Evidence for the Science & Innovation Strategy

University of Southampton

Name and role of respondent:	**Judith Petts, Pro Vice-Chancellor (Research & Innovation)**
Name of institution:	**University of Southampton**

For each of the areas below, detail your views and any potential sources of evidence. Please also indicate if you consider that your institution may be able to provide a case study to demonstrate your argument.

Benchmarking the UK

- What are the key challenges the UK needs to address to maintain and develop a globally leading science and innovation system?
- What indicators could be used to measure UK performance by 2020?

The UK has benefited from consistent investment and relative stability in science and innovation over the past two decades. The challenge is to maintain that long term stability but at the same time ensure that the system as a whole remains responsive to change.

The key to the UK's strength in science and innovation is a strong university base. Research intensive universities in the UK carry out research right across the spectrum from blue-skies to near-market, and many major companies work with UK universities to conduct industry focused research, either instead of or in collaboration with their own research laboratories. Rolls Royce, for example, maintains a network of University Technology Centres across the UK, two of which are located in the University of Southampton. This places research intensive universities at the centre of the science and innovation system in the UK providing an infrastructure which is not often replicated in other countries.

Science and innovation will continue to be a mix of collaboration and competition. The environment is increasingly competitive as many of the larger emerging countries have domestic capabilities which match those of more developed economies. Furthermore these emerging companies are continuing to invest heavily and therefore the need for continued invest by the UK is growing in importance.

Investment by other countries also provides opportunities for the UK – and the Universities are well placed to build on international collaborations. To take advantage of these international opportunities, the UK must operate a welcoming visa regime for students and academic staff, and there is an urgent need to rebuild the UK's reputation in this area. The UK also needs to be able to move swiftly on matching international research opportunities, and recognise that many emerging economies fund their research in a much more strategic top-down way. The newly announced Newton Fund may prove to be a good model but the method of award needs to be agile, and the Government needs to be strategic in its use, so that it meets the needs of both participating countries.

A sustainable research and innovation science base is expensive and a key challenge is therefore to ensure that this investment of public money is efficient. The data show that the UK is most effective country in the world for take up of research publication per GBP of investment, with 6% of research papers and 16% of the most highly cited papers on the basis of only 3% of global funding for research. Furthermore, the efficiency review of UK Universities led by Professor Ian Diamond UK identified many areas where there is scope for universities to increase the efficiency of their research operations. These have largely been adopted by the sector and realised real savings whilst maximising the outputs from the science base and budgets. In the recent report on the contribution of universities to the UK economy (3 April 2014) the data showed that Higher Education:

- contributed 2.8% of UK GDP
- generated 2.7% of all UK employment and for every 100 jobs at universities, 117 were generated in other sectors of the economy
- generated an estimated £10.7 billion of export earnings for the UK.

Universities in particular generate more GDP per unit of expenditure than many other sectors including health and construction.

A growing recent trend has been to increase collaboration between universities, and the Government should promote such co-operation with a view to actively tackling barriers which hinder collaboration. The Science and Engineering South Consortium (SES) brings together the Universities of Cambridge, Oxford and Southampton together with Imperial College and University College London. This cluster of research intensive universities is the most powerful in the UK with a combined annual research spend of more than £1.3billion. The Consortium works to optimise shared infrastructure and training to stimulate further international, national and regional synergy. The Consortium shares major facilities for research in the physical sciences, biosciences and engineering and in High Performance Computing to achieve greater efficient use of the science infrastructure.

Nonetheless, efficiency can only take you so far. The UK does extremely well in science despite the fact that it invests significantly less in GDP terms than its key competitors, and is well below the G7 and OECD average. If a competitive knowledge-driven economy is to be sustained, the total investment (public plus private) in R&D in the UK needs to rise. In part the investment is needed to create an environment where private investment in R&D is more attractive and increases.

Indicators to measure UK performance by 2020

The performance of the science base is already assessed against a number of metrics which are reported annually to BIS. Taken collectively these metrics help to provide a holistic view of the impact of research and innovation on the UK social and economic environment, but they are not perfect and serve to provide only a high-level view of the UK's performance. The Government may wish to consider metrics based on world university rankings but the subjective nature of the underlying data means and consequent variations in performance of UK universities year on year mean that this is less reliable measure.

