EENGM0004: Engineering Research Skills

ASync 1: How to Define and Manage a Project

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Dr. Fan (Aaron) Zhang

fan.zhang@bristol.ac.uk

Projects: Stages and Process

Starting a project

- Formulating a project.
- Project planning.
- Obtaining the resources for the project.

Executing a project

- Project management.
- Project implementation.

Managing and exploiting of the outcome of a project

- Dissemination of results.
- Intellectual property.
- Exploitation of research outcome.

Starting a Project

The type and motivation of a project

- Research projects.
  - Basic research.
  - Applied research.
- Development projects.

Think about your project and decide which type it belongs to!

Planning a project

- It is important to plan ahead for a project in order for it to be successful.

Obtaining resources for the project

- A project will need certain kinds and amounts of resources to implement.

Project Type 1: Basic Research Projects

Motivation

- Production of new knowledge.

Typical Aims

- Aims are the general directions or targets of the research.
  - To find scientific truth about a specific investigation subject.
  - To prove or disprove a scientific hypothesis.
  - To establish a set of theories / methodologies about a scientific field.

Hypothesis

- A proposed explanation to something made with limited evidence.

Project Type 1: Basic Research Projects

Typical Objectives

- Objectives are outcomes that can be achieved in this project.
- They must be steps of progress towards the Aims.
  - Establish facts and gather data.
  - Extract regularities/patterns/orders. E.g., from data.
  - Discover irregularities / disorders from data.
  - Prove/disprove/improve a theory.
- Objectives in basic research are often defined by researchers themselves.

Typical methodologies

- Critical review of the state of the arts.
  - Identify the various hypotheses (note: plural!) that have been proposed.
  - Analyse the plausibility and flaws of existing hypotheses.
  - Identify the key evidences and arguments needed to prove or disprove.

Project Type 1: Basic Research Projects

Typical methodologies

- **Evidence gathering**: survey, measurement, observation, etc.
- **Logical/reasoning**: induction (bottom up) or deduction (top down).
- **Analytical**: using mathematical tools to carry out deductive research.
- **Statistical**: using math tools (statistics) to carry out induction research.

Typical outputs

- Publications; research reports; databases; policy advice

Exploitation and application

- Long-term.

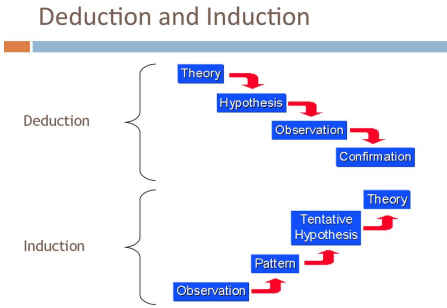

Figure: Source from *Conjoint.ly*

Examples of Basic Research Projects

Basic research examples in science

- A research to discover the components of the human DNA.
- A study on the contrast sensitivity characteristics of human visual system.

Basic research examples in health

- An investigation into the symptoms of Coronavirus.
- An investigation into the secondary symptoms of high blood pressure.

Basic research examples in engineering

- A study on the properties of electrical conductor.
- A study on the characteristics of the discrete cosine transform.

Research Project Type 2: Applied Research

Motivation

- Find a solution to a specific problem.

Typical aims

- To solve an important social/economical/technical problem.

Typical objectives

- Objectives are defined by the problem to be solved.
  - Which part of the problem will be solved?
  - To what extent will the problem be solved?
- Discover and verify a new method of solving the problem (or part of it).
- Improve existing solutions that have deficiencies.

Project Type 2: Applied Research Projects

Typical methodologies

- Identify the causes of the problem by
  - Applying known theories, modelling and simulation, and/or testing existing solutions.
- Critically review the effectiveness of existing solutions to the problem.
- Propose new solutions or improvements based on
  - Theoretical understanding, experience (practice), modelling and simulations results.
- Evaluate proposed solutions through modelling simulation and/or design/build.
- Improving solutions based on iterative optimization.

Typical outputs

- Technical reports, publications, patents and other intellectual properties.

