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# EPSRC

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Pioneering research  
and skills

**Statistics and Applied Probability Review Day**

**18<sup>th</sup> June 2014**

**Report and Next Steps**

**EPSRC Mathematical Sciences Theme**

## Foreword

Statistical mathematics, a phrase that I would take to include both applied and pure probability, provides the essential theoretical underpinning of statistical science – the embedding of statistical thinking within the design and analysis of research projects across the whole spectrum of the natural, biomedical and social sciences. I therefore very much welcome EPSRC's inclusion of Statistics and Applied Probability amongst its 15 "grow" areas, and equally the support that other UK Research Councils give to statistics within their respective research portfolios.

The key messages from the EPSRC review day, that there are major opportunities in statistics, that there has been some progress in this area but much more to be done, are in accordance with the RSS's own view. The key will now be to move from this analysis to action. The RSS and the wider statistical community stand ready to work in partnership with the UK Research Councils in helping take the actions outlined in this report forward.

Looking further ahead, the growing recognition of the ubiquitous relevance of "data science" presents a real opportunity to help promote cross-fertilization between statistical mathematics and statistical science. I hope to see more cross-Council initiatives that will continue to foster the UK statistics community's strong tradition of mutually beneficial interaction between methodological development and substantive application.

Peter J Diggle, President, the Royal Statistical Society

<sup>1</sup> International Review of Mathematical Sciences, 2010 (<http://www.epsrc.ac.uk/newsevents/pubs/international-review-of-mathematical-sciences/>)

# **REVIEW OF THE STATISTICS AND APPLIED PROBABILITY RESEARCH AREA, 2011 TO 2014**

*Report of the Statistics and Applied Probability Review Day held at the Birmingham Hilton Metropole Hotel at the NEC on the 18<sup>th</sup> June 2014*

## **Introduction/Background**

As part of the delivery plan for 2011-2015, EPSRC defined its portfolio into 111 research areas as part of our shaping capability goal. Each research area has a published definition, rationale and action category. There are three action categories – grow, maintain and reduce, all relative to EPSRC's overall portfolio. Statistics and Applied Probability is one of 15 grow areas, and the only grow area in the Mathematical Sciences portfolio. Further information on the Statistics and Applied Probability research area can be found on our website:

<http://www.epsrc.ac.uk/research/ourportfolio/researchareas/statistics/>.

The International Review of Mathematical Sciences (IRM) in 2010 recommended that research funders needed to preserve and strengthen the international excellence of mathematical sciences research<sup>1</sup>. Specifically it was highlighted that UK Statistics research is still in a weakened condition, despite the many areas of excellence, and that measures needed to be taken in the coming years to avoid the loss of the UK's international stature. EPSRC's strategy to shape support for Statistics and Applied Probability research area were in part due to the recommendations made by the IRM panel.

As we approach the next delivery plan period (after a one year extension to March 2016), EPSRC is looking at its portfolio and identifying areas where a closer inspection of the research area may be necessary. The Mathematical Sciences theme has selected Statistics and Applied Probability as an area to look at in more detail. Whilst the area has grown since 2011, the funding environment is changing and EPSRC wanted to consult the community on how things have changed over the past few years and identify potential actions for the future.

## **Purpose of the Review Day**

The aim of the day was to bring together a sub-section of the Statistics and Applied Probability community, from both academia and other stakeholders, to pose a number of questions regarding different aspects of the research area, to advise on changes since the International Review and to consider the current state of statistics and applied probability research in the UK, and opportunities and issues still to be addressed. A list of attendees for the day can be found in Annex 1, and a list of the questions posed at the day can be found in Annex 2.

EPSRC intend to produce an action plan for the research area which will inform any action or interventions until the end of the current delivery plan period (March 2016) and into the next one (2016 – 2021). The action plan is also part of a wider exercise at EPSRC, called Monitoring Portfolio Evolution (MPE), which aims to understand how EPSRC's support has been realigned towards the published shape.

<sup>1</sup> International Review of Mathematical Sciences, 2010 (<http://www.epsrc.ac.uk/newsevents/pubs/international-review-of-mathematical-sciences/>)

## Overview of the Review Day

The day began with an overview of Statistics and Applied Probability from different perspectives. The day was opened by a current member of the EPSRC Mathematical Sciences Strategic Advisory Team, Professor Mark Girolami (University of Warwick). This was followed by short presentations from the Biological and Biosciences Research Council (BBSRC, represented by Peter Burlinson), the Economic and Social Sciences Research Council (ESRC, represented by Rachel Tyrell) and the Natural Environment Research Council (NERC, represented by Avril Allman) on the relevance of statistics to their research council, priorities and potential funding opportunities, which are summarised below. Both the Medical Research Council (MRC) and the Sciences and Technologies Facilities Council (STFC) were invited to the review day but were unfortunately unable to send a representative. EPSRC also engaged with the Higher Education Funding Council for England (HEFCE) prior to the day.

