



UNIVERSITY OF PRETORIA

GRADUATE SCHOOL OF TECHNOLOGY MANAGEMENT

RESEARCH GUIDE FOR POST-GRADUATE STUDENTS

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Issue 22
Date of last revision:
1 October 2014

TABLE OF CONTENTS

RESEARCH GUIDE FOR POST-GRADUATE STUDENTS	1
1. RESEARCH PHILOSOPHY	3
2. PROBLEM AREAS.....	6
3. SUBJECT STRUCTURE	7
4. RESEARCH METHODOLOGY	7
5. NATURE OF SUBJECT LITERATURE	7
6. RESEARCH MANAGEMENT PROCESS	7
7. RESEARCH PROPOSAL.....	8
8. STRUCTURE OF DISSERTATIONS/THESES/REPORTS.....	15
9. WRITING A RESEARCH ARTICLE FOR A SCIENTIFIC JOURNAL	18
10. COLLOQUIUM, SYMPOSIUM AND CONFERENCE PRESENTATIONS...21	
APPENDIX 1: GLOSSARY OF RESEARCH TERMS	25
APPENDIX 2: SUBJECTS IN ENGINEERING AND TECHNOLOGY MANAGEMENT.....	28
APPENDIX 3: SUBJECT LITERATURE FOR ENGINEERING AND TECHNOLOGY MANAGEMENT.....	30
APPENDIX 4: RESEARCH FLOWCHART.....	32
APPENDIX 5: NOTES ON THE RESEARCH PROCESS	36
APPENDIX 6: SCHEDULE OF MILESTONES.....	41
APPENDIX 7: REVIEW REPORTS.....	42
APPENDIX 8: RESEARCH IDEA	60
APPENDIX 9: REFERENCES AND LITERATURE SOURCES	62
APPENDIX 10: RESEARCH LOGIC FOR THEORY-BASED EMPIRICAL RESEARCH	65
APPENDIX 11: GSTM HARVARD REFERENCING METHOD.....	66
APPENDIX 12: GUIDELINES FOR WRITING A JOURNAL ARTICLE	69
APPENDIX 13: GUIDELINES ON AVOIDING PLAGIARISM.....	72
APPENDIX 14: TECHNICAL EDITING	73

RESEARCH GUIDE FOR POST-GRADUATE STUDENTS IN THE DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

1. RESEARCH PHILOSOPHY

Through the growth of knowledge humankind has been transformed from primitive tribal societies to the information age. The purpose of research is to generate new knowledge. New knowledge not only enables us to better understand nature and our environment, including our interactions with others, but also enables us to better manipulate, use and manage the environment to our advantage. The purpose of the science of engineering and technology management is to provide us with the theoretical knowledge and practical techniques to better manage technology-based organisations.

Engineering and technology management links the engineering, science, and management disciplines. It provides an interface between technology and other corporate functions such as R&D, marketing, manufacturing and administration. It addresses the issues involved in the planning, development, and implementation of technological capabilities to shape and accomplish strategic and operational objectives of an organisation. It covers not only R&D management, but also the entire spectrum of managerial concerns in technology-based organisations. This includes issues relating to human resource management, innovation process management, project management, technological fusion, marketing, technological forecasting and strategic planning.

The Department's research programme should be devoted to the improvement and further development of the theory and practice of engineering and technology management and should appeal to both academics and practising managers. Studies must be academically rigorous research of scholarly calibre that advance the science and practice of engineering and technology management.

Many research processes (designs) have been used successfully in the past in all areas of scientific endeavour. For a comprehensive review of many different research designs, see Mouton (2001:143). Many of these can and has been used in the field of engineering and technology management. The science of engineering and technology management is a practical "applied" science. It deals with the "real world" problems of managing technology-based organisations in a competitive global market. For this reason, there is a preference for certain types of research designs. There is for example a bias towards "applied" - empirical - type of research versus "basic" -philosophical and theoretical - investigations. As management is a predominantly behavioural science, there is also a

Research Philosophy The balanced approach

- Theory
- Appealing to academics
- Basic research - philosophical and theoretical
- New theoretical knowledge and theories
- Practice
- Appealing to practising managers
- Applied research - observations and investigations of actual practice (*empirical*)
- New practical techniques, models & tools



Synthesis: Theory-based empirical research

preference for the approaches used in the human sciences rather than in the natural sciences. The predominant research designs in the natural sciences are laboratory and field experiments. These are less appropriate in engineering and technology management science as it is difficult to obtain the highly controlled conditions required for this type of research.

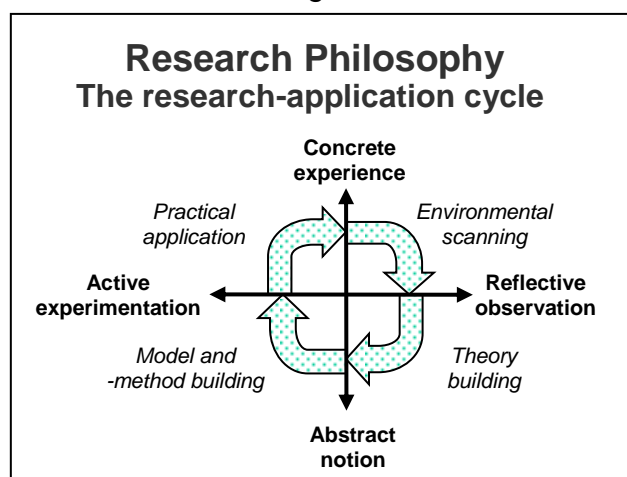
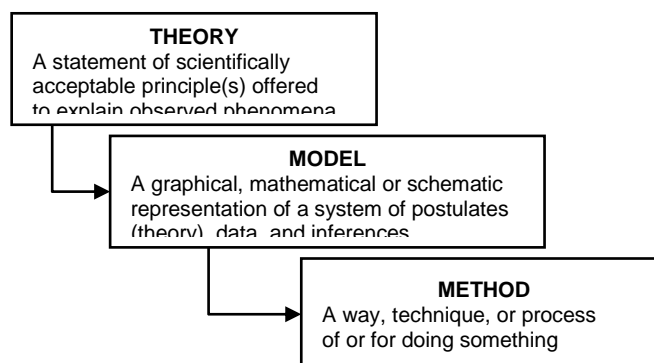
Management investigation	Management research
<ul style="list-style-type: none"> • Application of acquired knowledge • Management subjectivity • Requires insight and judgement • Is specific to the company environment • Company confidential 	<ul style="list-style-type: none"> • Generation of new knowledge • Scientific objectivity • Requires empirical proof • Is generalizable to other environments • Published in scientific journals

A common misconception amongst engineering and technology management students is that doing research is synonymous with doing a “management investigation”. This is not the case. A management investigation consists of the application of acquired knowledge to a specific management problem in an organisation, whereas research is the generation of new knowledge generalizable to other environments. The investigator’s subjectivity is acceptable when performing a management investigation but research requires scientific objectivity. Insight and sound judgement are expected of a good

management investigation, but research requires empirical proof. The outcome of a management investigation is mostly a company-confidential management report. Research is published in scientific journals.

Engineering and technology management science aims at understanding the processes involved in the management of technology-based organisations. The desired research output is new theoretical knowledge and practical techniques that can be applied by managers in their day-to-day management activities. What managers need

Theories, Models and Methods



are new and improved theories and models (tools) that can be applied in practice. Theories should be embodied in conceptual models (graphical, mathematical or schematic descriptions or analogies) or practical methods (procedures or techniques). These should however not only be of practical value, but should be based on observations and investigations of actual practice. As

already stated, this implies an empirical approach. Practical methods should however not only be based on observations but also have a sound theoretical basis. What is needed is theory-based empirical research. Research project should therefore contain elements of concrete experience, reflective observation, abstract notions and active experimentation as depicted in the research–application cycle. The types of research designs that are preferred are therefore theory-, model- or method-building, -testing and -application empirical research. (See Appendix 1 for a glossary of research terms.)

Studies must develop, test, or advance management theory and practice and should have well-articulated and strong theoretical foundations. All types of empirical methods - quantitative, qualitative, or combinations - are acceptable. Case studies and well-considered observations of management experience, survey research, methodological studies, replications and extensions of past research are acceptable providing it provides new conceptual or theoretical insights.

The application of existing theories, models and methods to routine management problems is management practice and cannot be considered as research. The ability to apply the acquired knowledge and skills is the most important outcome of the education process for managers. It is therefore required of management students to demonstrate their ability to apply their acquired knowledge and skills by conducting such management

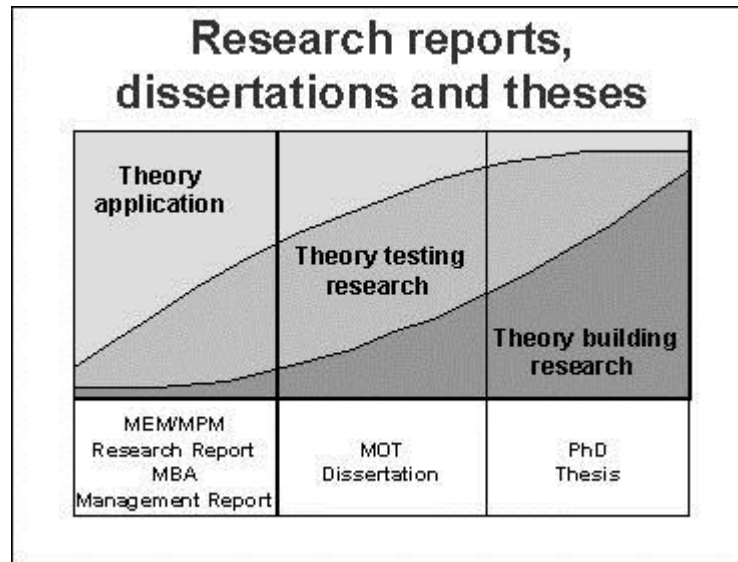
investigations. Such project assignments will result in “Management Reports” (“Guidelines for a Management Report 2002”, Graduate School of Management, University of Pretoria). To qualify as a research project, there must also be some generation of new knowledge. The application of existing theories, models and methods to a “new” problem or situation does generate new knowledge as it provides new insights and is a type of “theory-testing” research. This type of project is prescribed for MEM and MPM students. The instructions to the students state that although it “should demonstrate your understanding of the concepts ... and your ability to apply them to a specific problem”; it is also “essential to produce something original and useful” (“MEM/MPM Research Project IGB 895/ISC 895, Instructions for Preparing a Research Project Report”).

There are therefore three possible aspects to a research project:

- 1) Application of existing theories, models and methods to a “new” problem.
- 2) Testing of existing theories, models and methods.
- 3) Building of new or improved theories, models and methods.

The emphases between these are different for a MBA/MEM/MPM Research Report, MOT Dissertation and a PhD Thesis. This is shown schematically in the following figure.

