



**OR Theme Day Report**  
**15<sup>th</sup> September 2015**

## **Foreword from the working group**

This report was prepared by a working group of operational researchers and members of the EPSRC Mathematical Sciences team. The working group comprised an international representative (Professor Barry L Nelson, Northwestern University), representatives of the Operational Research Society (Professor Stewart Robinson, Mr Gavin Blackett) and UK academics (Professors Edmund Burke and Kevin Glazebrook), who currently serve on the EPSRC ICT and Mathematical Sciences Strategic Advisory Teams. The EPSRC contribution was led by Hannah Pearson.

The report reflects discussions held on the Theme Day and contributions made in advance. It is further informed by analysis and information provided by the working group. The working group would like to thank EPSRC staff for their hard work in planning the Theme Day and for their positive and supportive attitude throughout. Thanks also go to the many Operational Research (OR) groups and individuals who contributed to the Theme Day by providing comments and data in advance and to those who participated in the day itself.

OR plays a vital role within the UK economy and society, underpinning a wide range of industries and public services. A recent report of discussions within the Mathematical Sciences SAT on EPSRC Delivery Plan outcomes identified OR as having a leading role in meeting key challenges in all four areas (UK a Connected, Healthy, Productive and Resilient Nation). A recent NSF report has reflected on its role as a catalyst in meeting key contemporary and future challenges. The model fitting that underlies data science, and the translation of data into operational excellence, are built on OR.

However, there continues to be a shortage of the skills that OR provides in both academe and practice. We believe that it is vital that a vibrant OR research community is sustained in the UK to meet these challenges and that EPSRC has an important role in achieving that.

Gavin Blackett  
Edmund Burke  
Kevin Glazebrook  
Barry Nelson  
Stewart Robinson

# 1 Introduction

## 1.1 Background

UK is the home of Operational Research (OR) and continues to house a strong and thriving OR community. The Operational Research Society has a membership which is significantly larger than those of other national societies in Europe. After INFORMS (in the US), it is the second largest OR association in the world. OR in the UK has remained close to its interdisciplinary roots and has a worldwide reputation for its application focus and impact. Many UK companies employ operational researchers. Some continue to work in large dedicated OR groups but they are increasingly to be found in analytics roles in companies and consultancies. OR plays an important role in government and the public services. UK OR is considered world-leading in many areas. The International Review of Mathematical Sciences 2010 (IRMS 2010) stated that "UK researchers represent excellence in continuous, stochastic and combinatorial optimisation in particular; UK work on hyper-heuristic methods is world-leading and has had a significant impact."

Since its inception in the 1940's and 50's OR has had a major impact upon a huge array of application areas. A recent National Science Foundation (NSF) report '*Operations Research- A Catalyst for Engineering Grand Challenges*' points to a number of emerging areas under the broad heads of *Sustainability, Security, Human Health and Joy of Living* in which OR has a central role to play in shaping the future.

OR research can be driven by applications or methods. In the UK, the predominant research tradition pursues methodological innovation in response to applied challenge. For EPSRC-funded OR, this methodological innovation most often has its roots in mathematics and/or computer science. Consequentially, the EPSRC OR portfolio is primarily located within the Mathematical Sciences and Information and Communication Technologies (ICT) themes but also reaches out into Engineering and the Challenge themes. The only EPSRC research area in which OR is identified in the title is 'Mathematical Aspects of Operational Research' located within the Mathematical Sciences theme. However, OR is also explicitly identified within the description of the 'Artificial Intelligence Technologies' research area of the ICT theme. OR also has strong links to the areas of 'Fundamentals of Computing' (ICT), 'Logic and Combinatorics' (Mathematical Sciences) and 'Statistics and Applied Probability' (Mathematical Sciences). Research in OR has high impact and underpins research in the EPSRC Challenge themes. To date, it has proved critical in tackling challenges within the Manufacturing the Future and Energy themes. It should be said that divining boundaries between OR and related disciplines is not always straightforward. OR-developed tools are in routine use in other disciplines, with optimisation being part of many general purpose toolkits such as Matlab.