EPSRC Mathematical Sciences Strategic Advisory Team: Professor Girolami outlined the success and strength of statistics in the UK, but highlighted that there are still some serious issues in spite of that success. The issues include things such as: fewer REF submissions in 2008 compared to 2001, recruitment difficulties especially at faculty level, pressures on departments to do contract work, and the absorption of separate statistics departments into 'mathematics and statistics' departments.

BBSRC: Information provided by Peter Burlinson gave an overview of BBSRC's funding opportunities for statisticians, highlighting areas such as data driven biology, systems biology and tools for informatics. He also welcomed input from statisticians in the community networks that BBSRC are currently setting up (e.g. multi-scale systems biology).

ESRC: Rachel Tyrell gave an overview of ESRC's strategy in quantitative methods (QM), especially highlighting project which have social scientists and experts in QM working together. The current funding opportunities were detailed, along with their most relevant current investments.

NERC: Avril Allman gave an overview of NERC's strategy and highlighted current opportunities and recent investments that are relevant to statistics, in areas such as omics, uncertainty and risk, and modelling.

As an introduction to the afternoon sessions, Professor Peter Diggle (Lancaster University, attending on behalf the Royal Statistical Society, RSS) gave an overview and his personal perspective on what he felt statistics was, strengths and weaknesses, how the growth in data science will affect the area and an explanation of the capacity problem within statistics.

The remainder of the review day was split into 4 main sessions:

1. Current Landscape
2. People
3. Impact
4. The Future

Each session consisted of the delegates being split into 4 or 5 groups and answering a number of questions on the topic of the session.

Session 1 focussed on how the research area looks in the present and tackled the question of whether there are still concerns over the health of the area which were raised by both previous International Reviews of Mathematical Sciences (2004 and 2010).

Session 2 focussed on fellowship and CDT support over the indicated time period and what effect these have had in the area.

Session 3 focussed on impact and connectivity of the portfolio, specifically considering the impact that the Science and Innovation awards (S&I) have had and whether the area is sufficiently connected to other areas of the portfolio (not just in EPSRC's remit). This session also included an opportunity to populate a SWOT (strengths, weaknesses, opportunities and threats) for the area.

Session 4 focussed on the future and next steps for the research area, and for EPSRC in terms of their actions.

The raw information from each session can be found in Annex 3.

## **Conclusions**

The overall perception of the Statistics and Applied Probability research was that the growth since 2011 has been good for the area but there are still concerns over capacity and the need for continued growth. There is a strong feeling within the community that this growth is only one step in the right direction and there is still a long way to go before the health of the discipline is no longer a concern.

In terms of people support, EPSRC's fellowship opportunities are good for retaining talent in the UK and often lead to recruitment of another (permanent) person to a department. There is a strong feeling that in order to continue retaining talent in the UK, postdoctoral and early career fellowships in this area are essential, although the need for further established career fellowships is not as strong.

The recent CDT exercise (2013) has led to concern over the concentration of statistics PhDs around the CDTs and consequently this may lead to not enough provision for statistics students elsewhere in the country. The idea of having smaller CDTs was discussed (i.e. 5 students per cohort year), which would reduce concentration and enable a broader number of areas to be covered by the CDTs. It was also felt that the current setup of the CDTs will reduce the diversity of statistical training in the UK. From the opposite viewpoint, the success of APTS (Academy for PhD Training in Statistics, a Taught Course Centre which provides broadening training in statistics to EPSRC funded mathematical sciences PhD students) was highly praised, as were the steps that have been taken to ensure its sustainability for the Academy when the current tranche of EPSRC funding ends in 2016. APTS provides training for both CDT students and other EPSRC funded students.

Further to the above concern regarding concentration of statistics PhDs, it was clear that concentration of staff is also an issue in the community. The ideal situation for the community would be to have a professor of statistics (and/or applied probability) in every UK university, and to have a strong shortlist of candidates for every position.

A positive for the area is that the impact of statistics research is often wider than statistics itself and other areas benefit from the practical applications. However, it can be difficult to quantify that

impact using the current metrics. Statistics has applications in most of the other research councils' space, but it is felt that the use of statistics in other disciplines can be very poor and there is a need to improve this for benefit of both parties.

The opportunities that are arising from big data are being very well received by the community and it has created a lot of positive feeling and excitement. EPSRC is committed to working with the community, and the other communities in mathematical sciences, to ensure their participation in current and future big data activities.

The industry perspective suggests that PhDs graduates in this area are very valuable as they have strong fundamental skills. This is a threat to the academic people pipeline but is a compliment to those training PhD students in statistics, as well as to the calibre of the students. Whilst collaborations are a very positive thing, when industry faces financial cut-backs, research and development is often the first thing to be affected. It is felt that collaborations could be further encouraged for EPSRC applications, especially in standard application mode.