Infrastructure

- The Department of Business, Innovation and Skills' consultation on proposals for long-term capital investment invites evidence to be submitted in this area. To complement that consultation, we invite any further views relating to science and innovation infrastructure that are not covered by the Department's consultation; for example, how could we make the most of existing research and technology organisations and their infrastructure, in both the public and private sectors, to strengthen science capability and support for businesses?

High-quality research infrastructure within universities is essential for:

(i) undertaking and sustaining the world-leading UK research base;
(ii) promoting the development of novel facilities and instruments;
(iii) attracting and retaining internationally excellent researchers;
(iv) ensuring appropriate preparatory research in advance of using national and international facilities;
(v) training and maintaining the pipeline of research skills;
(vi) supporting partnerships and sharing between leading institutions not least to

enrich major and strategic research collaborations;

(vii) enabling innovation through SME and industrial as well as NHS Hospital Trust access to both leading facilities **and** skilled researchers and consultants, and

(viii) supporting and enriching research-led education and training, engaging students in the intellectual challenges of research and successfully delivering excellent graduates into the UK economy.

The UK science base must ensure the right balance between recurrent investment and investment in scientific capital. The introduction of RPIF has been an important new tool for this. It clearly works particularly well when the university already has an industrial partner and the requisite planning permission. The University of Southampton, for example, currently has the largest University-business collaborative project with the construction of a £140M joint engineering campus in collaboration with Lloyd's Register, which the company's global research headquarters and 400 staff transfer to our campus. RPIF was crucial in the construction of a new £20M experimental facility as part of this new campus.

Research capability and impact

- In what key ways do the strategic principles informing UK science and innovation (such as dual support and autonomy) support the system?
- What factors are important in ensuring we have the right balance of different types of research (for example basic research, experimental research, and research directed towards application)?
- How could we further the progress already made on maximising the impact of research?
- Which models, and characteristics of models, of government support to catalyse innovation, knowledge exchange and impact work best? In what context or contexts?

In any research funding regime, a mix of stability and flexibility is necessary. Stability to allow long term investments to be planned and implemented against strategic imperatives (not just in infrastructure, but in human capital as well), and large, long term, multi-partner research investigations can be started in the knowledge that they are likely to be completed. Flexibility so that the researchers can identify new problems and issues and refocus efforts where necessary.

In the main the UK funding system does this well. Research Councils have become more strategic over the 20 years since Realising Our Potential, and have progressively introduced mechanisms for more directed research; for interdisciplinary and cross-Council programmes and for large equipment. However, they retain the principles of peer review, funding excellent science, and of retaining a significant element of responsive mode funding which allows the researchers closest to the field to determine the priorities for new work. As a result the Research Councils now have a significant strategic role in shaping the science base which has grown progressively over the years. This is a role the Research Councils operate extremely effectively and are aware of the need to manage issues at their boundaries sensitively.

Although QR funding has declined in recent years, this remains vital to maintaining innovation in the science base. If a University is going to move into a new area, or build collaborations with others which in time will lead to major research grants, or develop interdisciplinary research structures, it needs some undirected resource to do that – and the University of Southampton has used funding through QR for all of these. Without this flexibility universities would not be able to pursue new opportunities in such an unfettered way and that would impact negatively on the competitiveness of the UK.

QR funding is currently determined through the REF exercise and places a significant

bureaucratic burden on the academic community. However, REF has a global reputation for improving research quality in UK universities. In some countries, long term continual investment without such a demand to demonstrate quality can lead to long term stagnation and complacency. We would however support efforts to move to a more streamlined system for the REF, perhaps by greater use of metrics. Metrics-based assessment is closely aligned to previous RAE results for many disciplines. Separate arrangements may be needed for those disciplines where metrics are not a good match.

Universities have extensive partnerships with industry and also with the public sector. The largest area of interaction is with the NHS, where leading research universities have partnerships with hospital trusts to deliver research, education and patient care. These partnerships work in an integrated way in terms of staff, students, capital and equipment. Universities are also a primary supplier of research for Government Departments.