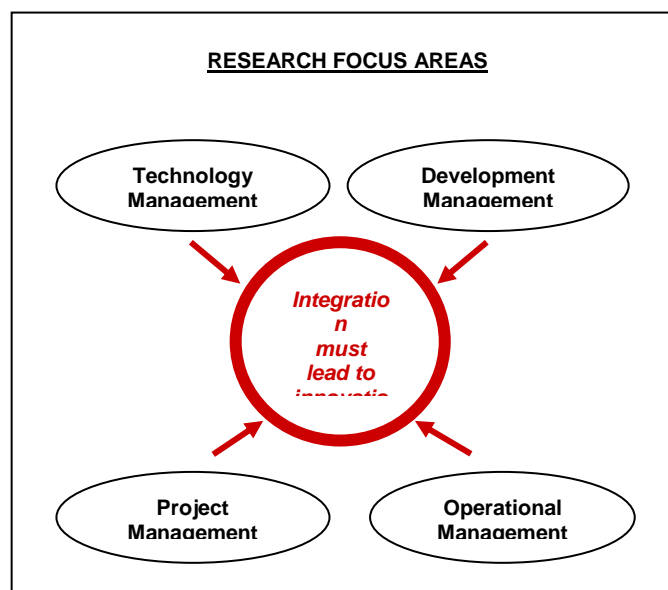




2. PROBLEM AREAS

The problem areas that are appropriate for studies in Engineering and Technology Management cover a wide spectrum. They can broadly be divided in three broad categories:

- 1) Problems related to the Strategic Management of Technology, Innovation, Operations, Maintenance and Projects.
- 2) Problems related to the Operational Management of Technology, Innovation, Operations, Maintenance and Projects.
- 3) Problems related to Policy Issues regarding Technology, Innovation, Operations, Maintenance and Projects.



3. SUBJECT STRUCTURE

The subject structure is based on the contents of the Department's programs. A list of subjects is attached as Appendix 2.

4. RESEARCH METHODOLOGY

The preferred research design for studies in Engineering and Technology Management is *theory-, model- or method-building, -testing and -application empirical research*. (See description of theory-building or model-building studies, (Mouton 2001:176). Page & Meyer (2000) is essential reading for theory-based empirical research methodology, and Yin (2003) for case-study research methodology.

Related research designs that can also be considered are statistical modeling and computer simulation studies (Mouton 2001:163), surveys (Mouton 2001:152), case studies (Mouton 2001:149), implementation (process) evaluation (Mouton 2001:158), field/natural experimental design (Mouton 2001:157) and experimental and quasi-exp. outcome studies (Mouton 2001:160). Although these could be complete studies in their own right, it is preferred that they be used as data-gathering and data-analysis techniques for theory-, model- or method-building, -testing and -application studies. Stand-alone literature reviews (Mouton 2001:179) will not be supported. Theory and research reviews should be an integral part of all studies, irrespective of the particular research designs used.

5. NATURE OF SUBJECT LITERATURE

Subject literature is mainly those contained in textbooks, articles in scientific journals, published conference proceedings and master's dissertations/PhD theses. A list of key literature sources is attached as **Appendix 3**, but students must search beyond these.

6. RESEARCH MANAGEMENT PROCESS

To enable students to work in a systematic and orderly way, the research project is divided into the following five phases:

- | | | |
|---------|---|-------------------------------|
| Phase 1 | : | Research Proposal |
| Phase 2 | : | Research Plan |
| Phase 3 | : | Research Execution |
| Phase 4 | : | Dissertation/thesis/report |
| Phase 5 | : | Examination and Dissemination |

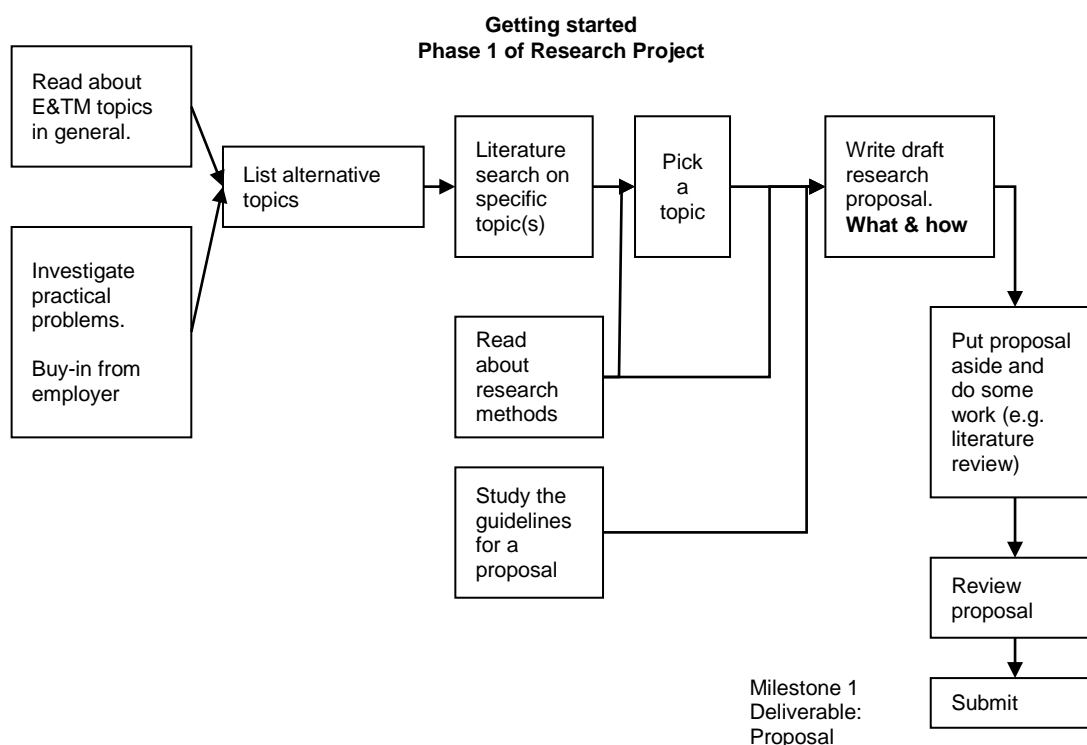
Each phase has a set of actions, an output, a review baseline and a milestone as shown in **Appendix 4**. This process is also shown as a flowchart in **Appendix 4**.

At the conclusion of each phase the output documentation is submitted to the Study Leader or the Research Committee (in the case of M-dissertation and PhD students) for review and approval. **Appendix 5** contains notes on the research

process, adapted from Malan, Coetzee & Van Breda (1992, P. 37). A typical schedule of milestones for a two-year research project is shown in **Appendix 6**. There are specific dates every year when dissertations/theses/reports must be submitted for examination. Research project schedules should keep these in mind (see **Appendix 6** for details). **Appendix 7** contains the Review Committee's pro-forma Review Reports.

7. RESEARCH PROPOSAL

Research could mean, “to search again”¹. This implies that there is a “first search”. This could be seen as the preliminary search that is done before a research proposal is submitted. The preliminary search should help you to focus your thoughts on a topic and the way you are going to approach and structure the work. Also, it will familiarize you with the relevant academic literature.



Here are a few useful points to keep in mind when doing the preliminary search:

- Be inclusive with your thinking and see how many different research projects you can identify.
- Try not to be overly influenced at this time. Search for something that you are really interested in.
- Keep in mind that first and foremost the whole research project should be a learning experience for you. The process of conducting the research may be just as important (or more important) than the outcomes of the research.
- Write down your ideas using the one-page format provided in **Appendix 8**. Discuss your ideas with friends, colleagues and potential study-leaders.

¹ The English word “research” originates from the Old French *re-* + *cerchier*, meaning, “to search”. However, the prefix “re-”, coming from the Latin *re-*, means “again”. Research could therefore also have the meaning of “to search again”.

Here's a final check before you should start writing your proposal. Does each of these statements describe you?

- I am familiar with the theories and past research that has been conducted in areas related to my research project.
- I have a clear understanding of the steps that I will use in conducting my research.
- I feel that I have the ability to get through each of the steps necessary to complete my research project.
- I know that I am motivated and have the drive to get through all of the steps in the research project.
- I have found a study leader that is prepared to guide me through my research project.

Now you're ready to write your research proposal. Here are some ideas to help with the task:

- Read through someone else's research proposal.
- Do a comprehensive theory and research review. The rationale behind the theory and research review is to make sure that this research is needed and the methodology is appropriate for the question that is being asked. The more general sources such as textbooks, course notes and overviews are more appropriate at this stage. You should consult at least the following number of literature sources:

MEM/MPM/MTM	5
Dissertation	10
PhD	20

(Practical advice: When you read something that is important to your study, capture the relevant article or section in your filing system, either as paper copies or in electronic format. Keep your copies organized according to categories and sections. And, most importantly, record the bibliographic citation so that you can easily reference the material in your bibliography. Then, when you decide to sit down and actually write the theory and research review, retrieve your copied records, arrange them into logical and sequential order, and then begin your writing. MS Word has a function that can be activated to record references as you write. The list of references can then be compiled later. The library also offers a course in Refworks to students.)

- A good proposal should begin with a statement of the problem/background information, then move on to a review of theory and past research, and conclude with a defining of the research methodology. Of course, it should be written in a future tense since it is a proposal.

PLAGIARISM

Plagiarism is committed when someone uses another person's *words, ideas* or *opinions* without acknowledging them as being from that other person. Special care should be taken with information taken from web sites and other electronic sources. Transgression could result in expulsion from the University. See **Appendix 13** for guidelines on how to avoid plagiarism.

- Focus your research very specifically. Don't try to have your research cover too broad an area.
- Include a title on your proposal. Preparing a good title means: having the most important words appear toward the beginning of your title, limiting the use of ambiguous or confusing words, breaking your title up into a title and subtitle when you have too many words, and including key words that will help researchers in the future find your work.
- It's important that your research proposal be organized around a set of questions that will guide your research. When selecting these guiding questions try to write them so that they frame your research and put it into perspective with other research. These questions must serve to establish the link between your research and other research that has preceded you. Your research questions should clearly show the relationship of your research to your field of study. Don't be carried away at this point and make your questions too narrow. You must start with broad relational questions.

A good question: "Are the technology management challenges faced by high-tech start-up firms in Pretoria similar to those faced by start-up firms in general?"

A poor question: "What are the technology management challenges faced by high-tech start-up firms in Pretoria?" (too narrow)

A poor question: "What are the technology management challenges faced by firm XYZ?" (not generalisable)

- Choose your methodology wisely. A well-designed quantitative research study can often be accomplished in very clear and direct ways. A similar study of a qualitative nature usually requires considerably more time and a tremendous burden to create new paths for analysis where previously no path had existed. Sometimes a combined methodology makes the most sense. You can combine a qualitative preliminary study (to define your population more clearly, to develop your instrumentation more specifically or to establish hypotheses for investigation) with a quantitative main study to yield a research project that works well.

Research proposals should be at least twenty typed pages (PhD candidates), ten typed pages (MOT students), or five typed pages (MEM/MPM/MBA students) in length.