Perceptions within the community suggest that statisticians thrive when placed with other scientists/disciplines. It would be beneficial if scientists in other disciplines had some statistical expertise, but this is often not the case and so it is therefore important to fully involve a statistician in a research project to obtain the best results. There are plenty of opportunities for UK statisticians to engage with other disciplines and the (combined) hard work often produces great results and impacts.

The S&I awards have played a key part in helping to build capacity in statistics and applied probability over the past few years and are due to end in 2016. As these awards end, there is potential for the area to reduce significantly and this is an obvious concern for the community. It is uncertain at the present time whether or not there is enough momentum in the area to fill the gap that the S&I awards will leave. There is further concern in the community over what will happen to the workshop activities that are currently run by the award holders; they are regarded as very valuable in the community. The postdoctoral awards that the S&I awards have made in the last few years are attracting strong young talent to the UK and it should be explored how this might be able to continue in universities post 2016.

Finally there are questions over the community itself and how supportive they are of each other. It has been suggested that researchers in this area are critical of each other (in peer review), potentially to the detriment of one another.

## **Next Steps**

An action plan for Statistics and Applied Probability is being put together with assistance from the EPSRC Mathematical Sciences Strategic Advisory Team, drawing on inputs from the 2014 EPSRC Strategic Advisory Teams Conference, portfolio knowledge and this review day. This will be finalised and published in due course as part of the Monitoring Portfolio Evolution (MPE) exercise.

Below is a list of suggested actions that EPSRC will look at over the next few years:

- Investigate closing the established career fellowship priority area in statistics and applied probability and explore the possibility of statistics mobility fellowships.

- Take an in-depth look at the grants funded in this area to understand the split of the portfolio between statistics and applied probability.
- Take an in-depth look at the grants funded in this area to understand the split of the portfolio between core statistics and applied statistics.
- As part of the taxonomy review later in the 2014/2015, it will be considered whether any changes to statistics and applied probability research area are appropriate.
- Work together with the community (in statistics and other areas of mathematical sciences) to exploit big data opportunities, building on the excitement and potential that researchers are experiencing.
- Monitor fellowship applications and subsequent fellowship cohorts, as well as the CDTs as they progress over the next few years.
- Explore the role of advocacy with our current and future fellows.
- Work with other research councils to understand more fully what they are funding in statistics and where there are synergies and differences to ensure research does not “fall between the cracks”.
- Explore how EPSRC can encourage more collaborative research in statistics and applied probability.
- Look back at the area once big data investments have been made, for example the Alan Turing Institute.
- Explore the mathematics REF panel information to investigate levels of statistics papers and how the community connects with other disciplines and stakeholders.

EPSRC appreciates that not everything raised at the review day will be possible to address, nor will it be possible to achieve things in isolation without working together as funders and the community.

## Annex 1: Attendee List

First Name	Second Name	Institution
Avril	Allman	NERC
John	Aston	University of Cambridge
Ron	Bates	Rolls-Royce
Nicky	Best	GSK
Sue	Carter	EPSRC
Peter	Diggle	Lancaster University
David	Elston	BioSS
Jon	Forster	University of Southampton
Samantha	Francis	EPSRC
Steven	Gilmour	University of Southampton
Mark	Girolami	University of Warwick
Peter	Green	University of Bristol
Philippa	Hemmings	EPSRC
Gareth	James	Office for National Statistics
Adam	Johansen	University of Warwick
Wilfrid	Kendall	University of Warwick
Andreas	Kyprianou	University of Bath
Malwina	Luczak	Queen Mary, University of London
Jerome	Ma	EPSRC
Ralph	Mansson	DSTL
Alex	Mijatovic	Imperial College London
John	Moriarty	The University of Manchester
Guy	Nason	University of Bristol
Gareth	Roberts	University of Warwick
Matthew	Roberts	University of Bath
Richard	Samworth	University of Cambridge
Jonathan	Tawn	Lancaster University
Charles	Taylor	University of Leeds
Nicola	Tilt	P&G
Rachel	Tyrrell	ESRC
Michael	Ward	EPSRC
Christopher	White	EPSRC
Daniel	Williamson	University of Exeter
David	Woods	University of Southampton
Nikolaos	Zygouras	University of Warwick

## Annex 2: Questions Posed

- The International Review of Mathematics (2010) expressed concern about the health of UK statistics, whilst recognising that there is outstanding research being undertaken in this country. Is this still the case?
- The area of statistics and applied probability grew steadily between 2011 and 2013 (0.2% growth relative to the entire EPSRC portfolio) but growth slowed between 2013 and 2014 (0.05%). Is this level of growth appropriate? Does the area still need to grow further? Are we funding the right sort of grants (first/standard/programme/fellows)?
- Support for statistics and applied probability fellowships across all career stages has been a priority since summer 2011. What has the impact of this increased investment in fellowships been?
- The S&I awards have done a huge amount to improve the reputation of statistics in the UK, as they come to an end, what has their impact been and is there enough momentum/activity/capacity for this to continue without further major investment/intervention from EPSRC?
- Has statistics adjusted sufficiently to take account of the change in the funding environment, including the opportunities presented by Big Data and the other 8 Great Technologies? (Understanding that EPSRC have not put dedicated funding into Big Data yet.)