One area where the UK could fine-tune its research funding structures is in respect of research institutes. There are a number of different models for institutes with ownership ranging across Research Councils, Government Departments, charities and universities, often in combination with each other. Institutes are particularly valuable where a significant proportion of their work is in specialist non-research activities on behalf of the UK research community and the country more generally. This includes, for example, curation of large numbers of physical samples or managing very large expensive facilities. They also play a role where the UK has a need for research, often over the long term, which is strategically important but not necessarily cutting edge. Some of these institutes are maintained by a university, on behalf of the community as a whole. For example, the University of Southampton hosts of EPSRC's National X-ray Crystallography Service.

We believe that the move to institutes being run as a separate legal entity is probably inevitable, but that it does lead to issues, for example how research funders balance investment in their own institutes versus investment in universities and other research providers. Given the strength of UK universities, we believe that all research institutes should have strong links with one or more universities. We are also concerned about recent trends to establish new, large, physical research centres separate to universities. We believe that research institutes whose primary role is cutting edge research should be located within one or more universities, for a number of reasons:

- The ability to draw on the wider range of university expertise, structures and facilities
- The ability work across disciplinary boundaries
- The stability of a larger environment

Government Support to catalyse innovation knowledge exchange and impact

It is worth bearing in mind that the needs of small and large companies are quite different.

Compared with some of our competitor countries, the UK has a less developed tradition of venture capital investment, and this weakens the country's ability to focus on the most promising technological ideas and see them commercialised. Incentivising this is a significant challenge for the Government but would make a major difference to commercialising the world-leading research which is being carried out.

The University is a partner in the very successful SETsquared consortium which has been named the number one university business incubator in Europe and second best in the world. SETsquared is a collaboration between the Universities of Southampton, Bath, Bristol, Exeter and Surrey which partner in enterprise activities and collectively support the growth and success of new business opportunities through spin-outs, licensing and

incubation. The Partnership also works with industry through research collaboration and consultancy.

The ranking, published 25 June 2014 by the University Business Incubator (UBI) Index, places SETsquared as one of the world's leading three incubators, ahead of SCUT Science Park at South China University of Technology and just behind number one, The Rice Alliance for Technology and Entrepreneurship at Rice University, Houston.
Dhruv Bhatli, Co-founder and Director of Research at UBI Index, said: "SETsquared did really well on our Global Benchmark and beat numerous business incubators based at top universities. They are one of the best incubation places in the world and certainly the best in Europe, as evidenced from their performance on our global benchmark. Its client companies show exceptionally high survival and growth rate and generate higher number of jobs than the global average. It is an outstanding business incubator that provides exceptional quality to its client companies and produces growth companies and high economic impact."

At Southampton, SETsquared success stories include a number of companies from across a wide range of industries and sectors. They include established companies such as PrimerDesign, who developed the world's first swine flu detection kits; Ilika, which specialises in the rapid development of new materials for energy and electronics applications; and Symetrica, which has a $220m drawdown contract with the US department for homeland defence; to emerging businesses such as software as a service companies Cloudtrade, growing at seven to eight per cent a month and Triggered, who's turnover is now 10 times what it was last year; and Softiron, who have developed the world most energy-efficient computer hardware.

SETsquared, which specialises in accelerating high technology and innovative businesses, says its position reflects the impressive economic value of the client companies it has helped build over the last 11 years. Since its inception it has worked with more than 1,000 high-tech start-ups and spin-outs, with a survival rate of 80-90 per cent, and have raised over £1 billion in investment.

Each year SETsquared holds an investment showcase in London, attracting a high quality audience of over 150 investors including venture capitalists, business angels, high net worth individuals and government funding bodies. Spanning a diverse range of sectors including energy generation, farming, enterprise software, clean technology, mobile apps and e-commerce, the showcase is supported by an intensive investor readiness programme. The businesses which showcase at the Investor event are all spinouts from the partner universities seeking investment of between £250,000 and £5 million each.

The one day event includes ten minute investor pitches from eight of the companies attending; all twenty companies have exhibition stands which allow potential investors to engage in direct discussions with those of interest.

In the past eight years, participating companies have raised over £120 million in investment along with significant customer orders. The investors who attend find the event an efficient way to see a large quantity of high quality propositions under one roof. The support SETsquared provides for the spinouts and the fact that it works with high tech, high growth ventures reassures investors that they are going to be presented with high quality investment-ready opportunities.