The framework as described in the brochure *Magister- en Doktorale Studie: Riglyne vir Studielejers, Promotors en Studente*, obtainable from the Buro for Academic Support Services, may be used as a guideline for preparing the research proposal. Use formal South African English and the scientific style of writing (e.g. "It is proposed..." not "I propose ..."). For guidelines on paragraphs, numbering, etc. consult the UP Guidelines for the Preparation of Written Assignments (<http://www.up.ac.za/asservices/ais/assign.pdf>.) and departmental procedure documents (See e.g., Appendix 14: Technical Editing). Make use of scientific research terms (See Appendix 1: Glossary of research terms).

The research proposal which is submitted prior to admission, must contain at least the following information:

Title

The proposed title should be one sentence, free from all elaboration and superfluous detail, which gives a clear, complete and formal description of the research project.

To ensure that the proposed topic/title is not a duplicate of previous or current research, a search has to be carried out on the Research Report database of the National Research Foundation.

To do the search, follow the instructions below:

- Go to the NRF nexus database website: <http://stardata.nrf.ac.za/>
- Click on Current and Completed Research Projects Database
- Use the following ID and password
 - ID: zup01 or zup02 to zup05
 - Password: up
- Search the database to ensure that the intended topic/title is not a duplicate of previous or current research.

Table of contents

Give a listing of the section headings with page numbers.

1. Introduction and background

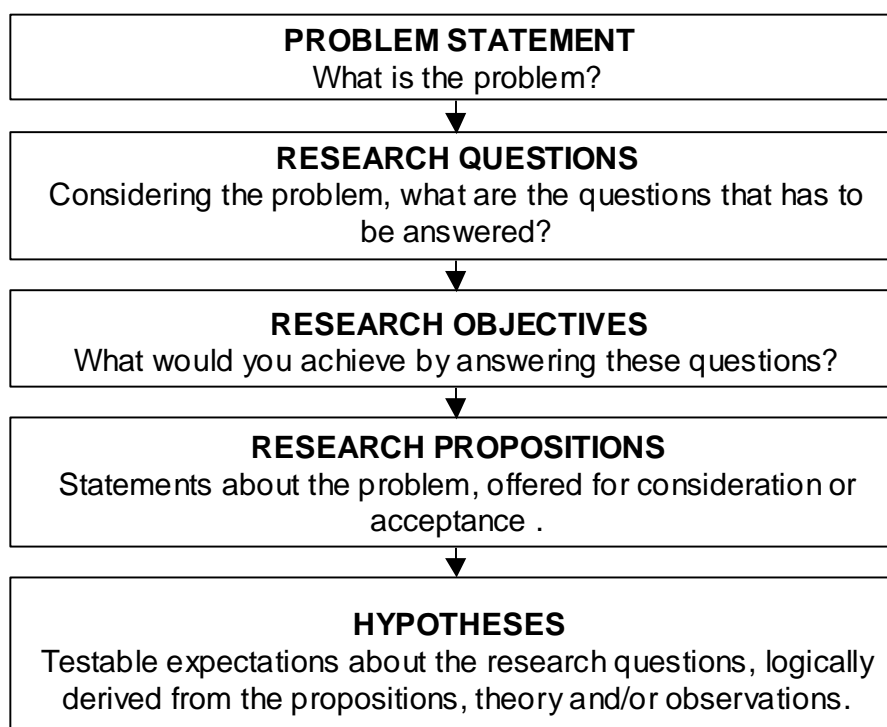
- 1.1 Describe and give an introductory overview of the technological, industrial and/or organisational context of the study.
- 1.2 Indicate the proposed topic of the research – what is the broad issue to be investigated?
- 1.3 Give reasons for selecting the particular problem - the rationale for the study.

2. Theory and research review

- 2.1 Give a preliminary overview of the relevant theories properly referenced (see **Appendix 11**). What research has already been done on this topic or in this field, and what important findings have been made thus far?
- 2.2 Describe and give a critical analysis the main theories, models and methods that currently exist.
- 2.3 Indicate whether a need exists for a new or improved theory and identify the key attributes of the desired theory and derived models or methods.

3. Problem Statement and Research Objective/s

- 3.1 Formulate the proposed problem statement in one paragraph, free from all elaboration and superfluous detail
- 3.2 Give clear, complete and formal descriptions of the research question/s.
- 3.3 Describe the research objectives – what will be achieved?
- 3.4 Give clear, complete and formal descriptions of the research proposition/s or hypotheses. (See the framework provided on the next page.)
- 3.5 Indicate the relative weight of the following types of research that you propose to undertake:
 - Theory building research
 - Theory testing research
 - Theory application research
- 3.6 Indicate the importance of the problem – why should this particular problem be addressed?
- 3.7 Describe the limitations of the study and the assumptions on which the research will be based.



FRAMEWORK FOR RESEARCH OBJECTIVES

4. Expected Contributions

- 4.1 Describe the expected nature of the results.

4.2 What will the contribution(s) of the research results be? Describe the contributions towards scientific knowledge and what other values the research will have.

4.3 Who will benefit from the research?

5. Research Strategy

5.1 Present the proposed approach and strategy for performing the research.

5.2 Describe the method of study or research design and methodology to be followed.

5.3 Indicate the proposed research instrument/s (questionnaire, case study, interview) and methods of data collection and analysis. Give some justification of why the methods are proposed.

5.4 Give a proposed project plan and schedule for performing the research.

6. Ethics Committee Approval

6.1 All research involving interaction with people must be submitted to the Ethics Committee of the Faculty for approval. The application form for approval must be attached to the research proposal. See appendix 15 or http://www.up.ac.za/ebit/r_ethics.html.

7. Proposed Table of Contents of Thesis/Dissertation/Report

Give a proposed chapter plan and a preliminary outline of the chapter divisions. The following is the basic structure for all theses/dissertations/reports:

	Preliminaries
Chapter 1:	Introduction/Background
Chapter 2:	Theory and research review/Theoretical background
Chapter 3:	Theoretical framework/Conceptual model or method
Chapter 4:	Research design and methodology
Chapter 5:	Results: Data gathered and analysis
Chapter 6:	Conclusions and recommendations
	List of references and appendices

8. Conclusion

A concluding statement on the feasibility of completing the study as proposed.

9. References and preliminary bibliography

8.1 List all the references that have been referred to, in the prescribed format (see **Appendix 9:1** Policy, procedures and regulations and **Appendix 11**).

8.2 Give a preliminary bibliography listing the most important and recent specialist literature that has been consulted.

9. Personal information

Give the following information:

- Name and student number
- Postal address
- E-mail address and telephone number(s)
- Your complete academic record(s) as well as work history.
- A list of your previous research results, e.g. research reports, masters dissertation, publications, articles, conference papers, etc.

8. STRUCTURE OF DISSERTATIONS/THESES/REPORTS.

The dissertation/thesis/report is the final embodiment of your research project. It is a reconstruction and documentation of the logic of your research. The research logic for theory/model/method-building, -testing and -application empirical studies are shown as a flowchart in **Appendix 10**. In the rest of this discussion only the term “theory” will be used, but it could also mean any models or methods derived from or based on the theory.

The dissertation/thesis/report should start with the research problem, followed by the research design, the evidence and the conclusions. The reader should never be in doubt as to where you are in this process. You should indicate this clearly in introductory and closing paragraphs in each chapter. Here are some guidelines for the structure of the dissertation/thesis/report:

Preliminaries

The dissertation/thesis/report should start with a *Title Page, Acknowledgements, Summary/Abstract, Table of Contents and List of tables/List of figures*.

Chapter 1: Introduction/Background

Chapter 1 should contain background information regarding the *technological, industrial and organisational setting* for the study. It should describe and give a thorough overview of the historical development and current state of the industry, organisation/s and technology under investigation. It should present the reasons for selecting the particular problem - the rationale for the study - as well as a statement of the research problem (and/or research objectives or research question/s). You should identify the key attributes of the desired theory and derived models or methods that is required to solve the research problem. Your objective could read: “To [develop a new] or [test the] or [apply the] theory for ...”. Your goal could be to show that the theory you have developed, tested or applied is *valid and useful* for solving the research problem (or answering the research question/s). See Mouton (2001:122) for detailed instructions on writing this chapter. Sub-headings for this chapter could be:

- 1.1 Introduction
- 1.2 Historical development and current state of the <industry, organisation/s and technology under investigation>
- 1.3 Research problem
- 1.4 Rationale for the study
- 1.5 Research objectives and/or research question/s
- 1.6 Key attributes of the desired theory and derived models or methods

Chapter 2: Theory and research review/Theoretical background

Chapter 2 should contain a comprehensive review and critical analysis of the theory and past research that represents the most authoritative scholarship in those fields related to the research problem. This should be a wide-ranging survey of the broad area of interest, including work in related fields. You should indicate

what research has been done and what theories currently exist and if any of them can or have been applied to the research problem. Don't just list or describe what you have read, give a critical analysis of the theory and past research. You have to show whether a 'gap' exists for a new or improved theory that is specifically tailored to the research problem.

It is very important to revisit your literature review before you submit your final dissertation/thesis/report to check that there have not been new publications in your field of study. One of the most common criticisms from external examiners is: "The student ignored the following recent publications in this field: ..."

See Mouton (2001:123) for detailed instructions on writing this chapter. Sub-headings for this chapter could be:

- 2.1 Theory and research review
- 2.2 Current theories
- 2.3 Need for a new or improved theory (optional for theory-building research)

Text references must give the author's surname, year of publication and page reference. (See **Appendix 11** for more detail.) For example;

"Landman (1998:12) points out that without a thorough literature study, on which adequate time has been spent, the research work in question can only be considered superficial and naive."

OR

"Without a thorough literature study, on which adequate time has been spent, the research work in question can only be considered superficial and naive (Landman 1998:12)."

The reference number refers to Landman's work as shown in the list of references at the end of the dissertation/thesis/report (see last item in this chapter).

Chapter 3: Theoretical framework/Conceptual model or method

In chapter 3 you will present the current and proposed theory and derived models or methods that are directly relevant to your research problem. The theory should be embodied in conceptual models (graphical, mathematical or schematic descriptions or analogies) or practical methods (procedures or techniques).

For a theory-testing or -application study, you will present the models or methods you wish to test or apply. The relevant current theories should be extracted from Chapter 2, integrated and presented again in summarised form.

For a theory-building study, you will use either deductive or inductive (retroductive) reasoning. When using deductive reasoning, the deduction of new theoretical propositions must be substantiated by references to real-world observations (Chapter 1) and past scholarship (Chapter 2). You have to describe how you

developed your new or improved model or method based on the new theoretical proposition. You have to describe your model or method in detail and show that what you are proposing is new. Remember that applying a known model to a new application is also “new”.

Theories should be subjected to empirical testing to evaluate their validity. The deduction of research hypothesis (expectations based on theory) can serve as a useful methodological guide. When observational facts support a hypothesis, the probability of its being true is increased, but if any contradicting facts are uncovered, the hypothesis must be rejected. The hypotheses will also be useful when doing the research design. This is a powerful methodology for theory testing and should be used whenever appropriate. Hypotheses could be omitted when using only retroductive reasoning (see **Appendix 1**). This is often the case in surveys, case studies, exploratory, and application studies. Sub-headings for this chapter could be:

- 3.1 Theories, models or methods to be used for this study.
- 3.2 Hypotheses (optional).