## SESSION 1 – CURRENT LANDSCAPE

### Table A Session 1

- EPSRC should make the case for role of stats in Big Data
- EPSRC should expect universities to create permanent positions for completing fellows
- Good growth in Math Sci lack in other EPSRC themes, e.g. related to Big Data
- Is UK science more or less data based than in 2010?
- EPSRC must be able to help strong medium universities in stats
- Cost of reproducibility? > statistics budget
- UK Science needs research groups in statistics in their own universities
- Good Practice – Medical research requiring statistical assessment of grant applications
- APTS good disaggregated excellence financial sustainability
- A measure of success could be stats taken seriously in other fields
- VCs are the problem “they” closed departments!
- Capacity stats departments’ weak and small still. Not enough centres too concentrated.
- Recruitment issues no premium in UK
- CDT initiatives out of 60, too few show clear stats without being statistical themselves
- Warwick now clear global landmark for UK stats
- Grants in fields has attracted talent from overseas at post doc level but then difficult to find jobs.

### Session 1

- Industry values PhD grads, for their fundamental skills
- More mini S&I, More mini CDTs, More shorter fellowships
- How supportive is the stats community of proposals in stats?
- Distinctness between stats / applied probability
- Funding for International Students
  - Training with academic views
  - If emphasis is given on industrial connections then we’ll see more people leaving to industry than staying in research
- Statistics not stats / applied probability
- What is applied probability?
- AEK:
  - Don’t agree that individual stats depts. Are necessarily the way to preserve & provoke statistical research differ
- Geographical distribution of funding could be influencing the ability to address the challenge of growth
- Statistical epidemic modelling – Random networks of applications with data
- Need a PhD student a year to be a viable research group
- Statistics thrives in partnership with other sciences. Yet DTCs are concentrating postgraduates at a handful of universities. Away from these centres, where diverse and world leading science is also conducted, we won’t have enough postgraduates statistical support to go around.
- DTCs will also reduce the diversity of statistical training in the UK.
- Putting statistics groups in colleges with other scientists is one route that allows statistics to thrive.
- It has been successful in the UK, and internationally

- GAPS between research councils that applied probability & statistics naturally fall through are too common.
  - Proposed methodology too novel/risky for NERC / BBSRC / ESRC
  - But application drive proposal so EPSRC redirect. Need cross panel routes.
- When you think about opportunities for novel non statistical ideas in Big Data, with reference to the Google flu hacking app.
- No point growing for 3/4/5 years if you want to improve the pipeline...need to grow for 10/20/30 years.
- Smaller DTCs?
  - Small (5-10 people)
  - Groups cannot get a steady flow of people
- EPSRC missing chance articulate importance of stats to other sciences
  - Rest of maths is paying, when other sciences should be paying!
- Does the UK environment for statistics differ from other international environments?
- Given the importance of statistics and probability to all sciences, isn't 1.5% funding EPSRC much too low?

### **Session 1**

- Big Data: Could be: Strength, opp, threats & weakness
- Funding between Gaps:
  - Joined up strategy to collaborate with applied end
  - Could be more joined up across councils
  - Need more people
  - Growth has brought area back up to required level, now it needs more growth
- People need communication skills people pipeline key problem
- Salaries compared to USA, not competitive recruiting internationally challenging
- Challenges recruitment in academia & industry
- EPSRC should lead collaborative calls that partner statisticians + applied scientists, even if the application is normally NERC/ESRC/BBSRC. Particularly for statisticians at non CDT/DTCs.
- Some areas competitive internationally, isolated pockets of excellence.
- National centre for statistics & ecology > success for UK
  - United institutions
  - Different skills working on some problem
- Tension between centres & excellence + spreading expertise across ROs
  - Diversity, geographical + research
- DTCs tend to concentrate

### **Session 1**

- Spectrum of research in statistics
  - Theoretical > Applied
  - Not always clear where EPSRC sits on this spectrum
- Funding OS PhDs
  - Where they come from is irrelevant – its where this goes afterwards
- Breadth and inter-disciplinary aspects of statistics may lead to unfavourable grant / peer reviews
- Statistics is not well served by being embedded within Maths
- Statistics is good value

- Issues with naming:
  - Statistician vs Data Scientist vs Analyst vs .....?
  - Avoid too many strict distinctions between theory, inference etc.
- Industry budgets are tight research is what goes first
- Loss of identity
- Next to preserve connectivity across statistics through to pure probability
- Methodological statistics strong in the UK
- Panel & peer review behaviour affects success rates – different applications
- Statistics Mobility Fellowships:
  - Bring them back other schemes to get people to convert statistics
- Need more PhD students funding from Europe & OS
  - Can EPSRC help more?
  - Lots of these students stay in the UK for first destination and beyond
- People pipeline worse than 2010, same for academic & industrial employment
- Research being squeezed out reduced budgets & too few staff

