CUPSA & WABRI
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Curtin University of Technology, Australia

RESEARCH METHODS IN ENGINEERING AND SCIENCE

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OUTLINE

1 Introduction

- Who am I? And who are you??

- Question: Why are you doing a PhD? What do you hope to get out of a PhD?

  Better Question: What are you suppose to be able to do if you have a PhD?

- Three attributes:

  (i) Specialised skill(s), e.g. operate specialised machinery or equipment, computer skills

  (ii) Expert knowledge – your research field

  (iii) Research skill

- Specialised skill(s) – about 5 year lifespan unless kept up

  Expert knowledge – about 10 year lifespan unless kept up

  Research skill – for life, and **portable** (job mobility)

- Stuart Anderson, Peter Wainwright

- PhD = research training .

2 Publish or Perish

- Your PhD: the goal – your **thesis**

- **Advice for Examiners** – see next page

- Main point – thesis should be supported by **publications**

  Examiners will find it difficult to fail you if your thesis is supported by publications in peer-reviewed journals and conferences

- So, how to publish? Criteria similar to Advice for Examiners

CURTIN UNIVERSITY OF TECHNOLOGY

Advice for Examiners for the Degree of:

Doctor of Philosophy **Doctor of Public Health**
Doctor of Science Education **Doctor of Education**
Doctor of Mathematics Education **Doctor of Business Administration**

The purpose of the Doctoral Degree programs at Curtin is to:

- provide the community with graduates of enhanced ability, knowledge and diversity of experience, particularly skilled in advanced research performance and scholarly presentation;
- provide opportunities for suitable candidates to engage in significant research tasks;
- assist industry and the community by providing access to technical and educational facilities for the purpose of applied research;
- encourage the academic staff to play an active part in applied research and to maintain an awareness of developments in their areas of expertise;
- establish a mechanism for the interaction of academic staff and professional members of industry, commerce and the community on research matters of mutual interest.

The topic for study is normally selected by the candidate in consultation with the supervisor (and where appropriate, the candidate's employer).

The thesis must be a substantial original contribution to the knowledge or understanding of any field of study and demonstrate the capacity of the candidate to conceive, design and carry to completion independent research. The Doctoral candidate should uncover new knowledge either by the discovery of new facts, the formulation of theories or the innovative re-interpretation of known data and established ideas.

In particular, the thesis should demonstrate that the candidate has:

a) surveyed literature relevant to the thesis;

b) skills in the gathering and analysis of information and report presentation;

c) demonstrated a critical, perceptive and constructive analysis of the subject;

d) carried out original and significant research in the field.

In assessing the thesis, the examiners should prepare a report on the prescribed form, indicating whether the criteria in (a)–(d) above have been satisfied and, if not, what modifications are necessary.

The thesis should be examined principally in terms of:

(i) The candidate's understanding of the field of study;

(ii) The originality of the work embodied in the thesis; and

(iii) The significance of the thesis as a contribution to knowledge or understanding of knowledge in the field of study;

(iv) The candidate's demonstrated capacity to conceive, plan and conduct a program of research

After examination of the thesis, the examiner may make one of the following recommendations:

a) *The thesis be classified as PASSED UNCONDITIONALLY. The Examiner may specify this category for a thesis which only contains errors of presentation. The University Graduate Studies Committee will require that the candidate correct such errors as pointed out by the Examiner; or*

b) *The thesis be classified as PASSED CONDITIONALLY, subject to amendments being made to the satisfaction of the Chairperson of the Thesis Committee as outlined in the Examiners Report. The Examiner may specify this category for a thesis which requires correction of deficiencies other than errors of presentation, but which are not of sufficient importance to warrant submission for re-examination by the original Examiners, and which are amended to the satisfaction of the Chairperson of the Thesis Committee; or*

c) *The thesis be SUBMITTED IN A REVISED FORM FOR RE-EXAMINATION by the origina Examiner/s. The Examiner may specify this category for a thesis that requires major amendment and submission for re-examination by the original Examiner. In the report the Examiner should give detailed guidelines which may be given to the candidate to assist revision; or*

d) *The thesis be classified as FAILED, without right to resubmit the thesis, on the basis that a limited amount of additional work or modification will not raise the thesis to an acceptable standard.*

The examiner is requested to detail as fully as possible in the report the reasons for this recommendation.

