

# Identifying and delivering high impact research

## A seminar

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# Outline

- 1 Identifying the research opportunity?
  - Strategic positioning
  - The challenge
  - Sources of research funding
  - Measuring the significance of the opportunity
- 2 Writing the research proposal
  - The process and preparation
  - Introduction and context
  - Research programme
  - Management, beneficiaries and impact
  - Proposal reviewing
- 3 Ensuring it delivers great research
  - The Scientific Method and reproducibility
- 4 Conclusions

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# Why should we do research?

- Raises institutional profile
  - Builds reputation internationally
  - Added value from public investment
  - Builds capacity - attracts and retains talent (staff/students)
  - Increases collaboration and income
  - Provides gearing internally and externally
- Raises personal profile
  - Motivates staff and students and builds reputation
  - Builds research teams and networks
  - Adds credibility in teaching
  - Builds CV – with high citations and high impact factor publications
  - Personal satisfaction, **fame and fortune!**



# What is impact? Research that makes a difference

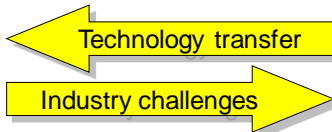
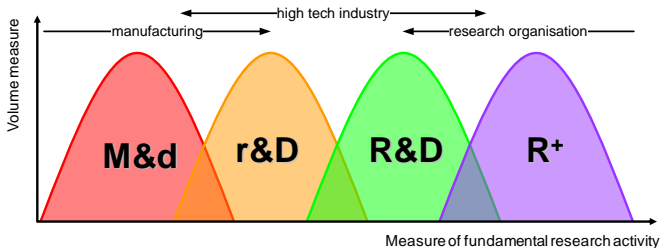
- Excellent research should:
  - Address major challenges
  - Be exploitable to provide benefit to society or industry = return on Investment!
  - Change the way people think about a problem
  - Be synergistic:  $2+2=5$
  - Attract collaboration
  - Attract funding
  - Be publishable in the best places and widely accessible
  - Lead the way where others follow - gets the highest numbers of citations
  - ....etc

Identifying the research opportunity?  
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Strategic positioning  
The challenge  
Sources of research funding  
Measuring the significance of the opportunity

## Positioning: Research vs Development vs R&D

- Depends on your interests, the challenge and the funder:



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# Where do research ideas come from?

- Sometimes things brilliant ideas just appear!



- But usually we have to work hard at it!...
- Inspirations: Personal experience; known industry/societal problems; views of experts; government priorities....



# Understand the problem space and related work

- Understand government interests and priorities – refer to calls
  - Funding available and priorities of research funding bodies
  - e.g. <http://ec.europa.eu/programmes/horizon2020/>
- Understand industry / commercial / social needs and interests
- Understand regional needs
- Familiarise yourself with the relevant field(s) and its key players
  - Network - at high profile events and top conferences
  - Build on your own previous research experiences
- Read the literature
  - Be aware of highly cited papers but also bandwagons (or maybe take a ride?)
- **Think (laterally) and look for synergy!**
  - e.g. identify and learn from complementary areas

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## How to fund the research

- Home University
  - Pump priming or student funding
- Regional and Government
  - Departments of Trade, Health, Environment, Transport, Defence, Security etc.
- Research Councils
- European, US and other international programmes
  - EU H2020, EPSRC, DARPA, ONR
- Industry
  - Trade organisations, large corporates, SMEs, start ups etc.
- Charitable trusts

## Example calls (1)

- EU Horizon 2020: Non-EU countries can be collaborators (but must add value)



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Strategic positioning  
The challenge  
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## Example calls (2)

- Don't just look in your own specialist area



BILL & MELINDA  
GATES foundation

wellcome trust



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## Assess the significance of your idea

- How generic is the problem?
- Are the needs global, regional or specific?
- What is the level of Government and/or commercial interest?
- Are the potential benefits significant or transformational?
- How novel is it - is there scope for revolutionary approaches?
- How risky is it – level of adventure vs risk?
- But - all these must be balanced against:
  - Funder's criteria
  - How much funding is available?
  - How easy will it be to resource?
  - What are the deadlines?