## SESSION 2 - PEOPLE AND LEADERS

### Session 2

#### Table 1 – Session 2 – People & Leaders

- Fellowships good tool for retaining talent in the UK
    - Especially at Early & Est Career
    - Would be good to attract more senior talent
  - Processing time too long to attract talent at Post doc level
  - Fellowships applicants tend to be very strong
  - Post – Docs should receive priority over established
    - Would rather have funding for “Sabbaticals” at est career
  - May need more data to judge fully the effect of fellowships
  - Would be working well if it helps departments reach critical mass
  - Need information on what the centres of excellence are for stats in the UK
  - Interested in trajectories of different Institutions
  - Perceptions re hiring
  - Need to take the context (size of the problem) into account when judging numbers
  - Low numbers of applicants may be due to IOU success rates
  - Argument for keeping Early Career and definitely Post – Doc. Less need for Est Career
  - CDTs forcing out on to schemes for PhDs possibly
  - Ripple effects of CDTs
    - Message to Institutions that cohort approach is good
  - Perception that research is being concentrated towards few centres
  - Difficult to get PhD funding for methodological statistics
  - Quality of EPSRC data re people pipeline may need to be better
1. Who will take the next batch of lecture ships?
  2. Do we have fellowships open at the right career stage (Don't need established)?
  3. Need more help funding non UK/EU PhDs?
  4. Over – centralisation issues

**Session 2**

**Table 2 – Session 2 - People & Leaders**

- Pipeline growth needs sustained investment over many years
- Number of fellowships a drop in the ocean – 17 still needs to grow
- Other areas moving into areas
- Welcome growth – but a sticking plaster
- Is it bringing people into the UK, some evidence yes
  - S & I did this well
- Restriction that Post – Doc fellows can't apply for own funding, political banner to career
- Have EPSRC got breakdown of P/E/Established right
- Collaboration between academics and industry
  - Needs to be based on longer term models of joint working (not off CASE awards)
  - Both sides need to be equal partners in shaping the research and deliverables (perception in industry that they are just seen as holding purse strings, while academics go off and do the research)
  - EPSRC could help in setting up strategic consortia of academic and industry partners to tackle applied research problems.
- Consider relationship with industry / government – sponsorships, secondments, more formal, longer – term collaborations.
- One to consider further?
  - Need to define roles
  - Might need to raise awareness of what options already exist
- If HoD writes letter saying Post – Doc fellow will be given permanent position, could they be allowed to apply for other grants/ other postdocs / PhD Students?
- Communication skills for working with Science / Industry need to be grown – Fellowships could help (Leaders cup)
- CDTs good for statistics, but leads to centralisation in certain departments / Universities
- PG Training – A need to recruit from overseas!!
- Professor of statistics in every UK university & more than one in some – good measure of success
- Advising key parts 2010 review
- Good shortlist in recruitment for positions > industry & academics
  - Junior academic level contracts
- Statistics is successful at getting industrial money but more theoretical areas may phase out as statistics is deemed as sufficiency well catered for.

**Session 2**

**Table 3 - People & Leaders**

- Geographic spend becoming concentrated. A concern because research intensive universities should have statistic researchers. It's a pervasive discipline.
- Money to support workshops, networking to encourage connections across universities

- Could ask for workshops as part of Pathways to Impact
- Connectivity is important
- Shorter fellowships could have more
- Not enough fellows > particularly early career
- Relatively positive view of investments of fellowships
  - Supportive for fellows
  - Responsibility & Focus
  - Early Career
- Attract people back from industry > targeted fellows
- Route back in from industry
- Mobility fellowships into statistics from other disciplines & including, but not restricted to mathematics.
- Career progression fellow
- Centres & hubs could link out more in the UK
- Capacity problem in UK.
  - Lots of opportunities in the UK but not enough people
- CDTs don't have a lot of links to industry
- Demographics in stats has got better over the last 5 years (Wilfred had some stats)
- iCase awards very helpful to keep research momentum when in industry
- Is pathway of career clear?
  - Perhaps not a role for EPSRC

## Session 2

### Table 4 - People & Leaders – Inspire @ UG Level

- Proposals should be judged on excellence (scientific) it is often difficult to judge the impact that research will have to other disciplines. So disciplines should not be excluded.
- (Time) cost of applying for post – doctoral fellowships prohibitive
  - Of S&I research positions

