The UK National Quantum Technologies Programme
Current and Future Opportunities

Dr. Derek Gillespie
Engineering & Physical Sciences Research Council
derek.gillespie@epsrc.ac.uk
(01793) 44 4301
©DAGillespie
Getting from there, to here…

OH F**K!
Getting from there, to here...
Getting from there, to here...

“When money is short, we should ruthlessly prioritise those areas of public spending which are most likely to support economic growth, including [...] our science base and the skills and education of citizens.”

George Osborne, Spending Review 2010

“My children are eight and ten years old. I don’t want them to read about how China has just built the world’s most advanced aircraft; how India is leading the globe in computer design; and have to say to my children: ‘That used to be Britain’.

I want Britain to be the home of the greatest scientists, the greatest engineers, the greatest businesses – a land of innovators.”

George Osborne, 3 October 2011
UK R&D Spending

Gross expenditure on R&D as a fraction of GDP.

Value of R&D, as a fraction of GDP, performed in the business sector.
Shifts in science policy & investment

September 2010
EPSRC launch new Strategic Plan

October 2011
Innovate UK launches new network of Catapult Centres

February 2012
Announcement of funding for the Manchester Graphene Institute

January 2013
David Willetts discusses ‘Eight Great Technologies’ for the UK

November 2013
HM Government commits new public funding for UK National Quantum Technology Programme

November 2013
David Willetts launches new EPSRC Centres for Doctoral Training

June 2014
EPSRC releases extended Delivery Plan for 2015-2016

April 2011
EPSRC launches new Delivery Plan for 2011-2015

Department for Business Innovation & Skills

Industrial Strategy: Cable outlines vision for future of British industry

September 2012
Vince Cable announces a new commitment to a UK industrial strategy.
Science base cash injections
Additional funding for EPSRC

<table>
<thead>
<tr>
<th>FY 2011/12</th>
<th>FY 2012/13</th>
<th>FY 2013/14</th>
<th>FY 2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>£10M</td>
<td>£43M</td>
<td>£30M</td>
<td>£158M</td>
</tr>
<tr>
<td>e-Infrastructure</td>
<td>Graphene</td>
<td>Energy Storage</td>
<td>Quantum Technologies</td>
</tr>
<tr>
<td>£50M</td>
<td>£31M</td>
<td>£75M</td>
<td>£75M</td>
</tr>
<tr>
<td>ARCHER</td>
<td>Advanced Materials</td>
<td>£2M</td>
<td>Centres for Doctoral Training</td>
</tr>
<tr>
<td>£10M</td>
<td>£25M</td>
<td>£8.5M</td>
<td>£31M</td>
</tr>
<tr>
<td>RCUK Impact (£2M)</td>
<td>Autonomous Robots</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£10M</td>
<td>£5M</td>
<td>£10M</td>
<td>£10M</td>
</tr>
<tr>
<td>Fluid Mechanics (£5M)</td>
<td>Strategic Capital (£7.5M)</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£8M</td>
<td>Nuclear User Facility</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£10M</td>
<td>Big Data</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£10M</td>
<td>Mid-range Characterisation</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£10M</td>
<td>Cyber Security</td>
<td>£10M</td>
<td>£75M</td>
</tr>
<tr>
<td>£10M</td>
<td>£50M</td>
<td>£30M</td>
<td>£158M</td>
</tr>
</tbody>
</table>

Capital Investment
Resource Investment
Community action in 2013

A summary of the discussions, held in July 2013, between academia, industry and the public sector that explored the potential for the development of novel quantum technologies in the UK.

Issue date: 31 July 2013
Type: Report
Related themes: ICT, Physical sciences, Quantum technologies
New public investment

- The UK National Quantum Technologies Programme.
- A five-year programme to exploit the potential of quantum science and develop a range of emerging technologies with the potential to benefit the UK.
- Industry and academia working together to create opportunities for UK wealth creation.

Autumn statement 2013

£270M

UK Government investment in quantum technologies research
HOW’S YOUR QUANTUM COMPUTER PROTOTYPE COMING ALONG?

GREAT!

THE PROJECT EXISTS IN A SIMULTANEOUS STATE OF BEING BOTH TOTALLY SUCCESSFUL AND NOT EVEN STARTED.

CAN I OBSERVE IT?

THAT’S A TRICKY QUESTION.
Opportunities for the UK

- Community
- Applications
- Risk & Return
Community
A Quantum Community in the UK

- An **extensive science base** with recognised excellence.
  - Diverse approaches towards quantum technology ‘platforms’ explored – atoms/ions/molecules, solid state, photonics etc.

- An **industry base that is interested** – intrigued, perhaps?
  - Vital core skills in technology design, development and systems integration.
  - End users that want to better understand the potential capabilities.