## In other words -what are the benefits of success?

- Will it transform lives or only provide a 0.01% improvement in the performance of a system that is already acceptably good?
- Will it produce 5\* papers in leading journals?
- What, and how big, are the potential benefits?
  - Current imitations: What could be done that can't now?
  - Complexity reductions - speed, power
  - Quality improvements - accuracy, fidelity
  - Flexibility - adaptability, learning
- Who will benefit - what is the potential impact of your research?
  - Society, industry, security/military, consumer, academia?  
Start-up or licensing potential? New standards?
- Does all research need to be transformational?
  - No - it can't be.....but its better if it is!

## Examples of high impact research

- Newcombe et al. DTAM: Dense tracking and mapping in real-time, ICCV), 2011 [980 citations]
- D Taubman et al, High performance scalable image compression with EBCOT, IEEE Trans Image Processing, 2000 [3048 cit.]
- N Ahmed et al., Discrete cosine transform, IEEE Transactions, 1974 [4404 Cit.]
- DG Lowe, Object recognition from local scale-invariant features, Proc ICCV, 1999. [15171 cit.]
- I Daubechies, Orthonormal bases of compactly supported wavelets, Communications on pure and applied Math., 1988 [10777 cit.]
- CE Shannon et al., A mathematical theory of communication, Bell Sys Tech J. 1948 [105460 cit. – 20,000 in last 3 years!!]
- Detlev Marpe, Heiko Schwarz and Thomas Wiegand, Context-based adaptive binary arithmetic coding in the H.264/AVC video compression standard, IEEE Trans. CSVT., 2003. [1486 Cit.]

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## A typical proposal structure

- Successful proposals will be **clearly written**
- They will identify clear demand, benefits, aims and objectives
- They will be innovative and ambitious yet achievable
- A typical proposal contains:
  - 1 Introduction – aims and objectives
  - 2 State of the art review
  - 3 Methodology and research programme
  - 4 Project plan, management and risk assessment
  - 5 [Beneficiaries and impact]
  - 6 [Justification of Resources]
  - 7 [Exploitation routes]
  - 8 [Track record of individual / team / collaborators]

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# Introduction

- The Introduction section should include:
  - General background and context – why?
  - Problem statement + why can't it be done now?
  - Aims and objectives
  - Approach – how will you succeed where others haven't?
  - Novelty – what's new? Be adventurous
  - Benefits/ importance – who will benefit - quantify
- **CLARITY:** Remember that the readers may not always be as specialised as you!

## State of the art review

- **Show awareness** of work of others
- Reference your own, national and international work
- **Be critical and identify issues**
  - Identify strengths and limitations (complexity, robustness, generality etc.)
  - Relationship to standards and industry practise as appropriate
- Restate the problems addressed in your work and link to your research programme



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# Research Programme

- **Methodology**
  - Architecture / philosophy
  - Approach
  - Don't forget **the scientific method**
- Structure your work programme into **work packages**
- Each work package should clearly state:
  - Objectives
  - Technical approach
  - Deliverables and milestones
  - Responsibilities, inter-relationships and dependencies
- **What data will be used? Sample sizes -significance?**
- **How will the results will be validated benchmarked and demonstrated?**

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# Project management

- Project plan and timescales
  - Provide a graphical representation of flow, critical paths, dependencies
  - Relate to the work-programme and risk assessment
- Management structure and responsibilities
  - Is there clear and experienced leadership?
  - Are the management responsibilities clear?
  - How will you address failure, slippage and disagreement?
- IP arrangements
  - Foreground, background and prior art
- Collaboration agreement
  - Include details if appropriate (normally comes later)
- **Demonstrate that you can deliver!**

## Beneficiaries and impact

- Which sectors will benefit?
  - Economic, social, security, academia
- Ensure the work is reproducible.
- How will it transform the way things are done?
  - e.g. economy, health, mobility, entertainment, standards
- How will the work be exploited?
  - Process for protecting IP
  - Process for exploiting the outcomes – pathways to impact, partner roles and responsibilities
- Where will you publish your results and will you outreach to the broader public?
- **Show ambition!**

## Justifying resources

- In some cases you will need to justify the resources needed:
  - Staff: academic, RAs, studentships, other support, overheads
  - Equipment / use of facilities
  - Consumables and travel (Include infrastructure and estate costs – overheads)
  - Contributions of collaborators
  - Subcontracting - rationale and costs
- Be realistic in terms of resources requested, but remember that you are in a competition