Chapter 4: Research design and methodology

Chapter 4 should contain your discussion of the research design and methodology followed in your study in order to investigate the problem as formulated above. Once you have specified your theory, model or method, you have to show that it is valid (true) and/or useful. This you do by applying it to real-world case/s – this is the empirical testing or application phase. This is where working with hypotheses could be helpful, as they will determine the type of data required to test them. Describe the data-gathering and data-analysis techniques and instruments you intend using. See Mouton (2001:123) for detailed instructions on writing this chapter. Sub-headings for this chapter could be:

- 4.1 Research strategy
- 4.2 Research methodology
- 4.3 Research instruments

Chapter 5: Results: Data gathered and analysis

Chapter 5 should contain the presentation and discussion of the data or information collected and analysed in the study. This includes the testing of hypotheses by showing that the observed facts support the hypotheses or not. When using retroductive reasoning, this chapter will include the inference of new hypotheses based on the observed facts. See Mouton (2001:124) for detailed instructions on writing this chapter. Sub-headings for this chapter could be:

- 5.1 Data gathering process
- 5.2 Data or information gathered
- 5.3 Data analysis
- 5.4 Hypotheses testing
- 5.5 New hypotheses, theories, models or methods

Chapter 6: Conclusions and recommendations

In chapter 6 the main conclusions of the study are summarised, discussed and interpreted, and where appropriate recommendations are made for further research and practice or policy. You have to show that current theory or your proposed theory and derived models or methods are supported by the research. This is also where you could use retroductive reasoning to formulate new theory.

The most important conclusion is that you have achieved the stated objective: “To [apply/test/develop] theory/model/method for ...”. You have to convince the reader that you have made an important and unique contribution to the “state-of-the-art”. An honest appraisal of what you have accomplished is however also appropriate. Without diminishing the value of what you have done, you should state any shortcomings and areas for further research. This should be contained in the recommendations. See Mouton (2001:124) for detailed instructions on writing this chapter. Sub-headings for this chapter could be:

6.1 Research results

6.2 Implications for and/or contributions to theory and practise

6.3 Self-assessment

6.4 Recommendations

List of references and appendices

List all the references by number in the order they were referenced. Adhere to the prescribed format (see **Appendix 11: Referencing Method**). See Mouton (2001:125) for detailed instructions on writing this part.

General Regulations **G.58** and **G.59** must be adhered to in the technical editing of the thesis/dissertation/report. Additional regulations that apply in the Department of Engineering and Technology Management are given in **Appendix 14**.

9. WRITING A RESEARCH ARTICLE FOR A SCIENTIFIC JOURNAL

It is a requirement of the Department of Engineering and Technology Management that all post-graduate students submit research articles for publication in scientific journals. The following are the main requirements that has to be adhered to:

9.1 Authors

The student and his/her study leader/s are the authors of the articles. The name of the individual who was the principle writer of the article (usually the student) should appear first when the names of the authors are given. The affiliation of the authors must be given. Students must give their affiliation as the Department of Engineering and Technology Management, University of Pretoria and not their employer's name.

9.2 Accredited journals

Articles may only be submitted for publication in peer-reviewed scientific journals accredited by the South African Department of Higher Education and Training (DHET). The Department's List of Accredited Journals is compiled from journals included in ISI and IBSS, as well as South African journals selected by the Department for this purpose and listed under List of Approved South African Journals. Consult the lists of accredited journals acknowledged by DHET at <http://www.ais.up.ac.za/journals/journalsaccredited.htm>.

The following are some high-quality journals to consider for the publication of research articles:

JOURNAL TITLE
Academy of Management Journal
Academy of Management Review
American Journal of Mathematical and Management Sciences
British Journal of Management
California Management Review
Discovery and Innovation
Energy Policy
Engineering in life sciences
Entrepreneurship: Theory and Practice
Environment and Development Economics
Environment International
Environment, Development and Sustainability
Environmental & resource economics
Environmental Engineering Science
Environmental impact assessment review
Environmental Law
Environmental politics
Environmental values
Harvard Business Review
IEE Transactions (Transactions of the SA institute of Electrical Engineering)
IEEE Engineering in Medicine and Biology Magazine
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Engineering Management
International Journal of Engineering Education
International Journal of Engineering Science
International Journal of Forecasting
International Journal of Information technology & decision making
International Journal of Life Cycle Assessment
International Journal of Operations & Production Management
International Journal of Management Review
International Journal for Production Research
International Journal of Technology Management
International Studies of Management and Organisation

Issues in Science and Technology
Innovation: Management, policy & practice
Journal of Cleaner Production
Journal of Engineering and Technology Management
Journal of Engineering Education
Journal of Engineering Technology
Journal of Environment and Development
Journal of Environmental assessment policy and Management
Journal of Environmental Economics and Management
Journal of Environmental Engineering and Science
Journal of Environmental Engineering-ASCE
Journal of Environmental Law
Journal of Environmental Management
Journal of Environmental Planning and Management
Journal of Management
Journal of Management in Engineering
Journal of Management Studies
Journal of Medical Engineering & technology
Journal of Operations Management
Journal of Product Innovation Management
Journal of Professional issues in Engineering Education and Practice
Journal of Risk Research
Journal of Sustainable Agriculture
Journal of the South African Institute of Civil Engineering
Knowledge, Technology and Policy
Management International Review
Management Science
Organizational Dynamics
Organization Studies
Production and Operations Management
Quality and reliability Engineering International
R & D Journal
R & D Management
Research-Technology Management
Regional Studies
Risk analysis
Risk, decision and policy
South African Journal of Chemical Engineering
South African Journal of Science
Southern African Journal of Environmental Education
Science & Society
South African Journal of Business Management
South African Journal of Economic and Management Sciences
South African Journal of Industrial Engineering
South African Journal of Science and Technology
Strategic Management Journal
Technology Analysis & Strategic Management
Technological Forecasting and Social Change

Technology and Culture
Technology Review
Technovation
Waste Management

9.3 Structure of a research article

Appendix 12 contains guidelines for the structure of a research article.

9.4 Journal's instructions to authors

Every journal has its own instructions to authors for the articles they will accept for publication. These covers matters such as technical layout (e.g., paper size, font, line spacing, margins, page numbering, format of figures, tables and references, etc.) and method of submission (e.g., number of copies, electronic submission, etc.) These instructions are given in every copy of the journal. Students should therefore obtain a copy of the journal and follow their instructions when writing the article. Unless otherwise advised by their study leaders, MEM and MPM student's articles will be submitted to the South African Journal of Industrial Engineering. **Appendix 12** contains this journal's instructions to authors.

10. COLLOQUIUM, SYMPOSIUM AND CONFERENCE PRESENTATIONS

Key requirements of scientific research are that it must be **public** and **reproducible** (by others). Therefore, an exposure of how the scientific research is structured and executed is of crucial importance, so that others are able to agree or disagree that the observed and/or measured event/s have (or have not) occurred (Page & Meyer 2000:12). It is therefore expected of researchers to present their research at colloquia, symposia and conferences.

10.1 Colloquia presentations

The Department of Engineering and Technology Management organises colloquia on a regular basis to give students the opportunity to present their research to academics and fellow students. It also forms part of the Research Management Process described in Section 6 of this Guide. MOT and PhD students are required to make a colloquium presentation whenever a milestone has been reached. MBA/MEM/MPM students make only two colloquium presentations: the first at the beginning (project proposal); and the second on completion of their research projects. Students **MUST** submit their presentations to their study-leaders, who must approve that it complies with the requirements as set herein, before they do their colloquium presentations

The purpose of a colloquium presentation is twofold: 1) to give a progress report on completed work, and 2) to present your planning for the continuation of the research project and discuss any problems you are experiencing. The relative

weight of the two parts will change as the project progresses - initially it will consist of only part 2), but after the completion of the project it will consist of only part 1).

The basic structure of a research presentation is the same as for a dissertation, thesis, research report or a research article. Typically, the presentation should start with the research problem, followed by the research methodology, the findings and the conclusions. Here are some guidelines (and examples of PowerPoint slides) for the structure of a research presentation at a colloquium:

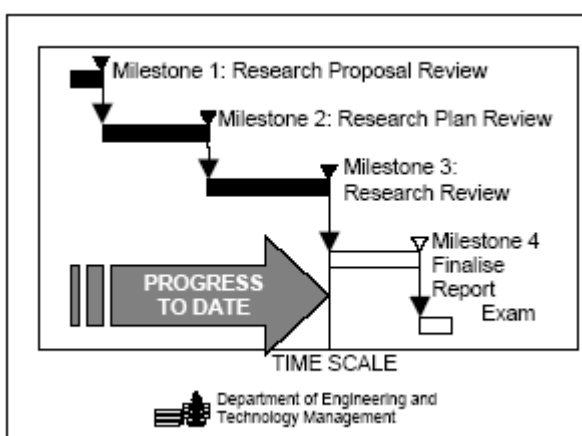
Topic and author/s

The presentation should start with the title of the presentation and name/s and field of study of the author/s.



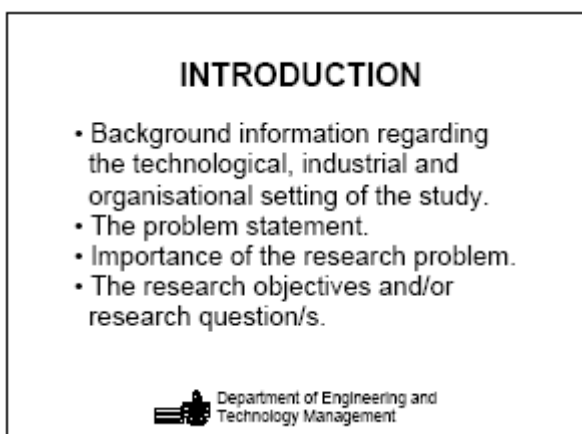
Current status/progress to date

Give the current status of the project by presenting the progress to date in terms of the schedules of milestones (See **Appendix 6**).



Introduction

Present the background information regarding the technological, industrial and organisational setting of the study. Give the reasons for selecting the particular problem, as well as a statement of the research problem and/or research objectives and/or research question/s.



Theoretical framework

Present a (short) review of the relevant scientific literature. Describe the current theories, models and methods that are relevant to the research problem. For a theory, model or method -building study, the deduction of new theoretical propositions, models or methods should be presented, as well as any research hypotheses.

THEORETICAL FRAMEWORK

- Theory and research review.
- Current theories, models and/or methods. (Use graphics.)
- Proposed new theories, models or methods. (Use graphics.)
- Hypotheses.



Department of Engineering and
Technology Management

Research Methodology

Describe the research strategy/design and methodology followed in the study, including the methods used for data collection and analysis. Discuss the testing of hypotheses and the derivation of new theoretical propositions, models or methods when using retroductive reasoning.