OR has received important large awards from EPSRC in recent years. The 2004 *Review of Research Status of Operational research in the UK* identified a threat to the future health of

UK OR in that the community ‘developing new theory and methodologies’ was too small. As a consequence, ‘foundational OR’ received EPSRC support via the Science and Innovation programme in the form of the LANCS Initiative (2008-2014) (<http://www.lancs-initiative.ac.uk/>). LANCS spanned mathematics and computer science and took the form of a collaboration between EPSRC and four UK Universities (Lancaster, Nottingham, Cardiff and Southampton). Its principal objective was to ‘*build and maintain national research capacity in foundational OR*’. Another Science and Innovation grant which built OR capability, though on a rather smaller scale, was DIMAP (*‘Discrete Mathematics and Its Applications’*, 2007-2014; Warwick).

To date, one Centre for Doctoral Training (CDT) and two Programme Grants have grown from the LANCS investment. STOR-i is an industry-facing Centre for Doctoral Training (CDT) in statistics and OR at Lancaster University. It was established in 2010 and was subsequently refreshed and awarded a second round of funding from 2014. The DAASE (2012-2018; Birmingham, Stirling, UCL, York) and OR-Master (2015-2021; Lancaster, QMUL) programme grants bring innovative OR approaches to bear on challenges arising respectively in search based software engineering and the deployment of airport capacity.

Within the Mathematical Sciences theme, the research area ‘Mathematical Aspects of OR’ has been set as a ‘maintain’ portfolio within the EPSRC Strategy. However, the amount of research funding coded to this area has declined over the period April 1<sup>st</sup> 2011 to April 1<sup>st</sup> 2015. Note that a more detailed discussion of the current position of EPSRC funding for OR is included as Section 2 in this report. As a result of this decline, an internal review of the research area was undertaken which engaged with the Mathematical Sciences Strategic Advisory Team. An action plan for the area was then formulated. EPSRC committed to working with the Operational Research Society to organise a review day to explore the OR portfolio. The agenda for the day included consideration of the funding routes for OR and whether the current OR taxonomy was still appropriate. It sought to define a clear vision for the future of OR. For more details see <https://www.epsrc.ac.uk/research/ourportfolio/researchareas/maor/maoractionplan/>. Although EPSRC approached this theme day from a mathematical sciences perspective, it was clear that the agenda items would need to embrace more than OR’s mathematical aspects alone. The theme day involved colleagues from both the ICT and Engineering themes in its planning and delivery. The EPSRC Mathematical Sciences team also shared information and ideas with colleagues in the challenge themes: Energy, Healthcare, Manufacturing, Digital Economies and PACS (Partnership for Conflict, Crime, and Security Services).

The workshop was held on Tuesday 15<sup>th</sup> September 2015 and was a productive opportunity for different communities of academics, industry and the Operational Research Society to engage and to explore OR’s landscape, including future opportunities and the possible barriers to progress.

The results of the workshop, including this report, the notes taken during the day and continued engagement with the working group, will be used to assist EPSRC in developing future understanding and direction of the OR portfolio.

## 1.2 Aims and Objectives of the Theme Day

Drawing upon the advice of the working group, the action plan for OR and the priorities for the Mathematical Sciences theme, the following objectives were identified for the event:

- To encourage discussion between a diverse selection of the research community including mathematicians, engineers, computer scientists, business representatives and other users resulting in:
  - Better understanding of the research area, in particularly why there has been an apparent decrease in funding in the 'Mathematical Aspects of OR' area;
  - Explore research and application areas within the broad theme of OR;
  - Exploring who is part of the OR community, and understanding the concerns around the people pipeline;
  - To understand the future opportunities for OR and what barriers may potentially hinder progress.
- To help develop an EPSRC-wide understanding of OR research and whether new research directions should be pursued to address any concerns in the evolution of the OR grant portfolio.
- Seek to define a clear vision and set of challenges for OR.

## 1.3 Attendance at the Theme Day

There were 38 delegates in attendance at the event from a range of academic and industrial disciplines including mathematical sciences, manufacturing, ICT and engineering (for the delegate list, see Annex 1).