### Cultural implication of concentration academics diversity

- Concentrating funding causes concentration of culture which means UG teaching diversity of experience is affected (will affect next generation)
- Why DTCs not TCCs (Taught Course TCCs)
- DTC Problem:
  - Quote of interests per year means the quality falls down!
- If there aren't that many "young" people in statistics, why focus exclusive funding on fellowships?
- Teaching cmpt to fellowships?
- CDTs for UGs?
- Fellowships > is it desirable to separate people doing excellent research from students
- Focus more on UG community to encourage growth later on
- Inspire & engage – UG > PhDs
- Fellowships partitioning research and teaching

- Challenging the attitudes of pure mathematics @UG level
- UG summer bursaries
  - Pick of the best UGs led by fellows / inspiring academics

## SESSION 3A – IMPACT AND CONNECTIVITY

### **Impact & Connectivity Session (Jerome)**

- S&I Fellowships / Post Docs less bureaucracy for everyone faster turnaround
- Nimble – new strategic areas
- Excellent recruitment (Apply to known recognised centres not anonymous acronyms)
- S& I specifically CRiSM, sustain when they shut down, then who will run the services of workshops the currently put on?
- Key values:
  - Being able to respond quickly and flexibly, no bureaucratic hops, just responding to a good idea.
  - Plays into the agenda of dispersion of statistics in UK
- EPSRC should make it clearer on website / proposal guidance that academic impact is on equal footing to industrial impact.
- Existing mechanics for workshop provision from EPSRC are too piecemeal, take too long to apply for, not responsive enough.
- NAWOPIS (National Workshop Programme in Statistics)
  - Apts good model
  - Sustainability SPAWN
  - To energise and co-ordinate UK statistics agile engagement in rapidly developing areas of priority research, leveraging the particular strengths of UK stats research
  - National connectivity fast response, Infrastructure to admin workshops
- User Needs:
  - Balance of funding right questions that users + research can collaborate on
  - Smith Workshops Institutes
- Barriers to Connectivity – Lack of extension, Language barrier, Getting the context, incentives?

### **Impact Session (Sam)**

- Hub & Spoke Model:
  - Neighbouring university teaching undergrads (sharing expertise)
  - Connectivity in the UK
- Should statisticians be involved by design on other grants?
- Big Data must include statistics
- Matched funding can have impact
  - Universities & RCs
  - NHS co-funding
  - No prioritisation in Responsive Mode
- Could be clearer in responsive mode that stats is a grow

- Industry benefit from trained students should there be an industrial grouping to fund stats research
- More cross council working / funding
- S & I awards has had impact on discipline – attracted to overseas people
- Co-funding by university + EPSRC to rebuild statistics as a viable academic grouping. (use S&I mechanism?)
- Continue to support applied prob within a statistics environment, at the stats / prob interface
- Forced joint research ensures statisticians are involved at the start of research to plan / design study and research methods

### **Impact Session 3 (Mike)**

- Connectivity with other disciplines requires an investment (of time and effort in in familiarisation) and there is a risk.
- EPSRC could fund stats/prob through “applied science with novel statistics” type calls, instead of funding “mathematical statistics” as currently.
- Need specific calls with input from different councils
  - So no danger to being out of remit
- Collaboration not explicitly promoted through responsive mode
- Perception of difficulty with interdisciplinary proposals (part it between councils)
- Need separate panel lists for interdisciplinary proposals?
- Ref maths panel looting of stats papers
  - Discovering corrections with other fields
  - Safer to stay in maths
- EPSRC don’t seem to actively encourage / fund “Connectivity”
- Grand challenges quite a passive way of encouraging connectivity > specific calls
- Good deal of current connectivity but more opportunities than people
- Danger that S&I award positions have replaced rather than augmented existing positions
- If had more collaboration would be greater uptake of methodologies
- An increase in the level of funding for statistics coming from other themes would be an indication of increased connectivity

### **Session 3 (Chris)**

- Research where both disciplines are on an equal footing
- The impact of statistics is not always within statistics only.
- Other areas benefit from practical applications
- Areas of EPSRC e.g. engineering not recognising uncertainty
- Statistics needs to be recognised over centralisation has helped this.
- Opportunity of big data etc. requires mathematical sciences community together.
- Enterprise model of Ptl
- There’s a need for research into topics that can be applied readily by industry / govt.... possibilities for collaboration e.g. Big Data
- Interdisciplinary has to pretend to be a single subject and vice versa. Impact statements are fake.
- I don’t own my research – it will propagate or not organically following testing by my peers
- EPSRC could promote statistics to other RCs better
- UK statistics has big impact but hard to quantify using current metrics
- Impact statements can cause perfectly strong proposals to look weaker by distracting refs

- Investment in UG innovation will have impact into the field itself and therefore impact moves broadly.