Exploitation and application

- Mid - short term

Examples of Applied Research Projects

Applied research examples in science

- How to improve agricultural crop production?
- How to treat or cure a specific disease?

Applied research examples in health

- An investigation to identify the healing properties of a specific herb.
- An investigation to identify the side effects of using a particular drug.

Applied research examples in engineering

- The application of the discrete cosine transform in image compression.
- Volcano unrest detection based on deep learning.

Project Type 3: Development Projects

Motivation

- Development of new products and services, profitability/financial gains, and/or social benefits.

Typical Aims

- Develop a product or service not yet available: opening new opportunities.
- Develop a product or service that will replace existing ones: higher performance and/or lower cost.

Typical Objectives

- Objectives should be highly focused - avoid unnecessary objectives.
- Objectives are dictated by the specifications of the end-product.
- Specifications: a detailed list of functionality and performance parameters.
- Break-down the general specifications into objectives for the project.
- Describe the assessment method for each objective: **objective** assessment (measurements) and/or **subjective** assessment (human observation, experience, scoring).

Development Projects

Typical methodologies

- Design and build a part of the whole product/service.
- Test functionality, evaluate performance and iterative optimization.
- Evaluate user experience, cost-effectiveness of production process and profitability.

Typical output

- Intellectual property, technological knowhow, designs, and prototypes.

Exploitation and commercialisation

- Short term - immediate

Examples

- Develop a video quality assessment interface software.
- Design an external heart rate monitor.

Relationship between Different Types of Projects

Project Resources

Public funding

- International: e.g., European Union, UNESCO, international collaborative funds.
- National and regional government funding bodies: e.g., EPSRC, BBSRC and CSC.

Private funding

- Industrial funding: e.g., Amazon Research Awards and Google PhD Fellowship Program.
- Internal funding: e.g., Vice Chancellor's Fellowships (UoB).

Organization and human resources

- Project consortium and organizations (company, department, etc.)
- People: leaders/supervisors, managers/administrators, researchers and technicians.

Material resources

- Infrastructure (e.g., buildings and labs); equipment; experimental materials; software; electricity, water.

Project Planning and Execution

Project Planning

- **Work Package** and **tasks**.
- **Critical Path**: the longest route (shortest time) to achieving all objectives.
- **Milestones**: critical stages of a project when certain targets are to be achieved.
- **Deliverables**: reports, papers, software, hardware, etc., that show the achievement of Milestones.

Project Management

- **Project Meetings**: internal review of progress; technical discussions.
- **Project Reviews**: panel of experts / assessors reviewing progress of project.
- **Risk management**: avoid failure due to unforeseeable factors.
  - Try to predict potential issues that may cause delay or failure of the project.
  - Plan for alternative measures that can mitigate these risks.

Dissemination

Dissemination plan

- How do you plan to make your research results known to people?

Publications (primarily for academics)

- Journals, conferences, books, book chapters, special issues, arxiv.

Workshop or Conference

- Oral presentation, poster presentation.

Industrial / Commercial events

- Exhibitions, promotions.

Websites, social media, mainstream media reports

- Twitter and tech blogs.

Protection and Exploitation of Intellectual Property Rights (IPR)

IPR protection

Foreground and background knowledge

- Foreground: new knowledge generated during a project.
- Background: existing knowledge before the start of a project.

Ownership, joint ownership

- Who owns the knowledge (intellectual property rights – IPR)?

IP protection, patenting

- Protect your innovation before it becomes public!

IPR Exploitation

Access rights

- Who can use the IPR and how?
- Free of charge (usually for the purpose of project completion).
- Licensed (for a fee) or sold (for commercial exploitation).

Exploitation modes

- Commercial product development.
- Used in further (follow-on) research and/or for education (professional & general public).

Commercialization, marketing and value

- Angel investors, venture capital, spin-off or start-up companies.
- Go on to become an independent company selling product.
- Capitalisation through initial public offering (IPO).
- Large corporate buy-out.