## 2 The funding landscape for OR

The central claim concerning the decline in funding within 'Mathematical Aspects of OR', which gave rise to the action plan of which the OR Theme Day is a part, is summarised by the figures given in the recent Mathematical Sciences SAT briefing as follows:

***Portfolio change (excluding training): This research area has changed from 0.44% (£11,272,626) on 1 April 2011 to 0.20% (£5,453,236) on 1 April 2015 as a proportion of the EPSRC portfolio.***

Given both the OR-wide focus of the Theme Day and the potentially distorting effect of the presence of recently finished large grants, the working party considered it important to give an account of OR funding across all EPSRC themes which would give a more nuanced and more complete picture than the above statement. The working party takes note of the following:

- Of the £11.3M 'Mathematical Aspects of OR' portfolio active on 1/4/11, no less than £8.5M arose from large grants (ie, of more than £3M). The principal contributors were the capability building Science and Innovation awards LANCS (total EPSRC contribution: £5.4M) and DIMAP (£3.8M). Neither of these were active in the portfolio on 1/4/15;
- Given the above, it is already clear that the active 'Mathematical Aspects of OR' portfolio beyond the Science and Innovation awards has in fact grown in the period to 1/4/15. It is worth noting that capability building investments would be expected to have this effect. Furthermore considerable funding success within the 'Mathematical Aspects of OR' portfolio after 1/4/15 means that several recent investments (including the OR-Master Programme Grant, 2 MAOR Fellowships and responsive mode grants) representing an EPSRC investment in research in this area almost £4M are not included in the above figure of £5.4M for 1/4/15;
- Considerable investment in OR is current in the Artificial Intelligence Technologies research area within the ICT theme. This includes the DAASE Programme Grant (total EPSRC contribution: £6.8M). We have made no attempt to estimate a total figure, but a brief inspection of grant titles/summaries in Grants on the Web would suggest that the figure is considerable. In several cases of research investments in OR (or areas closely related to it) within the ICT theme, no reference to 'Mathematical Aspects of OR' is made in the grant summary.

The working party concludes:

- (i) that the picture of current EPSRC research investment in 'Mathematical Aspects of OR' is significantly healthier than a straightforward reading of the above headline figures would suggest;
- (ii) that no adequate picture of EPSRC investment in OR overall can be achieved without a serious interrogation of the situation within the ICT theme and beyond.

### **3 Theme Day Outputs**

The Theme Day included five sessions (for the full agenda, see Annex 2) building on introductions from EPSRC and the Operational Research Society. It also drew upon an initial session which developed a SWOT analysis of UK OR, the research area and its application to industry and other end users. Subsequent sessions considered specific concerns, particularly around the people pipeline and the EPSRC taxonomy. They also reflected on the future of OR research and its applications. The following discussion provides a review of the outcomes of the workshop and an indication of key areas of interest which were developed during the course of the day. The report concludes with recommendations from the day and suggested responses and actions related to some of the recommendations.

### **3.1 Strengths, Weaknesses, Opportunities and Threats**

#### **Aims**

The aim of the session was to understand the OR landscape in terms of strengths, weaknesses, opportunities and threats. The first two need to be addressed from a UK perspective, the second two from a broader international perspective.

#### **Activity**

In order to understand the OR landscape, an initial analysis was undertaken in groups. To begin with, participants were asked to focus on what is strong and weak in the UK, including areas of research, university departments, industry strength, funding related issues, capacity related issues and the people pipeline.

With opportunities and threats it was considered to be important to think more broadly than just the UK. For example, are there calls for funding through Horizon2020 that the UK should be targeting? Are we losing academics or industry to other countries? If so, why? Are other countries investing more in OR than the UK?

#### **Key outputs**

Common themes for strengths and weaknesses for the research area are summarised below. In addition, following from the SWOT analysis the key opportunities and threats were chosen and clustered. They were agreed as follows:

#### **STRENGTHS**

1. Large and thriving OR community;
2. A thriving Operational Research Society which sustains strong links with end users;
3. Respected internationally as the home of OR;
4. Strong international engagement;
5. World-leading sub-areas, including a strong computational search and optimisation community which spans mathematics and computer science;
6. Strength in some of the softer aspects of OR including simulation, decision-analysis, and system dynamics;
7. Outstanding early career people and a new generation of research leaders;
8. Pro-active research council, in EPSRC, which is keen to engage and facilitate the environment for a healthy research base;
9. Strong focussed centres for training and research with critical mass;
10. Strong application relevance and focus; scientifically challenging research agendas rooted in complex real-world challenges;
11. UK OR remains close to its interdisciplinary roots.

