our national collaboration and engagement across all areas of STI investment in pursuit of economic and societal goals?

More joined-up thinking is required. We need to break down disciplinary, institutional and departmental silos and look at the bigger national picture. DIAS has demonstrated its ability to do this in helping, inter alia, to establish ICHEC, and wishes to continue to be of service as a trusted neutral venue and enabler of national research collaborations.

Pillar 6 - IP regime

No comments as this is not an area of great relevance to DIAS.

Pillar 7 Government wide goals

- What steps need to be taken to further the translation of investments in STI into the achievement of stated public policy goals? How can the Strategy enable research programmes to optimally support policy development and actions to address key national challenges in areas such as environment, health, etc.

We suggest that greater involvement of civic society through professional associations, the Royal Irish Academy, IBEC and similar bodies in monitoring, developing, implementing and discussing the SSTI would help.

- What are the synergies between Government's goals in building a better society and the goal of creating jobs and economic growth?

Economic well-being is a sine qua non for societal well-being, but it is important that the Government's aim is to build a better society and not just a more productive economy. Economic growth is not an end in itself, but a means to supporting the whole range of social and cultural activities that give meaning to life. Science is of course one of these.

- How can we address national challenges and also provide economic opportunities through development of new products, processes, systems?

This can only be done by supporting an excellent and research-informed educational system which teaches our young people to think critically and have the mental agility to seize opportunities as they arise.

- How can we address local and national challenges that are also regional and global challenges - how can Ireland through its research turn national challenges into global opportunities in areas such as sustainable land use, urban and rural development, and vulnerabilities to global trends and changes?

We need a strong and deep research-base integrating the human sciences and the natural sciences. These global challenges, as ICSU has recognised in its Future Earth programme, require inputs from the social sciences, the humanities and the natural sciences for their understanding and solution. Ultimately the problems are caused by humans, and we need to understand not just the science, but the historical evidence and the factors that motivate people.

- How can Ireland harness the opportunities presented by the major developments on observation systems, including the analysis and use of Earth Observation data by a wide array of sectors and users?

We refer to the comments above about the potential of Ireland as a natural location for green-computing centres and data stores. Ireland is well-placed to become a major centre for data science and advanced computing.

Pillar 8 Research for knowledge and Human Capital

- What more can we do to best harness the potential of our knowledge base for sustainable economic and social well-being?

We need to be more open to new and unusual ideas. The danger of prioritisation is that one ends up betting on the favourites, which everyone else is also backing, and misses the long-shot winner. The current system is too inflexible.

- What additional steps can government take to ensure the development of human capital across the population to ensure the success of the new Strategy?

Maintaining and enhancing the quality of the educational experience at all levels (including life-long learning) must be a priority. The system should be appropriately differentiated and access should be strictly on the basis of merit and potential to minimise the misallocation of expensive resources.

- How can we ensure that the requisite links between research and scholarship are maintained across all RPOs?

Peer review and benchmarking against comparable international bodies.

- In order to achieve a sustainable research capacity, are the outputs of our research system at doctoral and postdoctoral level the right ones in terms of volume, quality and relevant discipline?

The system is in danger of overproducing specialists in the priority areas and not enough in other important areas of under-pinning science. Anecdotal evidence points to a sharp drop in the number of students commencing PhDs in pure mathematics for example, and pure mathematics underpins all of science.

- How can the new Strategy support and strengthen the reforms taking place under the Higher Education Strategy and align with the new National Skills Strategy and develop capacity to enable Ireland to deal with new and emerging challenges across the full breadth of government strategies?

By supporting more curiosity-driven research and access to big science.

- How can we better leverage our research talent into the economy? How can those individuals active in research (and those seeking to be), both in the public and private sectors, be best supported to perform and progress including through optimum researchers' careers, recognition and mobility mechanisms.

We need to develop proper research career pathways and structures, with realistic expectations at each level. In particular (and anticipating the next question) we are under-utilising our female talent pool. The third level employment framework is currently very rigid and consideration could be given to something along the lines of the US system where it is possible for researchers to self-fund their salaries as part of grant proposals.

- How can gender equality in publicly funded research activity be further enhanced?

We need to recognise and counter hidden and unconscious gender-biases in appointments, perhaps by appropriate training of selection panels, and by making sure that job openings are appropriately advertised.

- How can the Action Plan for Jobs 2015 objective to increase the number of researchers in enterprise be fulfilled?

The only mechanism that is likely to have much direct effect is the fiscal one of tax concessions for R&D active industry. However mechanisms to facilitate increased contact between academic researchers and industry, perhaps through secondments or funded industrial sabbaticals, would also be helpful. IBEC and other bodies should be consulted on this.

- Should research and innovation performers be supported to engage citizens more actively in the innovation process to achieve optimal outreach to the public?

Yes! A scientifically informed and sophisticated electorate is essential in a democracy if innovations are not to meet irrational objections (eg the debates around genetically modified organisms, energy policy etc).