RESEARCH METHODOLOGY

- Research strategy/plan
- Research instruments (e.g. survey questionnaires)
- Data collection
- Data analysis
- Hypotheses testing
- New hypotheses, theories, models or methods



Department of Engineering and
Technology Management

Conclusion

The main conclusions of the study should be summarised, interpreted and discussed. Where appropriate, recommendations should be made for further research or practice or policy.

CONCLUSION

- Research results
- Implications for and/or contributions to theories, models and methods
- Recommendations for further research, practise and policy



Department of Engineering and
Technology Management

10.2 Symposium and conference presentations

Students are encouraged to present their research at local and overseas symposia and conferences. Conference organisers usually require presenters to submit a paper (or an abstract) for publication in the proceedings. They have their own unique prescriptions for the format of the papers they will accept for publication. The guidelines for writing conference papers are the same as for journal articles (see **Appendix 12**).

The basic structure of a conference presentation is the same as for a colloquium presentation, but would normally deal only with completed research.

10.3 Presenting skills

Presenters should prepare thoroughly for their presentations. Time utilisation is of the utmost importance as the time allowed is usually very limited and some time should also be allowed for questions and discussions. Typically speakers have 15 to 20 minutes for presentations at colloquia, symposia and conferences. Audio-visual aids should be used to best effect. The use of MS PowerPoint presentations have become the standard, but the use of posters, transparencies and flip-charts are acceptable.

The following are useful guidelines to presenters:

- Speak to the audience and not to the screen. Never turn your back to the audience. Have written notes or read from the computer display in front of you, but don't turn around to read what's on the screen.
- Project your voice by speaking to the furthest person in the hall and not to those closest to you.
- Don't read only what's on the screen or expect of the audience to do so. (If that is your intention, then why do the presentation? Just hand them a hard copy to read!). The purpose of the images on the screen is to provide the audience with a visual reference to what you are saying. It also allows you to show graphical images such as photographs, diagrams, flow-charts, etc. It is also useful as "speaker's notes" to remind you what to say next.
- When pointing to something on the screen, use an aid such as the arrow cursor of the computer (this works well in PowerPoint) or a pen (when using transparencies) or a laser pointer or a rod to point on the screen. Don't stand in front of the projected image and point with your hands!
- Be very careful not to clutter the images with too much detail. Use large fonts (recommended are Ariel regular, 28 pt or larger for PowerPoint presentations.) and high contrast (dark colours on light background or vice versa).
- Practise presenting your presentation and time yourself. You will always take somewhat longer when you present it in front of an audience, so allow for this. A good rule-of-thumb is that you cannot get through more than one slide per minute at most! More complicated slides like diagrams that need a lot of explaining will take much longer.
- Pay attention to voice intonation (do not speak in a monotonic way) and non-verbal communication (body language; do not stand as a salt pillar, do not jump around).

APPENDIX 1: GLOSSARY OF RESEARCH TERMS

Assumption

A fact or statement taken for granted (assuming it to be true).

Axiom

A statement accepted as true or a self-evident truth

Concept

Abstract or generic idea generalized from particular instances

Conceptual

Relating to, or consisting of concepts

Conjecture

A proposition before it has been proved or disproved.

Empirical

Originating in or based on observation or experience

Fiction

A fiction is either a deliberate or an unintentional fantasy, which is not based on reality. Sometimes a false assumption (fiction) can be introduced deliberately for the purpose of clarifying a scientific problem methodologically. (Gitt, 1997)

Hypothesis

A tentative assumption made in order to draw out and test its logical or empirical consequences. A hypothesis is an unverified scientific conjecture which contains speculations, and which amplifies an incomplete empirical result, or provisionally explains some fact. If a hypothesis serves as a methodological guide when a new research project is undertaken, it is known as a research hypothesis. When observational facts support a hypothesis, the probability of its being true is increased, but if ONE contradicting fact is uncovered, the hypothesis must be rejected (falsification). (Gitt, 1997)

A hypothesis is usually stated as a testable expectation, logically derived from a proposition, theory or observation.

Method

A way, technique, or process of or for doing something

Methodological

Relating to method

Methodological study

Study aimed at developing a new method, process or technique.

Model

A graphical, mathematical or schematic description or analogy of a system of postulates, data, and inferences. Models are representations of reality. Only the

most important properties are reflected, and minor or unrecognised aspects are not covered. Models are important because of their illustrativeness. A model is a deliberate but simplified representation of reality and it describes observed structures in a readily understandable way. It is possible to have more than one model for a given reality, and, because it is by nature provisional and simple, any model can always be improved upon. (Gitt, 1997)

Model-building study

Study aimed at developing a new model and theory to explain a particular phenomena. (Mouton 2001:176 - 178.)

Notion

Conception or impression of something known, experienced, or imagined

Paradigm

When a certain theory (or a system of hypotheses, or a world-view) pervades entire fields of research or an entire scientific era, it is known as a paradigm. Such a view then dictates the scope for specific researches and delineates the presuppositions used for explaining individual phenomena. If a system of hypotheses has been derived from presuppositions dictated by a world-view, it usually cannot be reconciled with the available facts. (Gitt, 1997)

Postulate

To claim as true, existent, or necessary

Proposition

Something offered for consideration or acceptance usually stated in sentence form near the outset

Research

Investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws. (Merriam-Webster Collegiate Dictionary)

Research is original investigation undertaken to gain knowledge and/or enhance understanding. Research specifically includes the creation and development of the intellectual infrastructure of subjects and disciplines (e.g. through dictionaries, scholarly editions, catalogues and contributions to major research databases); the invention or generation of ideas, images, performances and artefacts where these manifestly embody new or substantially developed insights; the use of existing knowledge to produce new or substantially improved materials, devices, products, policies or processes. It specifically excludes routine testing and analysis of materials, components, instruments and processes, as distinct from the development of new analytical techniques; the development of teaching materials and teaching practices that do not embody substantial original enquiry. (National Research Foundation)

Speculation

When a statement is based purely on discussion, fantasy, imagination, or contemplation, and does not correspond to reality, it is speculation, or merely an intellectual game. Because no actual experimentation is involved, it is easy to make undiscoverable mistakes. In thought experiments difficulties can easily be evaded, undesirable aspects can be suppressed, and contradictions can be deftly concealed. Thought experiments can probably raise questions, but cannot answer any; only actual experimentation can provide answers. Mere speculation without experimentation and observation is not science, neither is pure deduction from arbitrary presuppositions, nor is a biased selection of observations. Even the most abstract theory should not lose contact with reality and experimentation; it must be empirically verifiable. Thought experiments as well as deductions from philosophical postulates not based on observation, are speculations. (Gitt, 1997)

Supposition

Something that is supposed to be true.

Theory

A plausible or scientifically acceptable general principle or body of principles offered to explain phenomena. Theories endeavour to explain facts in a unified representation of models and hypotheses. To put it briefly, a theory is a scientific statement based on empirical findings. Since empirical results are seldom final, theories are of a provisional nature, and the inherent hypothetical element inevitably causes uncertainty - in the best case a statement can be made in terms of specific probabilities. Theories are therefore a means of tying observed facts together, and the best theories are those, which attain this objective with the least number of inconsistencies. (Gitt, 1997)

Theorem

An idea, proposition, or statement accepted or proposed as a demonstrable truth often as a part of a general theory

Verification

Verification means that a statement is tested experimentally. The result of such verification is not generally valid, however. It holds strictly only for cases that have actually been confirmed, because the possibility that hitherto unknown counter examples may exist cannot be excluded. If one contradictory case is found, then the statement is rejected (falsified!). This can also be expressed as follows: It is not possible to verify a theory; a theory can only be falsified. A theory is good if it could be falsified very easily, and when it survives all open criticisms and tests, it can be accepted. (Gitt, 1997)

APPENDIX 2: SUBJECTS IN ENGINEERING AND TECHNOLOGY MANAGEMENT

Decision Analysis

Development Management

Engineering Economics

Engineering Logistics

Engineering Management

Entrepreneurship

Financial Management

General Management

Information Management

Innovation Management

- Understanding the Dynamics of Technological Change (Substitution, Diffusion, Products and Processes Evolution, Performance Trajectories)
- Assessment of Technological Threats and Opportunities (Emerging Technologies Assessment, Technology Forecasting, Technological Landscape Scanning and Monitoring, Competitive Intelligence)
- Impact Assessment of Technologies
- Innovation Strategies and Methodologies
- Appropriate Technology and Appropriate Best Practice
- Technology Audits
- Technology Transfer Mechanisms
- Adoption, Uptake and Diffusion of Technology
- Incubation of Technology-based Companies (SMMEs)
- National Innovation System and Policy
- National Technology Policy Initiatives
- Impact of Technology on Competitiveness and Quality of Life
- Related Research Areas (Strategic Management of Technology, Research and Development Management, Entrepreneurship, Commercialisation, Manufacturing, Economic Analysis, Intellectual Property Protection, Marketing, Political and Environmental Assessments)

Law of Contract

Maintenance Management

Marketing Management

New Ventures & Entrepreneurship

Operations Management

People Management

Production and Operations Management

Project Contract Management

Project Cost Management

Project Financial Management

Project Human Resource Management

Project Management

Project Quality Management

Project Risk Management

Project Systems Engineering

Quality Management

R&D Management
Safety, Health & Environment Management
Strategic Management
Systems Engineering
Technology Management

APPENDIX 3: SUBJECT LITERATURE FOR ENGINEERING AND TECHNOLOGY MANAGEMENT

Textbooks

Textbooks prescribed and recommended by the lecturers in the Engineering and Technology Management programmes.

Journals

Search the UP Library Catalogue at <http://www.ais.up.ac.za/>.

List of relevant journals:

Academy of Management Journal
Academy of Management Review
American Journal of Mathematical and Management Sciences
British Journal of Management
California Management Review
Harvard Business Review
IEEE Engineering Management Journal
IIE Transactions
Industrial and Corporate Change
Industry and Innovation
International Journal of Forecasting
International Journal of Innovation Management
International Journal of Management
International Journal of Technology Management
International Journal of Project Management
International Studies of Management and Organisation
Issues in Science and Technology
Journal of Engineering and Technology Management
Journal of Management
Journal of Management Studies
Journal of Product Innovation Management
Management Focus
Management International Review
Management Science
Organizational Dynamics
Project Management Journal
Prometheus
R & D Journal
R & D Management
Research & Development
Science & Society
South African Journal of Business Management
South African Journal of Economic and Management Sciences
South African Journal of Industrial Engineering
South African Journal of Science and Technology
Strategic Management Journal
Strategic Management Journal
Technological Forecasting and Social Change

Technology and Culture
Technology in Society
Technology Review
Technovation

International conference proceedings

International Conference on Management of Technology (IAMOT)
International Conference on Management of Technology (ICMOT)
The International Conference on Management of Innovation and Technology (ICMIT).
International Conference on Industrial Engineering and Operations Management.
<http://www.iamot.org>

EURO Working Group on Project Management and Scheduling

IEEE Engineering Management Conference

Portland International Conference on Management of Engineering and Technology (PICMET). <http://www.picmet.com>

PMI Conference (USA)

International Society for Professional Innovation Management (ISPIM) Conference. <http://www.ispim.org>

UNIDO International Conference on Management of Technology.
<http://www.unido.org/doc/330942.htmls>

The R&D Management Conference. <http://www.radma.org>

ISPE International Conference on Concurrent engineering. <http://www.ceconf.com>

Master's Dissertations and PhD Theses

Visit the UP electronic theses and dissertations service (UPeTD) web site at <http://upetd.up.ac.za> for detailed information.