#### **WEAKNESSES**

1. No obvious home for OR in the UK funding system;

2. The research community has a lack of 'know how' regarding the funding system both as applicants and reviewers;
3. Perception that the UK's strengths (interdisciplinarity; strong application focus) may actually be impediments to funding success;
4. Research pipeline not well filled at any stage; very low numbers of PhD students who are UK nationals. There is an increasing reliance on non-UK nationals in the OR academic community;
5. Some sub-areas reliant on very small numbers;
6. The number of researchers undertaking foundational research remains too small;
7. Poor branding and visibility - OR not sufficiently well known and understood beyond its core community;
8. Operational Research Society insufficiently research focussed and insufficiently proactive in supporting research funding opportunities.

## **OPPORTUNITIES**

1. OR's capability to address topical and socially important large and complex real-world problems;
2. Access to end users with important research problems; Operational Research Society houses a receptive user community;
3. Big Data - realising the value in data for decision-making; real-time data/decision challenges; optimisation and computational search represent key mechanisms for Big Data analysis;
4. OR challenges posed by emerging applications and technologies and a 'doing more with less' world; OR central to outcomes for EPSRC Delivery Plan (cf. NSF report);
5. REF impact is empowering for OR;
6. 'Mathematical Aspects of Operational Research' a priority area for EPSRC Fellowships;
7. Openness of EPSRC to support OR and to re-think its approach;
8. Funders beyond EPSRC Mathematical Sciences and ICT themes: EPSRC Challenge Themes, Horizon 2020, Other EU, NIHR, other RCUK, NHS, regional sources;

## **THREATS**

1. OR's lack of visibility to potential PhD candidates, the huge array of excellent job opportunities outside of academia and uncompetitive academic salaries could all further diminish the research people pipeline;
2. Weak people pipeline threatens the future quality and quantity of OR research and international competitiveness;
3. Issues with peer review and OR community engagement with EPSRC could mean that key OR research will not get done;
4. Perception that a tendency for funders to offer funding via large grants could marginalise small OR groups and inhibit their growth;
5. Too few strong groups;



6. Discipline boundaries: OR is inherently inter-disciplinary and there is a perception that this may make funding more difficult to obtain;
7. Poor knowledge and understanding of OR means that it can often be overlooked (in the development of research initiatives, for example) when it has a key role to play;

## **3.2 People Pipeline**

### **Aims**

Determine an accurate picture of the UK capacity by looking at where the skilled people come from and their employment destinations. In addition, the sources of funding for the people pipeline should be analysed to determine where the difficulties lie.

### **Activity**

Attendees at the workshop were asked to provide information about the flow of people and associated funding sources. Moreover, delegates were asked to highlight areas that could develop into people pipeline difficulties in the future.

### **Key outputs**

- UK funders include EPSRC and other RCUK, Innovate UK, Industry, Charities, Leverhulme Trust, NHS, Learned Societies and Government Departments such as the MoD and Defra.
- International funders include the European Union, Overseas Government PhD Funding and some Hospital Trusts.
- OR is not visible at undergraduate level to more than a small potential pool of postgraduate students from within the UK. For this small pool, postgraduate study is in competition with attractive and lucrative career opportunities outside of academia.
- Masters programmes have traditionally been the main entry point for OR careers for UK students. Financial support for these programmes has declined markedly over the last decade.
- There is a concern over visa requirements for MSc and PhD students and the effect on international recruitment.
- Rules about UK funding for overseas PhD studentships could lead to a competitive international recruitment disadvantage for the UK.
- The English Language offers a competitive international recruitment advantage over other European countries
- OR MSc and PhD students are attractive to industrial sectors such as Finance, IT and Consulting which can often offer very high salary packages that universities cannot compete against.

## **3.3 The Future of OR**

### **Aims**

Identify strategic directions for OR and consider what challenges and actions would need to be undertaken to pursue these strategies. This included a consideration of who should be involved in the determination of these strategies.

## Activity

Before the workshop, participants were asked to describe their future visions for OR. During the workshop, participants were asked to address the following questions:

- Which disciplines should be involved?
- What are the application areas?
- What are the key research areas?
- What are the challenges? What are the barriers?
- What does EPSRC need to do to contribute towards achieving the vision?
- What do researchers need to do to contribute towards achieving the vision?