SETSquared has benefitted from HEIF funding and provides one example of the value of this funding stream. In addition to support for SETSquared, HEIF has allowed the University to develop an infrastructure and investment in award winning technologies such as MyJoulo and StarStream. We think that HEIF is well defined and can be well targeted, and clearly with more funding, more could be achieved.

ICURe – Identifying and Commercialising University Research

The University of Southampton is taking the lead within the SETsquared Partnership in working with TSB and HEFCE to develop and pilot highly effective and efficient techniques for commercialising research being undertaken in UK universities. ICURe begins by working with university research groups which believe that there are potential commercial applications that can result from or draw upon the outcomes from the research being undertaken. A three person team is created that is composed of the Principal Investigator of the research group, an 'entrepreneurial lead' who is typically a post-doc or post-grad actively involved in the research activity who has an interest in moving forward the commercialisation activities, and an external mentor from industry who possess industry sector and business knowledge. The team is first goes through an intensive 'boot camp' which provides the framework and sets the stage for a concentrated 3 to 6 month activity of testing the possible commercialisation of the research against the requirements of the marketplace and the needs of real customers. Throughout the activity, the team draws upon the expertise and support of the SETsquared Incubators and the universities' intellectual property, technology transfer, and commercialisation resources. The activity requires the team, and mostly the entrepreneurial lead, to discuss their potential products and/or services with a wide spectrum of potential customers, and to deduce from these many interactions if a viable offering is possible. Assuming a viable product/service is identified, then the team maps it onto a business canvass and finally into a basis business plan. For those teams which find they have a viable path to the marketplace, the formation of a start-up company will be encouraged, with the expectation that the entrepreneurial lead will move into the company, providing a personal transfer of the technology. TSB will provide funding to the newly created company to begin executing its business plan to commercialise the identified product/service. The SETsquared incubator will provide its expertise in assisting the start-up to develop and grow into a dynamic and viable company.

The ICURe program is seen as a way of 'bridging the valley of death' which the House of Commons Science and Technology Select Committee inquiry in 2013 investigated and that resulted in the report "Bridging the Valley of Death: Improving the Commercialisation of Research".

Impact Acceleration Accounts

The recent introduction by the Research Councils of Impact Acceleration Accounts has provided discretionary funding to enable the development of knowledge exchange and public policy influencing mechanisms for the benefit of the UK economy.

This funding source is used to support 60 Knowledge Transfer Secondments and Internships which aim to enable academics across the spectrum from Early Career Researchers to senior professors spending time working with industry partners to identify and implement new technologies into partner companies and across their innovation chain.
In addition to secondments the funding also supports early stage commercialisation support to commercialise close-to-market technologies, either through technology and marketing development work, licensing or spin-out formation. Projects currently in development are a nanoscope device and the award winning MyJoulo device which helps householders improve the efficiency of domestic energy use.

Skills for science and innovation

- What more could be done to expand the number of people available in the UK in science, technology, engineering and mathematics (STEM) disciplines at all levels of

qualification, from technician skills to graduates?
- How could we maximise the chances of people fulfilling their potential in STEM disciplines in the UK? In what ways can we raise awareness of science- and innovation-related careers and opportunities?
- Have we got the right balance between skills levels and disciplines for science and innovation? Are there particular areas where growth needs to be encouraged?
- Do we have master's and postgraduate degrees that prepare graduates well to take up technological and managerial roles in UK businesses?

Universities have a crucial role to provide graduates with higher level STEM skills. Further Education providers address other parts of the STEM skills spectrum. In both cases, choices made by students in school affects the supply of potential students in STEM subjects in Tertiary Education, and many pupils are put off studying STEM subjects. Clearly, the lead responsibility lies within schools, but universities can play a crucial role in ensuring that school students are enthused by STEM subjects and understand where they might lead them.

Examples of the University of Southampton's outreach activities include:

- The "Bringing Research to Life" Roadshow – around 30 days in 10 locations, this will reach around 10,000 people.
- The "Light Express Roadshow" and Astrodome, reaching around 18,000 people.
- The "Dragonfly" Day for 90 Year 9 female students, which is specifically designed to encourage young women to consider the benefits of further study and careers in science and engineering. This one day activity is likely to be expanded to two days in 2014/15 to accommodate increasing numbers who wish to participate.
- Three residential courses in STEM areas funded by Headstart, the Arkwright Trust and the Sutton Trust Host, bringing more than 120 Year 11 and 12 students to our campus.