- Establish credibility of you and your collaborators
  - General track record -
    - research group structure, resources and achievements
    - international reputation
    - personal highlights and achievements
    - track record of collaborators and relevance to the project
- Always align statements of experience with the project proposed or the funding body
- Highlight the inter/multidisciplinary nature of the team if appropriate
- **Emphasise - why should they fund you and not someone else?**

- Collaboration is becoming increasingly important
  - Adds value through interdisciplinary work
  - Strengthens team
  - Eases demonstration through industrial partners
- But is increasingly difficult to manage
  - Meetings, Reporting etc.
  - Balance of funding do they bring or consume funds?
- Needs clarity in IPR ownership and background
  - IP Exploitation agreement
- Always get agreement before submitting the proposal



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## What are assessors looking for in a proposal (I)?

- Team or individual track records
  - Strength of researchers - international recognition
  - Are the collaborating partners the right ones?
- Research context
  - Is it a high priority, significant or strategically important area?
  - What benefits would arise from a successful outcome?
  - Awareness of related work – is the work in context?
- Approach
  - What is the novelty?
  - Is the methodology clearly presented?
  - Are datasets / sample sizes appropriate?
  - Appropriate benchmarking of results?

# What are assessors looking for in a proposal (II)?

- Management
  - Is the project management sound and logical?
  - Are resources and timescales sensible and justified?
  - Are the dissemination and exploitation plans sensible and appropriate?
- **What is the likelihood of success** and, if successful, **what is the potential impact?**
  - Balancing risk and adventure
- Responsible Innovation - are ethics and other approvals considered?

## Some typical assessment criteria

- The **quality, significance, and relevance** of the proposed research, including the potential to advance knowledge and understanding within its own field or across different fields
- The **originality, novelty and validity** of the proposed research approach. The quality of the proposal with respect to its presentation, clarity, organization, and completeness. Is it well argued?
- The **adventure in the proposal** - is it 'me too research' or is addressing new challenges with new ideas?
- The **benefits** of the research outcome
- The **qualifications of the researcher(s)** to carry out the proposed work successfully based on the team members' past accomplishments and future potential



## How do you ensure its great research (I)?

- Make sure you are up to date with the SoA and other relevant work
- Apply the **Scientific Method**
  - Formulate the Question
  - Form the hypothesis Prediction
  - Test the hypothesis – is it correct?
- **Data**: make sure you have sufficient and diverse data for training and testing and evaluating your methods
- **Benchmark**:
  - Make sure that comparisons of performance are benchmarked against the state of the art: place your work in context.
  - Use appropriate metrics for evaluation

## How do you ensure its great research (II)?

- Be conscientious in planning and project management
- Make sure that the work is reproducible
  - Eases in house development and research collaboration
  - Eases comparison by other groups - benchmarking
  - Eases pull through by industry through increased utility
  - Increases citations
- Demonstrate results convincingly to sponsors and the public
- Present your work broadly
  - Publish in high profile conferences and journals
- Enable routes to exploitation
  - Consider the IP position
  - Explore licensing or other opportunities

## Reproducibility in research

- All research results should be independently reproducible using the code and data available (e.g. online).
- How do you make a piece of work reproducible? Together with each publication or activity, make available (e.g. via a website):
  - Title, Authors, Abstract of work.
  - Reference to your publication(s), with current status, and a PDF copy - allows others to cite it correctly.
  - Code to reproduce all the results, images and tables, with clear documentation, and a readme file explaining how to execute it.
  - The data (files, images, measurements, etc) to reproduce all the results, images and tables. Add a readme file explaining what the data represent.
  - A list of configurations on which you tested your code (software version, platform).



# Conclusions

- Good research areas are not always easy to identify and success is not guaranteed
  - But, by following the guidelines in this presentation, your chances can be improved
  - And, it can bring major benefits to individuals and institutions: resources and prestige
- Successful proposals will be clearly written with clear objectives
  - They will identify a clear demand and benefits
  - They will be innovative and ambitious yet achievable
  - They will often benefit from inter-disciplinary collaboration
- **Always address the reviewers comments**
- **Don't expect quick returns – take the long view**
- **Don't always expect success – its hard!**

# THE END

- **Good Luck** - don't be afraid to collaborate and ask for advice.