APPENDIX 4: RESEARCH FLOWCHART

PHASE 1: RESEARCH PROPOSAL
<p>Actions:</p> <ul style="list-style-type: none"> • Initiating problem or assignment (Research idea) • First environmental scanning • First theory and research survey • Definition of the research problem • Propose title for dissertation/thesis/report • Proposed research methodology • Estimation of potential for success <p>Output: <i>Research Proposal Document</i></p> <p>Baseline 1: Research Proposal Review</p> <ul style="list-style-type: none"> • Approval of <i>Research Proposal</i> by Research Committee of Department • Colloquium presentation <p>Milestone 1: Research Proposal Approved</p>
PHASE 2: RESEARCH PLAN
<p>Actions:</p> <ul style="list-style-type: none"> • Comprehensive environmental scanning • Comprehensive theory and past research survey and critical analysis • Conceptual model/s, propositions and hypotheses • Choice of research design • Development of data-gathering techniques and instruments <p>Output: <i>Research Plan</i> consisting of:</p> <ul style="list-style-type: none"> 1st Draft of Chapter I (Background, Research Question/s) 1st Draft of Chapter II (Theory and research review) 1st Draft of Chapter III (Conceptual Model [or Theory or Method]) 1st Draft of Chapter IV (Research design and methodology) List of references and appendices <p>Baseline 2: Research Plan Review</p> <ul style="list-style-type: none"> • Approval of <i>Research Plan</i> by Research Committee of Department • Approval of <i>Research</i> and <i>Instruments</i> (e.g. questionnaires) by Faculty Committee for Research Ethics and Integrity² • Colloquium presentation <p>Milestone 2: Research Plan Approved</p>

² All research involving interaction with people must be submitted to the Ethics Committee of the Faculty for approval. The application form for approval is available on the faculty website at http://www.up.ac.za/ebit/r_ethics.html. See also Appendix 15.

PHASE 3: RESEARCH EXECUTION**Actions:**

- Execution of data-gathering
- Execution of analysis
- Model (or Theory or Method) building or testing

Output: *Research Report* consisting of:
 2nd Draft of Chapter I
 2nd Draft of Chapter II
 2nd Draft of Chapter III
 2nd Draft of Chapter IV
 1st Draft of Chapter V (Results: Data gathered and analysis)
 List of references and appendices

Baseline 3: Research Review

- Approval of Research Report by Research Committee of Department
- Colloquium presentation

Milestone 3: Research approved**PHASE 4: WRITING OF DISSERTATION/THESIS/REPORT****Actions:**

- Finalise Chapters I to V
- Write Chapter VI with interpretation and findings
- Proof reading and compilation of draft dissertation/thesis/report
- Write article/s for peer-reviewed international journals

Output: *Draft dissertation/thesis/report*

Baseline 4: Dissertation/thesis/report Review

- Approval of draft dissertation/thesis/report by Research Committee of Department
- Approval of draft article/s for peer-reviewed international journals
- Colloquium presentation

Milestone 4: Dissertation/thesis/report Approved

PHASE 5: EXAMINATION AND DISSEMINATION OF RESEARCH RESULTS**Actions:**

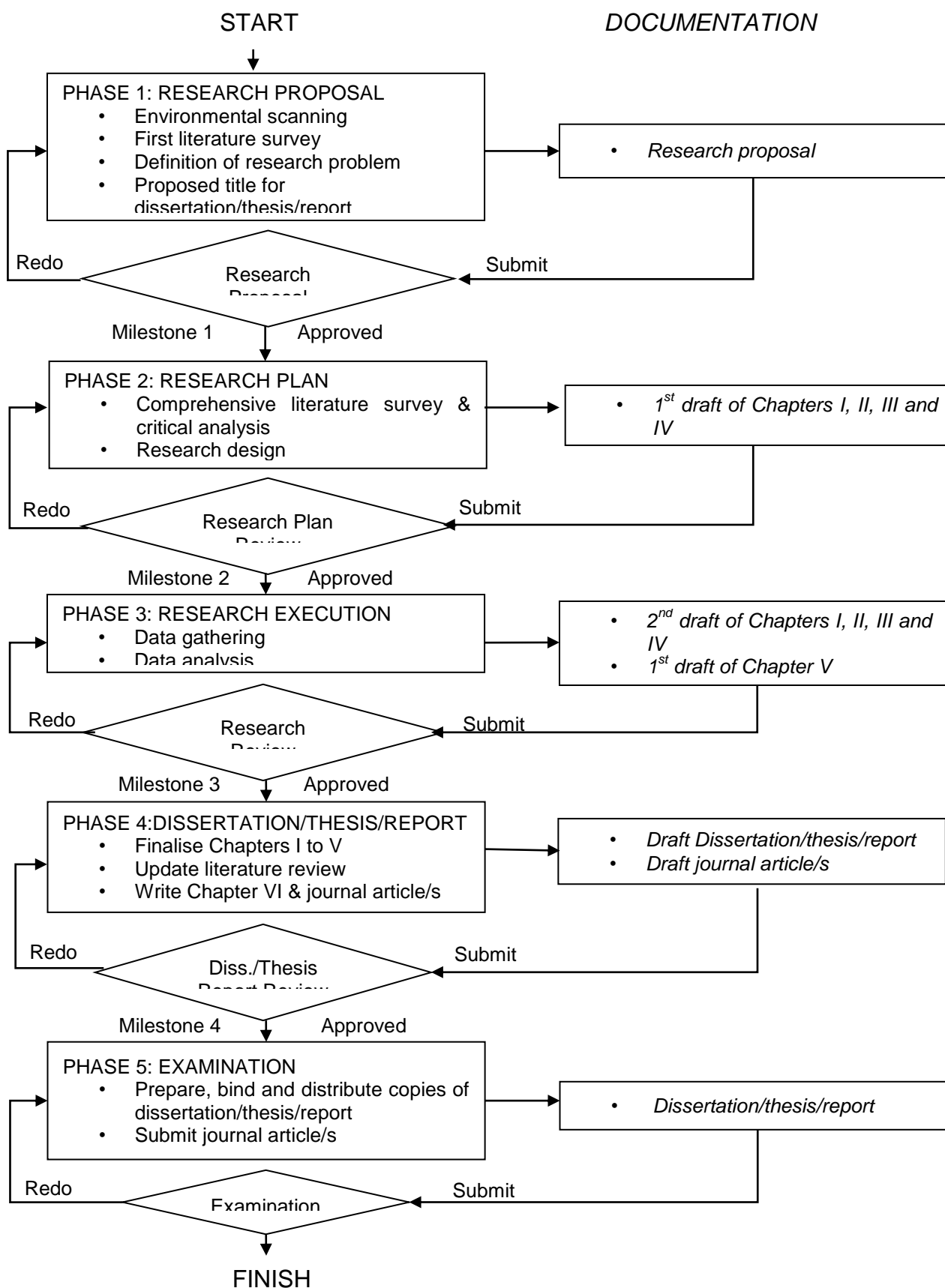
- Preparation, bind and distribute examination copies of dissertation/thesis/report
- Submit article/s to peer-reviewed international journals

Output:

Dissertation/thesis/report
Published article/s in peer-reviewed international journals
Symposium or Conference presentation/s

Baseline 5: Examination

- Internal and external examination



APPENDIX 5: NOTES ON THE RESEARCH PROCESS

(Adopted from Malan, Coetzee & Van Breda 1992, P. 37)

1 INITIATING PROBLEM OR ASSIGNMENT

1.1 Possible initiators for research

- To enlighten or confirm a current theory
- To resolve conflicting findings
- To correct faulty methodology or use of inappropriate techniques
- To solve existing practical problems

2 FIRST THEORY AND RESEARCH SURVEY

2.1 Functions of the Theory and Research Survey

- Recognition of the meaningful and relevant
- Gauging the quality of other research
- Raise a critical attitude
- Schooling in fine observation (also of traps)

2.2 Information Sources

- Primary and secondary sources
- Literature types
- Comprehension literature
- Research literature

2.3 Role of the Theory and Research Study

- Selection of research theme
- To define the boundaries of the terrain
- To delimit the scope of the research
- Choice of procedures, techniques and instruments
- To avoid unnecessary repetition
- To evaluate meaningfulness of own findings
- To formulate hypotheses sharper
- To do more purposeful research

2.4 Documentation Systems

2.5 Performing Source Studies

- Start with most recent work
- Start with recognised authors
- Start with articles, dissertations and theses
- Start with each source by first reading the abstract or summary to judge relevance

2.6 Make notes

- Bibliography cards
- Contents cards
- Numbering

- Allow for expansion of card system

3 DEFINITION OF RESEARCH PROBLEM

3.1 Precise demarcation of problem

- Proceeding from the initiating problem or assignment (Step 1) and in the light of the theory and research survey (Step 2), demarcate the problem precisely
- Give notional (concept) definitions
- Give functional or operational definitions

4 ESTIMATION OF POTENTIAL FOR SUCCESS

4.1 Considerations for the estimation of potential for success

4.1.1 Practicability

- Own capabilities and training
- Is the data available?
- Are there sufficient financial resources?
- Do you have the time?
- Do you have enough interest and perseverance?

4.1.2 Uniqueness

To ensure that a student does not duplicate the topic/title of his/her Dissertation/Thesis/Report, a search has to be carried out on the Research Report database of the National Research Foundation. To do the search, follow the instructions below:

Go to the Academic Information Service website: <http://www/ais/up.ac.za>

Select: Information Resources

Select: Databases

Select: H

Select: Human Sciences Research Council

Select: Research Projects

Use the following password and ID

ID: zup01 or zup 02 to zup 05

Password: up

Search the database to ensure that the intended topic/title is not a duplicate of previous or current research.