Names of Examiners are not released to the candidate unless the Examiner specifically approves the release of his/her identity, subject to the provisions of the Freedom of Information Act. *(refer Question 1)*

An examiner may recommend to the University Graduate Studies Committee an oral examination of the candidate to clarify aspects of the thesis. In this instance, the examiner shall clearly specify the purpose of the oral examination and the nature of the questions to be put to the candidate. *(refer Question 3)*

A candidate who submits an outstanding thesis which, in the opinion of the examiners, makes a significant contribution to the field beyond that normally expected for a thesis at this level, may be given a commendation by the Chancellor of the University. *Question 4* on the *Examination Report Form* asks whether, in your opinion as an expert in the field, the thesis makes such a contribution. As a guide, it is expected that about 10% of theses would receive a commendation.

Dean, Graduate Studies
Office of Research and Development
Telephone +61 8 9266 2111
Fax+61 8 9266 3793

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- Points a) – d) essentially summarises **RESEARCH METHOD**

- Publication – What does the reviewer look for?

- **IEEE Transaction of Signal Processing**
- **EURASIP Journal on Applied Signal Processing**

A. Suitability of Topic

1. Is the topic appropriate for publication in this journal?
2. Is the topic important to colleagues working in the field?

B. Content

1. Is the paper technically sound? In no, why not?
2. Is the coverage of the topic sufficiently comprehensive and balanced?
3. How would you describe the technical depth of the paper?
4. How would you rate the technical novelty of the paper?

C. Presentation

1. How would you rate the overall organization of the paper?
2. Are the title and abstract satisfactory?
3. Is the length of the paper appropriate? If not, recommend how the length of the paper should be amended, including a possible target length for the final manuscript.
4. Are the symbols, terms, and concepts adequately defined?
5. How do you rate the English usage?
6. Rate the bibliography?

D. Overall Rating

1. How would you rate the technical content of the paper?
2. How would you rate the novelty of the paper?
3. How would you rate the “literary” presentation of the paper?
4. How would you rate the appropriateness of this paper for publication in this journal?

+ Section for Detailed Comments

- **IEE Electronics Letters**

  Please indicate your confidence in your ability to referee this paper (%)

  Is the paper original?

  Is the paper novel?

  Is the paper suitable for this journal? If no, why?

  Is the paper technically sound?

  Is the use of English clear and unambiguous?

  Is the paper organised clearly to show what has been done?

  Please rate the paper by selecting one category from the following list

+ Section for detailed comments

- **GLOBECOM 2005**

Significance	1–5
Contribution	1–5
Originality/Novelty	1–5
Quality of presentation	1–5
Reviewer's expertise	1–5

  Overall recommendation

  Strengths: (text)

  Weaknesses: (text)

  Detailed Comments: (text)

3 Research Methods

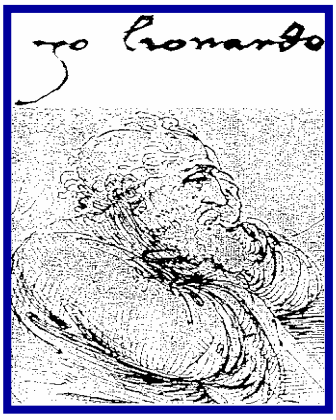
- Note keywords (thesis and publications):

  originality/novelty
  contribution
  significance
  technical soundness
  critical assessment of existing work
  (presentation and English)

- Keywords suggest what good research methods should lead to

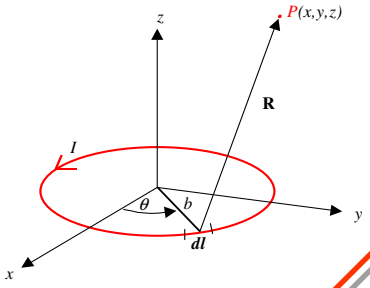
- Leonardo da Vinci

All sciences are vain and full of errors that are not born of experience, Mother of all certainty, and that are not tested by experience….



- Doggedness, thoroughness

  Explore and develop, otherwise not research!