## SESSION 3B – SWOT ANALYSIS

### SWOT

#### Opportunities:

- Uncertainty & variation are ubiquitous
- To be less concerned about definitions / boundaries (e.g. statistics vs probability)
- Joint bidding with other disciplines
- Hadoop
- Core support for software development and maintenance to facilitate impact of methods
- Currently there is interest for statistics / data analysis people / methods
- The use of statistics can be very poor in other disciplines
  - Much room for improvement

#### Threat:

- Uncertainty & variation are ubiquitous
  - So non-academic employers buy up our talent
- UK people pipeline weak in transferring UG students to statistics
  - Needs culture growth in UG teaching
- Hadoop
- Focus on metrics, some things are not easy to quantify

### SWOT

#### Opportunities:

- High performance computing
- Data science
- Big Data
- Big Data – Big experiments, big funding?
- Might be able persuade them – stats critical to underpin it
- Higher public profile for data (big or not)
- Increasing quantity of research and society
- SPAWN
- More collaboration between academics & industry
- Better management of uncertainty in modelling, leading to better decision making, it better risk management
- Ref: Impact clear from Ref for stats
- Educate the general public – Students, journalists, teachers, politics, judges about use & misuse of statistics , and the importance of the subject

#### Threat:

- Other groups more into fill voids (UQ, Data analytics)
- Big Data

- Willingness of some to make do with out of date methods
- Loss of identity to data science
- Loss of rigour to data science
- Too much fragmentation
- Why people distributing money don't understand stats, lots of other areas involved
- Academics will be attracted to other countries
- Too few good graduates applying to work in the area
- Everyone uses stats, so everyone thinks they can do it
- Highly paid jobs outside academic impacts pipeline of research leaders
- Competition from other industry – difficult to recruit
- We spend too much time thinking of threats, so miss the opportunities
- REF stats hidden
- Industrialisation of academic research. The impact of academic research can often be seen in long terms.
- The pipeline break might not be fixed of too much compliments on industry
- Areas with few researchers could vanish
- Too much time spent justifying research rather than doing it.

## **SWOT**

### **Strength & Weaknesses**

- Empirical Tradition
- Naturally multi-disciplinary
- Applied probability
- We are nice people – this helps inter-disciplinary
- Opportunities exceed potential supply
- Research has very high in traditional profile – helped by big initiatives like S&I and CDTs
- Applicable to many other subjects
- A great subject to study – A great community
- We “Do” uncertainty (well)
- Spot links across different disciplines
- UK statistics broad & connected
- Strong track record + reputation
- Methodological > Application/Impact

### **& Weaknesses**

- Too self critical
- Spread too thin – many people use statistics
- Other themes don't currently fund statistics very much
- Too few people means that some areas are overlooked for collaboration
- Demographics of UK Statistics
- Not enough capacity
- Need to inspire younger generation about the diversity and value of statistics
- Bad at hype (compared to our competitors)
- Journals
- Lack of funding for international PhD students
- There are not enough of us - Lots of demand
- Fragility of people pipeline

- Lack of diversity in academic, due to career progression patterns and demands
- Many areas of science lack the critical mass of statistics to have impact
- It is very risky for individual researchers to enter such application areas
- Not enough stats departments
- Subject is not well understood and sometimes mis-trusted by the public at large.

## SESSION 4 - NEXT STEPS

### Next Steps

#### Page 1 – Ideal Scenario in 5 years time

- Stats professor in every Uni
- Applied probability professor in every department
- Sufficient critical mass of statisticians in other science areas, to change culture of analysing data.
- Undergraduate mathematicians having more positive attitude to statistics
- Meaningful MSc funding
- Leading to supply of statistics expertise meeting future level of demand (which will be much greater than at present)
- Smaller / more / more versatile CDTs
- Statistics clearly enabling other sciences to do new things
- Funding better distributed across the country (more small / medium size grant opportunities)

### Next Steps

#### Page 2 – STEPS (How do we get to ideal?)

- Clear definition of applied probability
- 1<sup>st</sup> Steps: UG & MSc funding activities
- Funding for overseas PhD Students
- Funding summer students for UGS in stats, prioritise attendance from Universities not currently research active in statistics
- Send clear message that statisticians can work in other departments
- Outreach from existing centres of excellence
- Bath Uni trip to BT of 10 researchers > 2 PhD studentships
- Quicker application process for small grants (Under £1000) especially regarding impact (active cost for application)
- Try to have visible impact outside academia
- EPSRC on incentive risk taking in moving into new areas – fellowship opportunities
- Maintain S&I momentum – continue workshops etc.