Some students who may wish to pursue a STEM university education may not have taken the right combination of A-Levels. Our Engineering Foundation Year is designed to provide a route to an engineering degree for those without maths & physics at A-level. This has been particularly useful for those who may have been turned off by physics at school to change their minds.

Government also has a role, to bring together schools, universities and businesses, to promote skills and training in STEM subjects. The "Your Life" campaign, for which many leading UK universities including Southampton have made a pledge, is a good example.

It is important that universities, and individual university staff, are incentivised to engage in public understanding and reach-out activities. The Access Agreement sets requirements on universities to increase university applications from disadvantaged groups, and some of the money pledged under the Access Agreement is used for this work within schools. More however could be done to promote and celebrate the achievements of UK STEM within schools.

Teachers of STEM subjects in secondary schools are pivotal influences on, and advocates for, ambitious STEM-related career aspirations, and it is vital that these teachers are trained to the highest standard in school-university partnerships - particularly where the universities are research-intensive - so that a challenging balance between the (pedagogic and subject) theoretical and practical is maintained and STEM-focused. Additionally, in the primary sector, schools need access to STEM-specialists who have deep subject knowledge, secure conceptual pedagogic knowledge and the necessary curriculum leadership preparation to

strengthen the teaching of STEM-related topics and ensure that pupils reach secondary school with an enthusiasm for STEM subjects. It is therefore difficult to see how initial teacher training (ITT) in the UK can, or should try to, deliver the STEM 'agenda' without the proactive involvement of our leading universities who, like Southampton, are leading research and teaching in STEM fields.

Thereafter, whether as newly qualified teachers (NQT) or as full in-service teachers, it is vital that teachers of STEM subjects in schools are expected and encouraged to:

(i) engage with *subject-specific* continuing professional development (CPD) throughout their careers to stay up-to-date with STEM advancements; and
(ii) engage with *pedagogic CPD*, to stay up to date with the science of teaching and learning, the use of IT (broadly defined), emerging national targets and challenges, the scientific use of attainment data to improve outcomes, and more generally to retain / regenerate their enthusiasm and thirst for teaching their subjects in an effective way.

Research-intensive universities are best placed to offer ways to make CPD attractive and straightforward for teachers to engage in it. The University of Southampton's *Mathematics and Science Learning Centre* (MSLC), for example, was established with just this purpose in mind. Run on a social enterprise model with no direct government funding, it enables teachers of STEM subjects to gain from strong links with university research. Likewise, initiatives like *Maths Hubs*, *Maths at Work* days, *Gifted and Talented* schemes, Science workshops and A-level revision classes in STEM subjects all contribute critically to student aspirations and high attainment.

In addition, the University of Southampton runs a course called Science for Society, sponsored by the Ordnance Survey and Goldsmiths, which aims to show teachers what cutting edge work is being done in universities in their subjects. This course has been run successfully for two years and we will be running it again this year. It has been very popular with teachers, and extremely positive feedback.

The University is also supporting the Wessex 6th Form Teachers Networking Group to encourage more girls to study Physics at A Level, by sending trained female undergraduate students to talk to parents about careers in STEM subjects.

All these examples illustrate the strong role that the UK's leading research universities can play in ITT, in Subject Knowledge Enhancement (SKE) programmes for graduates from disciplines outside STEM, and in teacher in-service when an enterprising and innovative approach is used. Research suggests that this is what maximizes the number of school students seeking to develop their potential in STEM subjects and follow careers in related fields. Experience in Southampton tells us it can be done.

The decline in careers advice within schools is a worry. One reason why pupils do not take STEM A-Levels is a lack of knowledge about STEM careers. Universities help to fill this gap a little, but a greater focus on careers within schools would pay dividends.

The University of Southampton also believes in fostering student innovation and enterprise. Several university courses in STEM areas teach entrepreneurship, and the university ensures that self-run student entrepreneurial societies have what they need to flourish. For example, students from the University of Southampton have won the UK's Enactus competition for social enterprise three years running. As well as generating significant social benefits for the recipients, these activities provide vital opportunities for students to set up and run their own enterprises.