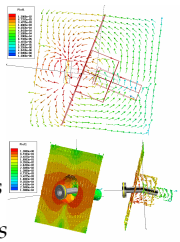
$$\mathbf{B}_P = \frac{\mu_o I}{4\pi} \oint_c \frac{\mathbf{dl} \times \mathbf{R}}{R^3}$$

Modeling

- *Fundamental*

Simulation

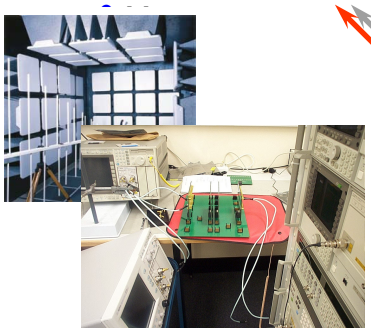
- *Device models*
- *System models*



R&D Methodology

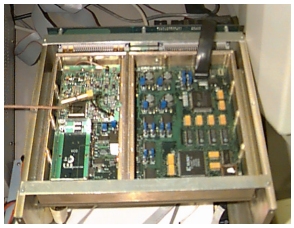
Verification

- *Instrumentation*



Design

- *Practical considerations*



- Engineering vs Science

You see things; and you say “Why?” But I dream things that never were; and I say “Why not?”

George Bernard Shaw

- A scientist sees a phenomenon and ask “why?” and proceed to research the answer to the question

  An engineer sees a practical problem and wants to know “how” to solve it and “how” to implement that solution, or “how” to do it better if a solution exists

  A scientist builds in order to learn, but an engineer learns in order to build

- However, in the course of their work, they may have to take on the other role

- Unlike scientific research, engineering research must address following question:

  Is the problem a significant problem? That is, why solve it?

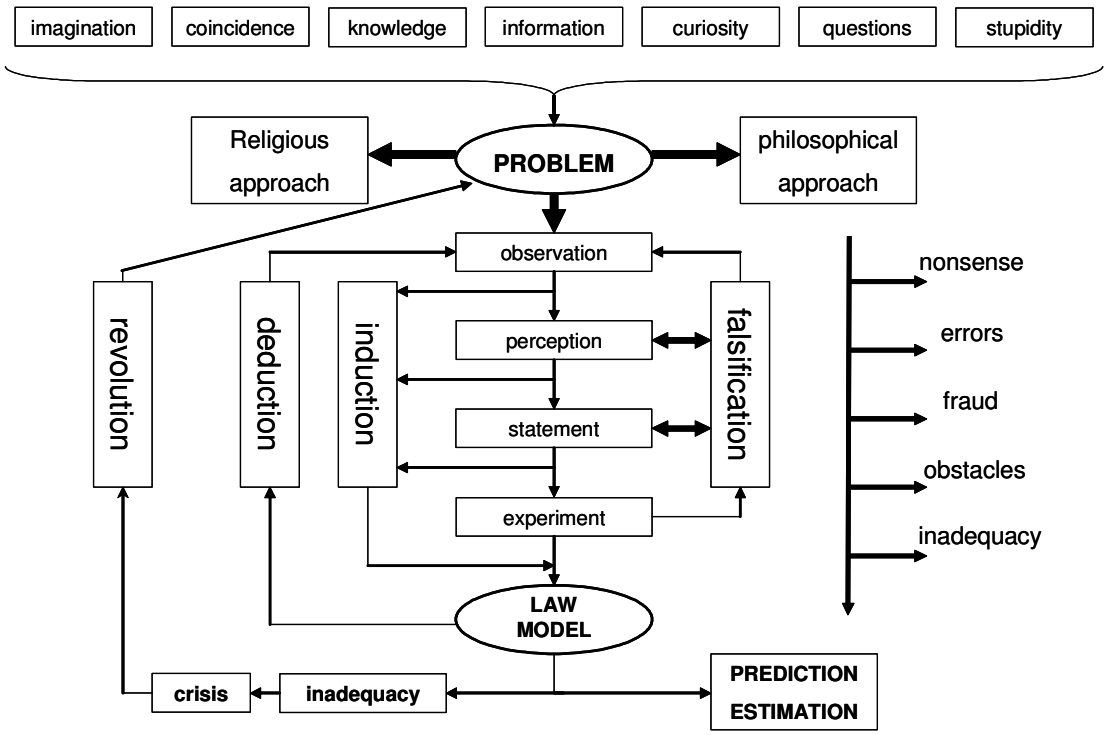
- Research methods – a philosophical view

  Qualitative vs quantitative – for the social scientist to debate

  We are firmly in the quantitative camp. We are “positivists” not “hermeneutics”!

- Quantitative methods

  (i) deductive – inferences from general principles
  (ii) inductive – from facts to hypothesis to conclusions
  (iii) model building



4 Case Studies

- B K Lau, PhD thesis, Curtin University, 2002

  Refocussing of research topic, robustness against real-world uncertainties, collaboration with mathematicians

- Y H Leung, industry contract, 1995-6

  Modelling to verification and closing the R&D methodology loop