### TABLE 2 (IN BOLD ARE GROUPINGS)

#### People

- Statistics is as sexy to maths undergrads as it is to Google executives
- We always select people, rather than begging them
- All vacancies filled with highly – skilled statisticians + good supply of new people

### **Training (ARROW TO COLLABORATION VIA GOVERNMENT FUNDING)**

- Taught CDT programmes to include statistics module(s)
- Methods better established for admin data and Big Data
- Good training, easily available in all aspects of stats, and for conversion to stats
- Statisticians skilled in whole range of other areas
  - Communication
  - Collaboration
  - Consultation

### **Government Funding**

- A country full of Warwicks, but all different
- Sufficient budget within government to be able to do research

### **Interdisciplinary & Visible**

- Statistics well represented in cross – disciplinary research
- More awareness of (and more capability in) stats by other disciplines at undergraduate level
- General acceptance of the central role of statisticians in data science collaborations
- Statistics as respected and integrated into all disciplines, as well as it is in genomics
- UK Science stops tolerating irreproducible results
- Core statistics activity to encompass new (fad) topics such as Big Data / Analytics regaining lost ground
- Statisticians recognised as essential in all disciplines
- Research councils re-organise so that statistics is not a minority bit of a typical subject in one and randomly scattered in the others
- People interested in statistics and the subject well respected in all walks of life

### **Collaboration**

- Potential collaborators understand what we can do and can find us
- Good collaboration between academia and industry / government

### **Next Steps**

- Mobility into statistics fellowships (LINKED TO TRAINING GROUPING)
- Collaboration with EPSRC & RSS?
- Peer Review process – ask them about the quality of data collection e.g. statisticians “sign off” on proposed methodology
- More better stats taught at UG level related degrees > more demand on stats department
- Call for joint research bid stats + X

## **TABLE 3 (GROUPINGS IN BOLD)**

### **People**

- MSc funding from RCS
- Inability fellowships to bring people into statistics from other disciplines
- More P&T and S & R studentships

### **I vitalise**

- NERC / BBSRC calls require statistical components that are EPSRC funded
- Fellows to propagate research culture into the UG > Mentors > PhD Cycle

- Statistical science cross council research theme
- Application driven statistics is routine targeted for interdisciplinary calls
- Central to interdisciplinary research teams
- Interdisciplinary (statistics) research culture as permitted through to UG mathematics & statistics degrees
- EPSRC better co-ordinate to dichotomy of academic peer review and driving themed agendas

#### Perception

- Recognised as a discipline, not a service
- We stop using the words “statistics & applied probability” and start using the word “statistics”

#### Central

- Fellowships / Initiatives opportunities not limited to researchers in DTCs
- CDTs are smaller more in number and more focused
- EPSRC finally listens to the local and international advice that over funding in counter productive

#### Data

- Central to data science

#### NEXT STEPS, HOW DO WE GET TO THIS

1. Statics & Applied Probability + other disciplines encouragement call?
2. Statistics grants should / can have a co-investigator from science
3. EPSRC fund masters in statistics & applied probability
4. Peer Review, questions as process to take better view of statistics & applied probability high potential
5. Another S&I to support smaller / groups at non critical mass grants

#### TABLE 4 – ACTIONS FOR HOW WE GET TO IDEALISED FUTURE IN BOLD

##### Next Steps

- New statistics departments established
- **To Do:**
  - **Get / redirect Uni funds to statistics e.g. mandate all grants to have stat input**
- Rebirth / revival of one or more major statistics groups at large universities where statistics is currently weak/absence
- Several large and medium sized departments of statistics
- Increased stats + applied probability faculty sizes.
- Increased diversity of topics
- Increased number of universities with significant coverage in stats & applied probability
- New statistics departments opening
- **To Do:**
  - **Strategic partnerships / consortia between academia + industry to build long term relationships + promote 2 way flow of skills + ideas**

- **To Do:**
  - **Education / awareness raising**
  - **What stats can offer to applied research / industry**
  - **Making stats “sexy” to next generation**
  
- Involvement of trained statisticians seen as essential in all applied research involving quantitative data analysis and sufficient trained statisticians to support this
- **To Do:**
  - **Reviewing have statistics is taught at school (when many are turned off)**
  
- More people appreciate “What is statistics”
- Big Data renamed to just Data
- Stats playing key role in Big Data
- Attract the best academics internationally
- Attract the best students internationally and nationally
- Strong shortlists for academic jobs at all levels
- UK salaries competitive?
- More competitive salaries to recruit top people
- Supply of suitable qualified statisticians meets demand
- More people, More Breadth
- **To Do:**
  - **Find ways to collect useful data on this**
  
- **To Do:**
  - **Offer top scientists, have difficulty in accessing research funding.**
  - **Naturally they would have no difficulty obtaining funding in other geographic locations (US, Asia, certain European countries)**
  
- Research international recognition
- UK authorship in top statistics journals shows increase
- UK statistics / faculty being hired by top international departments
- UK departments able to attract top talent abroad
- More positive comments from the next international review of mathematics
- **To Do:**
  - **Allow EPSRC funding for OS PhDs**
  
- Significantly increased PhD numbers (largely by boosting OS recruitment)
- More PhD Students
- More separate statistics departments
- More postgraduate students (funded?) MSc + PhD
- Greater engagement with industry two way embedding of staff (at uni + at companies)
- **To Do:**
  - **Incorporate statistics requirements explicitly into all relevant RCUK grant applications**
  
- RCUK to up on statistics
- RCUK programme on statistical science
- Separation of stats from Maths