## Key outputs

Two common elements emerged from the discussion:

- The tension between a recognised need for an interdisciplinary approach for OR and the challenge that this presents in terms of both an identity for OR and its fit to research council remits.
- The diversity associated with OR in terms of both the academic disciplines involved and the application domains of relevance.

The group was asked to consider the implications for OR if EPSRC does nothing *differently* or if EPSRC does nothing *at all*. Observations included:

- EPSRC has a critical role to play in maintaining the people pipeline in both academia and industry.
- EPSRC plays a pivotal role in the funding of OR research. It is far from clear that financial support for much key OR research (especially with a strong methodological drive) is available elsewhere.
- Any perceived ambivalence of EPSRC toward OR research would inevitably lead to a decline in OR's standing within universities. As with statistics, the challenge of maintaining OR strength in the academy has already led to concentration, with a relatively small number of strong groups.
- EPSRC support is critical in realising OR's huge potential for impact on industry and society. A recent NSF report provides evidence of OR's centrality to outcomes for EPSRC's Delivery Plan. (See Section 3.1 under 'Opportunities'). The importance of OR's role in this regard was further reflected in a recent report of discussions within the Mathematical Sciences SAT.
- *EPSRC doing nothing differently* would fail to recognise the difficulties which the current arrangements for OR within EPSRC pose for the subject and which inhibit its ability to realise this potential impact.

## **3.4 Taxonomy**

### **Aims**

This session was designed to gather information from the attendees regarding their understanding of how OR applications are dealt with and coded within EPSRC, as well as to understand what challenges the taxonomy posed for the community. This information will help EPSRC decide whether or not changes to the way OR applications are coded might be beneficial.

### **Activity**

A presentation outlining how OR proposals move through the grant system at EPSRC from academic submission to peer review was given. This focussed on the fact that OR proposals all come to the portfolio manager in the Mathematical Sciences theme who manages the 'Mathematical Aspects of OR' portfolio. It was also explained what EPSRC uses its taxonomy for and what limitations govern it. The biggest concern highlighted by EPSRC in this session was that it is currently very difficult to track OR proposals which do not have novel mathematical content as they are not coded to the 'Mathematical Aspects of OR' area. With OR being such a cross-cutting area, there may be much of EPSRC's portfolio which is relevant to OR, but not coded as such.

The attendees were asked for feedback on the following questions:

Who would describe themselves as an OR researcher?

Do academics do OR research but not call it OR?

Do you agree with the current taxonomy?

Would an arrangement like that for the current Complexity Science research area work for OR? This is a cross-cutting research area which is managed by one theme but where proposals go through peer review within the theme judged most relevant for the research proposed.

The above questions stimulated discussion on the peer review process, reviewing, interdisciplinary proposals and the possibility of a future OR call.

### **Key outputs**

- Most attendees see themselves as OR researchers. However their self-description often depends on who they are talking to or working with;
- There are many academics doing OR, or using OR techniques, who do not credit the research area. This can be frustrating and lead to missed opportunities for collaboration, reinventions of the wheel and a lack of visibility for the underlying research;

- The current taxonomy is not universally supported and many would go as far to say that it deters some academics who feel that their research would not be accepted by EPSRC under 'Mathematical Aspects of OR'. A name change for the area would be seen as a positive sign by the research community;
- There is concern regarding inter- or multi-disciplinary proposals and how these fare through EPSRC's peer review process. This concern also applies to other research councils.

### **3.5 Application Areas**

#### **Aims**

To look at how OR crosses EPSRC and the remit of other councils. What are the application areas of OR and how to engage with the diverse members of the community? This session aimed to build on the previous sessions concerning the future of OR and its people pipeline.