Research-business interface

In responding to the questions in this area, institutions may want to reflect on how their relationships with businesses relate to the issues raised

- What prevents businesses in the UK from investing in research and development as much as businesses do in other leading economies? What more could be done to catalyse business investment in the system?
- How could we ensure that more small and medium-sized enterprises develop new products and services to bring business innovation performance at the level of other leading economies? How could the science and innovation system better support some of these enterprises?
- How could the science and innovation system better contribute to supporting innovation in services, a large part of the UK economy? Are there areas that would require further consideration?
- How should Government and partners regularly identify the technologies in which the UK should prioritise investment, and what evidence should that be based on

The Government has introduced a number of structures and mechanisms over the past few years to enable closer working between universities and business. Some things are within the gift of universities themselves, and do not need Government support. The University of Southampton has established units specialising in consultancy for business in different technical areas, has introduced a one-stop shop for SMEs, has provided students to work on industrial problems in SMEs, and has established a science park which is self-sufficient.

The University has many established links with companies that do not require specific government assistance or structures. However some do and when Government support is supplied it relevant and particularly important in addressing the following:

- To bridge Technology Readiness Levels which fall in the “valley of death” between publicly funded research and commercialisation take up by industry.
- To work at a local and regional level to build critical mass.

The Government’s primary vehicle for taking forward the first of these is the Technology Strategy Board, TSB, which has changed and grown in size and mission over the years. Whilst the University support’s the TSB’s mission, the TSB has made few attempts to build a strategic relationship with HEIs. This is in stark contrast to Research Councils who work very hard on this. It is possible therefore that the TSB makes unfounded and inaccurate assumptions in areas such as Universities’ capability and capacity in certain technologies.

The concept of Catapult Centres and Andrew Witty’s Arrow projects are helpful in providing focus for funding and approaches in collaboration. In many cases, the UK will only achieve a significant step change if effort is concentrated.

The role of Government in the local and regional sphere has been subject to change, and the last few years have seen the death of RDAs and the birth of LEPs. RDAs had their faults, although £10M of SEEDA funding played a crucial role in helping achieve the £140M joint campus between the University of Southampton and Lloyds Register mentioned above. The primary problem with LEPs was that they were not originally established as structures to distribute significant sources of public money, but they have inherited this role in a slightly haphazard way. Many LEPs have struggled with this adjustment, although significant improvements are being made.

The University of Southampton agrees with Sir Andrew Witty that Universities should be at the heart of LEPs. However the LEPs cover a relatively small geographical area such that a University such as Southampton could span a number and cross-LEP working is still patchy

and ineffective.

One problem has been that different elements of Government have parcelled out small packets of money to LEPs through multiple routes with different deadlines. The move to Strategic Economic Plans is an improvement, but LEPs are too small to be able to deal with large numbers of bids with multiple deadlines. Central Government needs to adjust its behaviour to the new LEP world which is has created.

The Regional Growth Fund is an initiative that has been extremely positively received by the SME community. Future Solent, a collaboration between Hampshire Chamber of Commerce, Eastleigh Borough Council (Accountable Body), Local First CIC, University of Portsmouth, University of Southampton and Southampton Solent University was awarded funding to provide a focused range of interventions to support targeted SMEs in the low carbon economy. The combined expertise of the consortium delivers a range of business services to accelerate SME growth, services which are unlikely to be provided by the market alone.

The programme has been targeted at new and existing SMEs looking to expand across the Solent LEP area in the environmental technologies and services market. The RGF support totalling £3million has been allocated to projects falling into two areas:

1. **Support for Environmental technology R&D and Innovation Businesses.** Companies are supported with access to research and development facilities at the University of Portsmouth and University of Southampton Science Park, as well as access to networks and support in developing business plans. In addition, new and growing small companies have applied for grants to help deliver their business plans and new products.

2. **Sustainable support for loan capital to Solent Green Economy Businesses.** Small and medium sized businesses within the green economy are provided with access to loan capital to assist their development and expansion. Future Solent and Eastleigh Borough Council together with Local First operate a competitive programme to award loans to green economy businesses.