4.1.3 Scope

4.1.4 Actuality

4.1.5 Polyvalence (many values)

4.1.6 Return on effort

4.1.7 Integration with daily work

4.1.8 Decision to proceed, change planning or abandon theme.

5 SECOND THEORY AND RESEARCH SURVEY

6 CHOICE OF RESEARCH UNDERTAKING

6.1 Time orientation

- Past – Library research
- Present – Field research
- Future – Laboratory research

6.2 Depth of research

- Describe
- Compare (and if possible, predict)
- Evaluate (including diagnostics)

6.3 Degree of generalisation

- Basic research
- Applied research
- Commissioned research (including Contract Research)
- Action research

6.4 Research undertaking

- Testing investigation
- Instrumental-nomological investigation
- Descriptive investigation
- Explorative investigation
- Interpretive-theoretical investigation

7 HYPOTHESES

7.1 Definition, nature and purpose of hypotheses

- Preliminary solution
- Expectation
- Based on existing knowledge

7.2 Characteristics of a good hypothesis

- Compatible with previous research
- Reasonable explanation
- Terse
- In operational terms
- Testable within a reasonable time

7.3 Types of hypotheses

- Based on derivation
- Inductive hypothesis

- Deductive hypothesis
- Based on proposition
- Research hypothesis
- Unguided
- Directive
- Null hypothesis (statistical hypothesis)

8 CHOICE OF DATA-GATHERING TECHNIQUES

- Perusal
- Observation
- Questioning (consultation)
- Measurement

9 CHOICE (AND DEVELOPMENT) OF DATA-GATHERING INSTRUMENTS

9.1 Controlling if data-gathering techniques has the desirable attributes

- Reliability
- Validity
- Sensitivity
- Appropriateness
- Objectivity
- Feasibility
- Ethical acceptability

10 DEVELOPMENT OF PLAN OF ANALYSIS

- Choice of analytical techniques that are appropriate for type of research, inter-alia statistical techniques
- Clearing with computer personnel (if required)

11 DESIGN OF DATA-GATHERING PLAN

- Training of co-workers (fieldworkers)
- Experimental design
- Scheduling of key dates

12 CHOICE OF THE INVESTIGATION GROUP

- Sampling
- Singular random individual sampling
- Systematic sampling
- Stratified sampling
- Batch sampling

13 PRELIMINARY INVESTIGATION

- Trail run for data-gathering approach
- Opportunity to test data-gathering method
- Opportunity to test data-gathering instrument and to refine it
- Opportunity to test data-processing technique
- Opportunity to familiarise co-workers with the instrument

- Opportunity to familiarise co-workers with the analysis of the data
- Opportunity to make final choices regarding
- Approaches
- Techniques
- Instruments
- Opportunity to formulate hypotheses more precisely
- Opportunity to identify intervention variables and to eliminate/control them

14 EXECUTION OF DATA-GATHERING

14.1 Dual responsibility

- Towards the research
- Towards the research object/s
- Prior to data-gathering
- During data-gathering
- After data-gathering

14.2 Essential attributes of the data-gathering situation

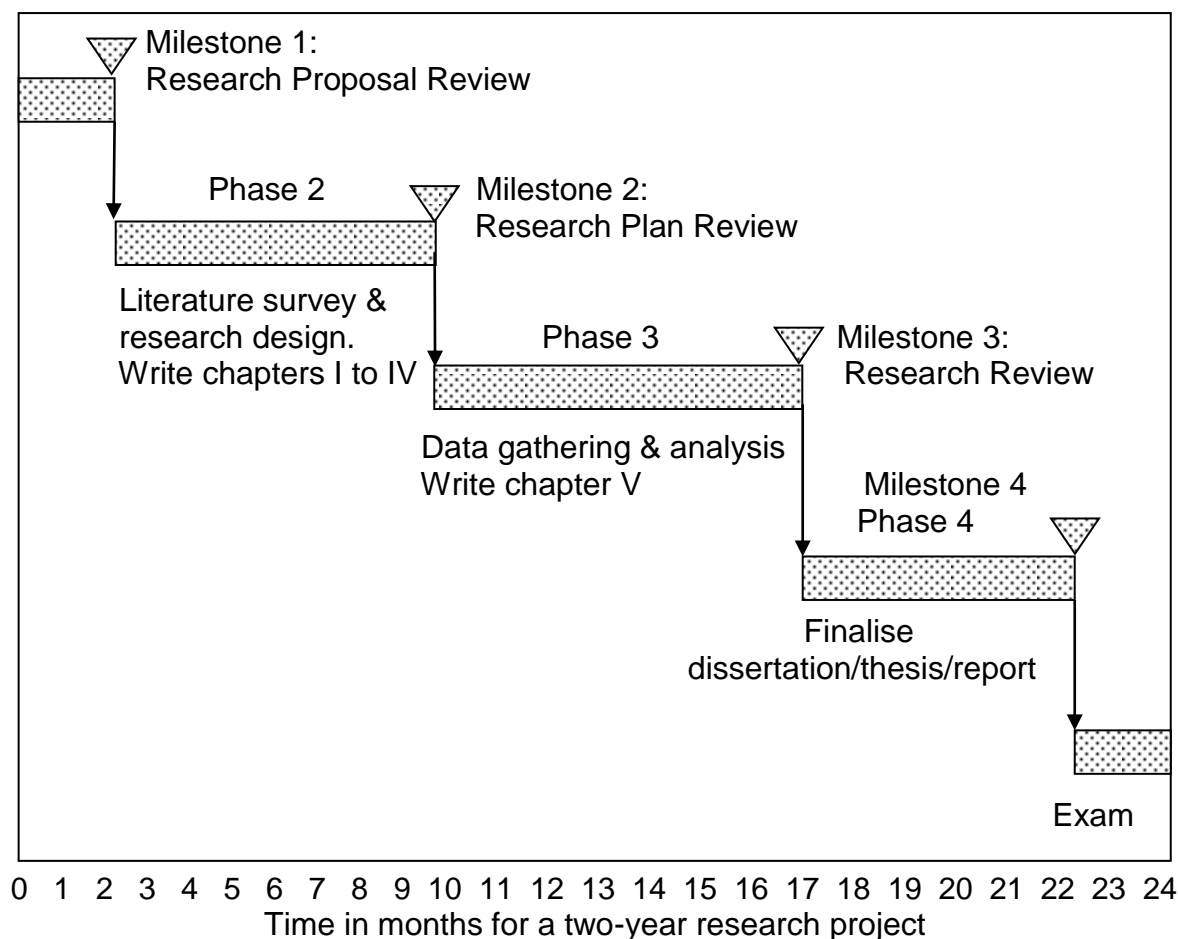
- Standardisation
- Provision for the unforeseen
- Sufficient time

15 EXECUTION OF ANALYSES

16 REPORT WRITING

17 DISSEMINATION

APPENDIX 6: SCHEDULE OF MILESTONES



KEY MILESTONE DATES

	PhD Thesis		MOT Dissertation		MEM/MPM Report	MBA Report
Milestone 1(a): Submission of title	Any time		Any time		Mid February (oral presentation)	Mid February
Milestone 1(b): Submission of proposal	Any time		Any time		End of February	End of March
Milestone 4: Complete draft document to study leader	End of July	End of Jan	End of August	End of Feb.	Mid-September	End of August
Milestone 5: Final document for examination	End of October	End of April	End of October	End of April	Mid October	End of October
Submission of examination result	End of January	End of July	End of January	End of July	End of January	End of January
Graduation ceremony	April	Sept	April	Sept	April	April

PLEASE NOTE: The above table contains only approximate dates. Students must consult their study guides for the exact dates applicable to a particular academic year.

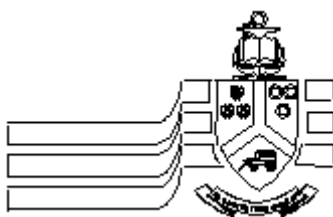
APPENDIX 7: REVIEW REPORTS

A11/1 PROPOSAL REVIEW REPORT

A11/2 RESEARCH PLAN REVIEW REPORT

A11/3 RESEARCH REVIEW REPORT

A11/4 DISSERTATION/THESIS/REPORT REVIEW REPORT



UNIVERSITY OF PRETORIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

Proposal Review Report (Milestone 1 Report)

Proposed Title										
Student										
Study leader										
Programme	PhD		MOT		MEM		MPM		MBA	
Revision date										
Reviewer/s										

LENGTH OF PROPOSAL		
Requirements: <ul style="list-style-type: none"> • >20 typed pages (PhD candidates) • >10 typed pages (MOT students) • >5 typed pages (MEM/MPM/MBA) 	Mark <input type="checkbox"/>	Comments <hr/> <hr/> <hr/>
LANGUAGE USAGE		
Requirements: <ul style="list-style-type: none"> • Formal South African English. • Scientific style (e.g. "It is proposed..." not "I propose ..."). • Paragraphs, numbering, etc. (See UP Guidelines for the Preparation of Written Assignments http://www.ais.up.ac.za/learning/docs/assign.pdf and departmental procedure documents.) • Use of scientific research terms. (See <i>Appendix 1: Glossary of research terms, Research Guide for Post-Graduate Students</i>) 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
PROPOSED TITLE		
Requirements: <ul style="list-style-type: none"> • One sentence. • No elaboration and superfluous detail. • Clear, complete and formal. • Not a duplicate of previous or current research. (NRF Research Report Database searched?) 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/>
TABLE OF CONTENTS		
<ul style="list-style-type: none"> • Listing of section headings with page numbers. 	Mark <input type="checkbox"/>	Comments <hr/>
INTRODUCTION AND BACKGROUND		
Requirements: <ul style="list-style-type: none"> • Adequate introductory overview of the technological, industrial and/or organisational context of the study. • Clear statement of the proposed topic of the research – what is the broad issue to be investigated? • Sufficient reasons given for selecting the particular problem - the rationale for the study. 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>

the research?	<input type="checkbox"/>	
PROPOSED RESEARCH STRATEGY		
Requirements: <ul style="list-style-type: none"> Proposed approach and strategy for performing the research. Proposed research design and methodology to be followed. Proposed research instrument/s (questionnaire, case study, interview) and methods of data collection and analysis. Justification of why the methods are proposed. Proposed project plan and schedule for performing the research. 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments
PROPOSED TABLE OF CONTENTS OF THESIS/DISSERTATION/REPORT		
Requirements: <ul style="list-style-type: none"> Proposed chapter plan and a preliminary outline of the chapter divisions. 	Mark <input type="checkbox"/>	Comments
CONCLUSION		
Requirements: <ul style="list-style-type: none"> Concluding statement on the feasibility of completing the study as proposed. 	Mark <input type="checkbox"/>	Comments
REFERENCES AND BIBLIOGRAPHY		
Requirements: <ul style="list-style-type: none"> Complete list of references. Referencing Method (See Research Guide for Post-Graduate Students.) Preliminary bibliography listing the most important and recent specialist literature that has been consulted. 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments
PERSONAL INFORMATION		
Requirements: <ul style="list-style-type: none"> Name and student number Postal address E-mail address Telephone number(s) 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments

[illegible]

Proposal approved as submitted	
Proposal approved with changes as indicated. (Study leader to approve changes)	
Proposal to be resubmitted to Research Committee with changes as indicated.	
Proposal rejected for reasons as stated.	