#### **Activity**

In groups, participants were asked to write down the ideas for the question "What are the application areas of OR?" They then moved groups to expand on previous ideas and discussions. A list of OR application areas (in no specified order) is:

- Artificial intelligence (ICT) – interdisciplinary approaches generally
- Decision support
- Big Data/analytics
- Transport
- Energy
- Government: policy development and evaluation
- Manufacturing and service industries
- Revenue Management
- Climate change
- Sustainability
- Healthcare
- Education
- Scheduling
- Timetabling
- Sport
- Finance
- Infrastructure planning and resilience
- Reliability and maintenance
- Security and defence
- Overseas development
- Search based software engineering

- Emergency management
- Inequality of access
  - Internet balloons
  - Drones for medicine delivery
  - Microfinance
  - Agro and water
- 24/7 NHS
- Intelligent adaptive systems research
- Bioinformatics
- Supply chains
- Logistics
- Telecommunications

Following this exercise, participants were then asked to consider the questions:

- Which type of researchers would need to be involved with OR research?
- Which research councils or other organisations should be involved? (include departments/themes for other research councils or organisations);
- Where would you seek funding for this research?

### **Key outputs**

- OR researchers can consider themselves in three ways:
  - 1) methodologically driven (with the methodology then deployed in a range of applications);
  - 2) application driven (where the focus is on the application and methodology is developed in response to this);
  - 3) practice driven (with a focus on how OR is practiced and how its practice could be improved).
- OR research has applications across many sectors and application areas. It is typically interdisciplinary and involves collaboration with a range of researchers including computer scientists, engineers, mathematicians, statisticians, economists and social scientists (depending on relevance and need).

Sources of funding are discussed elsewhere in the report. EPSRC plays a major role in the funding of methodologically driven research in OR in the UK. It also funds some OR research that is application and practice driven. In the latter, the Challenge Themes can play a role. See item 8 under 'Opportunities' in Section 3.1, Section 3.2 and the conclusion to Section 3.3.

## **4 Overall Conclusions**

- There is significant world-leading OR research in the UK and strong industry demand for operational researchers.

- As an academic discipline, OR is dispersed. It is to be found in a variety of different schools and departments within universities (e.g. mathematics, computer science, business and engineering). There is not a single disciplinary source for OR research and practice.
- OR is more than ‘Mathematical Aspects of OR’. Much OR research is interdisciplinary and needs strong links with mathematics, statistics, computer science, business, engineering, areas of application, industry, government and social scientists.
- OR research impacts upon real-world complex problems across a wide and diverse range of applications.
- EPSRC funding is vital to the future health of OR in the UK. However, some re-thinking of EPSRC’s approach to the subject and greater engagement from the community and the OR Society is required.
- There is considerable concern over the current state of the people pipeline which is not well filled at any stage. There are clear threats to the future quality and quantity of OR research and therefore eventually to OR practice.

## 5 Recommendations

There are a number of recommendations which came out of the theme day and these will be discussed with the working group, the Mathematical Science Strategic Advisory Team and wider EPSRC to consider the impact and feasibility of the recommendations. They can be outlined as follows.

- Develop engagement between the OR community (industry and academic), EPSRC and the Operational Research Society.
- Look for opportunities specifically within current themes including infrastructure, uncertainty, and data analytics for OR to engage with real-world problems in critical need of OR support. EPSRC and the Operational Research Society should signpost OR’s huge potential and communicate potential opportunities to the community.
- Carefully study the people pipeline, including regular monitoring to provide a continuous picture of the evolving skills landscape.
- Track OR funding. This comes from a variety of sources and should be monitored to see whether any shift in funding occurs over time and to be able to anticipate such shifts. The academic community and the Operational Research Society need to engage with this.

### Recommendations for Research Councils

- Change the taxonomy of “Mathematical Aspects of OR” within EPSRC to call it “Operational Research” and develop a suitable definition of the new research area.
- Consider OR representation on the EPSRC college and ensure that there is a broad and appropriate OR membership.
- EPSRC should ensure that there is a clear understanding of OR and the wider portfolio in and beyond the mathematical sciences.
- EPSRC should work with other organisations (for example, ESRC, Innovate UK and the OR society) to develop joint support/activity for OR.

- EPSRC should ensure that OR researchers are involved in discussions on emerging societal challenges and themes.
- Consider workshops focussed on OR and societal problems involving academics and industrialists. We are aware that EPSRC have started working more with the OR society in the organisation of the theme day and will look to engage more with the OR society going forward.