- An **aligned public sector** that can and will support the community.
  - An early-stage adopter and demonstrator of technology.
  - New and existing routes to research and innovation funding and facilities.
A Quantum Community in the UK

- End Users and Societal Drivers
- System Requirements
- Enabling Technology
- Fundamental Knowledge

Flow Diagram:
- Knowledge Base
- Technology Base
- System Integration
- End Users and Societal Requirement
A Quantum Community in the UK

- 32 Universities initially applied for Technology Hubs
- Over 160 Companies supported Hub applications
- More than 150 Doctoral students will be trained by CDTs
- 22 Companies submitted applications to the first round of innovation funding
Applications
The Transistor and the Integrated Circuit

- First transistor invented in 1947.
- Miniaturization of the technology, in line with Moore’s Law, is astounding.
- Complexity of integrated circuits has increased more than a billion-fold since the 1960s.
- The price of an individual transistor is now less than one millionth of the cost in the late 1960s.
  - Had the cost of automobiles fallen at the same rate, a new car today would cost less than one pence.
Don’t sell the science...

Mister Visionary @MisterVisionary. Mar 10

Quantum... I’m not sure if I’ve understood what it is that I’m supposed to understand that I’m not able to understand.

Jim Al-Khalili @jimalkhalili. Mar 10

@MisterVisionary: Precisely.
Don’t sell the science, sell what it does

**Accurate Financial Trading**

The speed of modern financial trading is such that transactions must be audited to the microsecond level or beyond – ‘quantum timing’ via chip-scale atomic clocks makes this a possibility.

**Sensitive Sub-surface Sensing**

Development of ‘gravity sensors’ could facilitate the detection of previously unknown fossil fuel deposits, or enable more accurate mapping of buried civil infrastructure such as pipes and cables.

**Secure Information Protection**

Advances in quantum key distribution technology will enable a new generation of secure electronic communication, applicable to personal finance, online shopping, and secure industrial communication.
Don’t sell the science...
Don’t sell the science, sell what it does

QT-based imaging systems could **improve the safety** and variety of Royal Navy mine sweeping operations.

Flood damage cost the UK £4Bn in 2012 – gravity sensing can more effectively monitor the water table to **aid prevention**.

4 million holes are dug in UK roads every year – nearly 20% erroneously hit **unknown or forgotten** buried utilities.
Risk & Return
Taking and minimising risks

“Genuinely revolutionary technology starts with research, which requires long term thinking [...] Unfortunately, politicians don’t always think on the same time frames [...] If Britain fails to match the competition then our companies will simply be left behind.”

Sir James Dyson CBE

- Substantial investment in an emerging technology is intrinsically risky.
- People don’t fully understand the capabilities, nor the markets.
- Public investment plays an important role in de-risking the technology:
  - supporting industry engagement with innovation
  - acting as an early adopter
  - creating demonstrators and facilities
Quantifying our returns

- Realising our vision for UK quantum technologies will take time.
- It is not possible to predict all our eventual successes, numbers of newly-created companies, nor the value of QT markets.

- **We can be confident** in stating that, over the next few years, we will:
  - Forge ever-stronger relationships
  - Provide new opportunities for UK businesses
  - Deliver new technologies into early-adopter markets
  - Begin training a new generation of highly-skilled individuals
What Next?
High-level summary

- **Discover**
  - EPSRC Research Programmes
  - Quantum Technology Hubs
    - Targeted EPSRC Quantum Technology Programmes

- **Integrate**
  - EPSRC/Innovate UK Innovation Programmes
    - Bespoke Innovation Activities
    - DSTL System Demonstrators
  - Quantum Technology National Network
  - Innovate UK/KTN Special Interest Group

- **Validate**
  - EPSRC Centres for Doctoral Training
  - EPSRC Fellowship Programme
    - Targeted EPSRC Skills Investments

- **Deploy**
  - Quantum Technology Hub Capital Equipment
  - EPSRC Capital Funding for Quantum Technology

**Indicative Technology Readiness Level**

1  2  3  4  5  6  7  8  9
Activities for 2015

- Quantum technology **hub network** initiated.
- **Fellowships** in quantum technology from EPSRC – application deadline is 29 January 2015.
- New **innovation funding** from Innovate UK, EPSRC and DSTL.
- Engagement with European funding streams.
- Further development of **national strategy and road-maps**.

Remember:

- All **standard funding routes** for quantum science and quantum technology remain available.
- The quantum technology **special interest group** is the forum for industry-academic networking in the QT Programme: [https://connect.innovateuk.org/web/quantum-technology](https://connect.innovateuk.org/web/quantum-technology)
The UK National Quantum Technologies Programme

“What’s different this time?”

Dr. Derek Gillespie
Engineering & Physical Sciences Research Council

derek.gillespie@epsrc.ac.uk
(01793) 44 4301
©DAGillespie