### **Recommendations for the OR Community**

- The OR community should strengthen its engagement with EPSRC in peer review including:
  - Updating details in the Je-S system to support EPSRC in finding appropriate reviewers for OR proposals and encourage colleagues to do the same.
  - Assist with review and participation in panels. Where relevant, the OR community should nominate appropriate replacements.
- The OR community should take a pro-active positive approach to close engagement with EPSRC.
- The OR community should make full use of the research councils' remit query services when proposals sit across remit boundaries prior to submission.
- The OR community should be proactive in promoting OR beyond its core community. A major upcoming conference jointly sponsored by the OR Society and the IMA is a positive example of engagement with the wider mathematical community.
- OR is important for data analysis and provides a framework for turning data analytics insights into decisions. It is important to look for opportunities in analytics and big data particularly within the current large investments in this area, including the Alan Turing Institute.

### **Recommendations for the OR Society**

- The OR Society should engage more strongly with EPSRC and with the academic OR community.
- The OR Society should be active in communicating potential opportunities to the community.
- There is a need for a greater emphasis on research within the OR Society.
- The OR Society should monitor the health of OR funding across different funding bodies including EPSRC, other RCUK, EU, charities, Government and industry.
- The OR Society should promote a stronger interfacing with COPIOR and HORF on research issues.

## Annexes

### Annex 1: Theme Day Attendees

<b>Working Group</b>			
Dr	Gavin	Blackett	OR Society
Professor	Edmund	Burke	Queen Mary, University of London
Professor	Kevin	Glazebrook	Lancaster University
Professor	Barry	Nelson	Northwestern University (USA)
Professor	Stewart	Robinson	OR Society
<b>EPSRC Staff</b>			
Dr	Anke	Davis	EPSRC
Dr	Philippa	Hemmings	EPSRC
Dr	Diane	Howard	EPSRC
Dr	Hannah	Maytum	EPSRC
Miss	Ruqaiyah	Patel	EPSRC
Dr	Hannah	Pearson	EPSRC
Dr	Chris	White	EPSRC
<b>Attendees</b>			
Professor	Steve	Alpern	University of Warwick
Professor	Thomas	Archibald	University of Edinburgh
Dr	Peter	Ball	Cranfield University
Professor	Sally	Brailsford	University of Southampton
Professor	Juergen	Branke	University of Warwick
Dr	Alistair	Clark	University of the West of England
Dr	Ozren	Despic	Aston University
Professor	Richard	Eglese	Lancaster University
Professor	Thomas	Erlebach	University of Leicester
Professor	Joerg	Fliege	University of Southampton
Professor	Paul	Harper	Cardiff University
Mr	John	Hopes	Ernst & Young LLP
Mr	Evan	Innis	Ocado
Professor	Michal	Kocvara	University of Birmingham
Dr	Raymond	Kwan	University of Leeds
Professor	Ashraf	Labib	University of Portsmouth
Dr	Dario	Landa-Silva	University of Nottingham
Professor	Jiyin	Liu	Loughborough University
Professor	Adele	Marshall	Queen's University Belfast
Dr	Ruth	Misener	Imperial College London
Professor	Gilberto	Montibeller	Loughborough University
Dr	John	Moriarty	Queen Mary, University of London
Professor	Alec	Morton	University of Strathclyde
Dr	John	Pearson	University of Kent
Professor	Sanja	Petrovic	University of Nottingham
Professor	Chris	Potts	University of Southampton
Mr	Alan	Robertson	DSTL



Professor	Manmohan	Sodhi	City University
Professor	James	Taylor	University of Oxford
Professor	Martin	Utley	University College London
Professor	Richard	Weber	University of Cambridge
Professor	Jian-Bo	Yang	The University of Manchester
Professor	Konstantinos	Zografos	Lancaster University

## **Annex 2: Theme Day Agenda**

9.30 Registration with coffee/tea available

10.00 Welcome and introduction (from EPSRC)

10.15 Welcome and introduction (from OR Society)

10.20 Presentation from Working Group

10.40 Session 1 - SWOT

[Coffee/tea available at 11am]

12.30 Lunch, networking and poster session

13.15 Session 2 - People Pipeline

14.15 Session 3 – The Future

[Coffee/tea available at 15.00]

15.15 Session 4 – Taxonomy

15.45 Session 5 - Application Areas/Other Council's remit

16.15 Wrap up

16.30 Close

**For specific questions or feedback related to Operational Research, please contact:**

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