47



UNIVERSITY OF PRETORIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

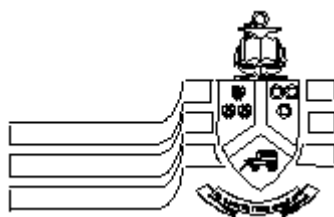
Research Plan Review Report (Milestone 2 Report)

Title										
Student										
Study leader/s										
Programme	PhD		MOT		MEM		MPM		MBA	
Revision date										
Reviewer/s										

LANGUAGE USAGE		
Requirements: <ul style="list-style-type: none"> Formal South African English. Scientific style (e.g. "It was found..." not "I found ..."). Paragraphs, numbering, etc. (See UP Guidelines for the Preparation of Written Assignments http://www.ais.up.ac.za/learning/docs/assign.pdf and departmental procedure documents.) Use of scientific research terms. (See Appendix 1: Glossary of research terms, Research Guide for Post-Graduate Students) 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
FIRST DRAFT OF CHAPTER I (BACKGROUND, RESEARCH QUESTIONS)		
Requirements: <ul style="list-style-type: none"> Background information regarding the <i>technological, industrial and organisational setting</i> for the study, including an overview of the historical development and current state of the industry, organisation/s and technology under investigation. Statement of the research problem and research question/s. Reasons for selecting the particular problem - the rationale for the study. Length of chapter 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
FIRST DRAFT OF CHAPTER II (THEORY AND RESEARCH REVIEW)		
Requirements: <ul style="list-style-type: none"> Comprehensive review and critical analysis of the literature that represents the most authoritative scholarship on the theory and past research of the problem. Description and critical analysis of the theories that currently exist and if any of them can or have been applied to the research problem. Does a 'gap' exist for a new or improved theory/method that is specifically tailored to the research problem (<i>theory-building research</i>)? Length of chapter 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>

Draft of Chapters I - IV approved as submitted - Milestone 2 achieved.	
Draft of Chapters I - IV approved with changes as indicated - Milestone 2 achieved. (Study leader to approve changes)	
Draft of Chapters I - IV to be resubmitted to Research Committee with changes as indicated.	

Date _____



UNIVERSITY OF PRETORIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

Research Review Report (Milestone 3 Report)

Title										
Student										
Study leader/s										
Programme	PhD		MOT		MEM		MPM		MBA	
Revision date										
Reviewer/s										

LANGUAGE USAGE		
Requirements: <ul style="list-style-type: none"> Formal South African English. Scientific style (e.g. "It was found..." not "I found ..."). Paragraphs, numbering, etc. (See UP Guidelines for the Preparation of Written Assignments http://www.ais.up.ac.za/learning/docs/assign.pdf and departmental procedure documents.)	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
SECOND DRAFT OF CHAPTERS I, II, III AND IV		
Requirements: <ul style="list-style-type: none"> Chapter 1: Introduction/Background Chapter 2: Theory and research review/Theoretical background Chapter 3: Theoretical framework/Conceptual model or method Chapter 4: Research design and methodology Length of chapters 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
FIRST DRAFT OF CHAPTER V (RESULTS: DATA GATHERED AND ANALYSIS)		
Requirements: <ul style="list-style-type: none"> Presentation and discussion of the data or information collected. Analysis and discussion of the data or information collected (Is the data sufficient to scientifically test the research hypotheses?). Testing of hypotheses (does the observed facts support the hypotheses or not.) Inference of new hypotheses based on the observed facts (retroductive reasoning). Length of chapter 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
REFERENCES AND BIBLIOGRAPHY		
Requirements: <ul style="list-style-type: none"> Complete list of references. Referencing Method (See DETM Research Guide for Post-Graduate Students.) 	Mark <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/>

Research progress approved as submitted - Milestone 3 achieved.	
Research progress approved with changes as indicated - Milestone 3 achieved. (Study leader to approve changes)	
Research progress to be resubmitted to Research Committee with changes as indicated.	

Date _____



UNIVERSITY OF PRETORIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

Dissertation/Thesis/Research Report Review Report (Milestone 4 Report)

Title										
Student										
Study leader/s										
Programme	PhD		MOT		MEM		MPM		MBA	
Revision date										
Reviewer/s										

LANGUAGE USAGE		
Requirements: <ul style="list-style-type: none"> Formal South African English. Scientific style (e.g. "It was found..." not "I found ..."). Paragraphs, numbering, etc. (See UP Guidelines for the Preparation of Written Assignments http://www.ais.up.ac.za/learning/docs/assign.pdf and departmental procedure documents.)	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
PRELIMINARIES		
Requirements: <ul style="list-style-type: none"> Title Page Acknowledgements English summary (<350 words - MOT) Afrikaans summary (<350 words - MOT) Table of Contents List of tables List of figures. 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
CHAPTER I (BACKGROUND, RESEARCH QUESTIONS)		
Requirements: <ul style="list-style-type: none"> Background information regarding the <i>technological, industrial and organisational setting</i> for the study, including an overview of the historical development and current state of the industry, organisation/s and technology under investigation. Statement of the research problem and research question/s. Reasons for selecting the particular problem - the rationale for the study. Length of chapter 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
CHAPTER II (THEORY AND RESEARCH REVIEW)		
Requirements: <ul style="list-style-type: none"> Comprehensive review and critical analysis of the literature that represents the most authoritative scholarship on the research problem. Most recent publications covered? Description and critical analysis of the theories that currently exist and 	Mark <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>

CHAPTER V (RESULTS: DATA GATHERED AND ANALYSIS)		
Requirements: <ul style="list-style-type: none"> • Presentation and discussion of the data or information collected. • Analysis and discussion of the data or information collected. • Testing of hypotheses. • Inference of new hypotheses based on the observed facts (retroductive reasoning). • Length of chapter 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
Chapter VI (CONCLUSIONS AND RECOMMENDATIONS)		
Requirements: <ul style="list-style-type: none"> • Presentation of conclusions of the research study (summarised, discussed and interpreted) • Contributions to theory (including derived models or methods) and practise. • Self-assessment of what has been accomplished (achievements and shortcomings). • Appropriate recommendations for further research and practice or policy. 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
REFERENCES AND BIBLIOGRAPHY		
Requirements: <ul style="list-style-type: none"> • Complete list of references. • Recent publications included? • Referencing Method (See DETM Research Guide for Post-Graduate Students.) 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/>
APPENDIXES	Mark <input type="checkbox"/>	Comments <hr/>
JOURNAL ARTICLE/S		
Requirements: <ul style="list-style-type: none"> • DOE Accredited Journal • Conforms to Journal's Instruction to Authors • Study-leader is co-author • UP affiliation indicated 	Mark <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Comments <hr/> <hr/> <hr/> <hr/>

Dissertation/thesis/report approved as submitted - Milestone 4 achieved.	
Dissertation/thesis/report approved with changes as indicated - Milestone 4 achieved. (Study leader to approve changes)	
Dissertation/thesis/report to be resubmitted to Research Committee with changes as indicated.	

Date _____

APPENDIX 8: RESEARCH IDEA

Name:	Degree:
<p>Problem statement (See Section 7):</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	
<p>Relevant theories – refer to problem area/subject (See Appendix 2):</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	
<p>Key subject literature references (See Appendix 3):</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	

APPENDIX 9: REFERENCES AND LITERATURE SOURCES

1. Policy, procedures and regulations

MEM/MPM Research Project (IGB 895/ISC 895³). 2001. Department of Engineering and Technology Management, University of Pretoria.

Policy and Procedures for Master's Degree Study : Technology Management. 2000. Department of Engineering and Technology Management, University of Pretoria.

Policy and Procedures for Doctoral Study. 2000. Department of Engineering and Technology Management, University of Pretoria.

Guidelines for a (MBA) Management Report. 2002. Graduate School of Management, University of Pretoria.

2. Research methodology

Botha, W.M. and Du Toit, P.H. 1999. *Guidelines for the Preparation of Written Assignments.* Pretoria: University of Pretoria. Available from: <http://www.up.ac.za/asservices/ais/assign.pdf>.

Cooper, D.R. and Schindler, P.S. 2001. *Business Research Methods.* 7th ed. Singapore: Irwin/McGraw-Hill.

Mouton, J. 2001. *How to succeed in your Master's & Doctoral Studies. A South African Guide and Resource Book.* Pretoria: Van Schaik Publishers.

Hussey, J. and Hussey, R. 1997. *Business Research.* MacMillan Press Ltd.

Leedy, P.D. and Ormond, J.E. 2001. *Practical Research Planning and Design.* 7th ed. New Jersey: Merrill Prentice Hall.

Malan, S.P.T., Coetzee, W.J.C. en Van Breda, P. 1992. *Magister- en Doktrale Studie: Riglyne vir Studieleiers, Promotors en Studente.* 2de uitgawe. Buro vir Akademiese Steundienste, Universiteit van Pretoria.

Monette, D.R., Sullivan, T.J. and De Jong, C.R. 1990. *Applied Social Research. Tool for the Human Sciences.* Orlando: Harcourt Brace Jovanovich College Publishers.

Mathews, E.H. & Taylor, P.B. 1998. *Making the researcher's life easier with research toolbox.* Borland: MCI (pty) Ltd.

Page, C. and Meyer, D. 2000. *Applied Research Design for Business and Management.* Sydney: Irwin/McGraw-Hill.

³ The codes of these modules have changed to IGB 898 and ISC 898.

Saint-Germain, M.A. 1997. *Research Methods*. California State University. Available from: <http://www.csulb.edu/~msaintg/ppa696/696menu.htm>

Stouthammer-Loeber, M. and Van Kammen, W.B. 1995. Data Collection and Management. *Applied Social Research Methods Series*, Vol. 5. London: SAGE Publications.

Trochim, W.M.K. 1997. *Research Methods Knowledge Base*. Cornell University Press.

3. Survey research

Backstrom, C.H. and Hursh G.D. 1998. *Survey Research*. MacMillan Press.

Scheaffer, R.L., Mendenhall, W. and Ott, L. 1979. *Elementary Survey Sampling*. Duxbury Press, Massachusetts, USA.

Fowler Jr. F.J. SURVEY RESEARCH METHODS. 2001. Second Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Fowler, Jr. F.J. and Mangione T.W. 2001. STANDARDIZED SURVEY INTERVIEWING. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Fowler, Jr. F.J. 2001. IMPROVING SURVEY QUESTIONS. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Lavrakas, P.J. 2001. TELEPHONE SURVEY METHODS. Second Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Henry, G.T. 2001. PRACTICAL SAMPLING. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Mangione, T.W. 2001. MAIL SURVEYS. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

4. Case Study research

Yin, Robert K. 2003. Case Study Research Design and Methods. Third Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi, Newbury Park, CA.

Yin, R.K. 2001. APPLICATIONS OF CASE STUDY RESEARCH. Second Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Harrison, M.I. 2001. *DIAGNOSING ORGANIZATIONS*. Second Edition, Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

5. Policy research

Majchrzak, A. 2001. *METHODS FOR POLICY RESEARCH*. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

6. Simulation

Whicker, M.L., and Sigelman, L. 2001. *COMPUTER SIMULATION APPLICATIONS*. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

Henry, G.T. 2001. *GRAPHING DATA*. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

7. Qualitative research

Maxwell, J.A. 2001. *QUALITATIVE RESEARCH DESIGN*. Applied Social Research Methods Series, Volume 5, SAGE Publications, Thousand Oaks, London, New Delhi.

5. Statistical analysis

Tabachnick, B.G. and Fidell, L.S. 2001. *Using Multivariate Statistics*. Fourth edition, Allyn and Bacon Publishers.

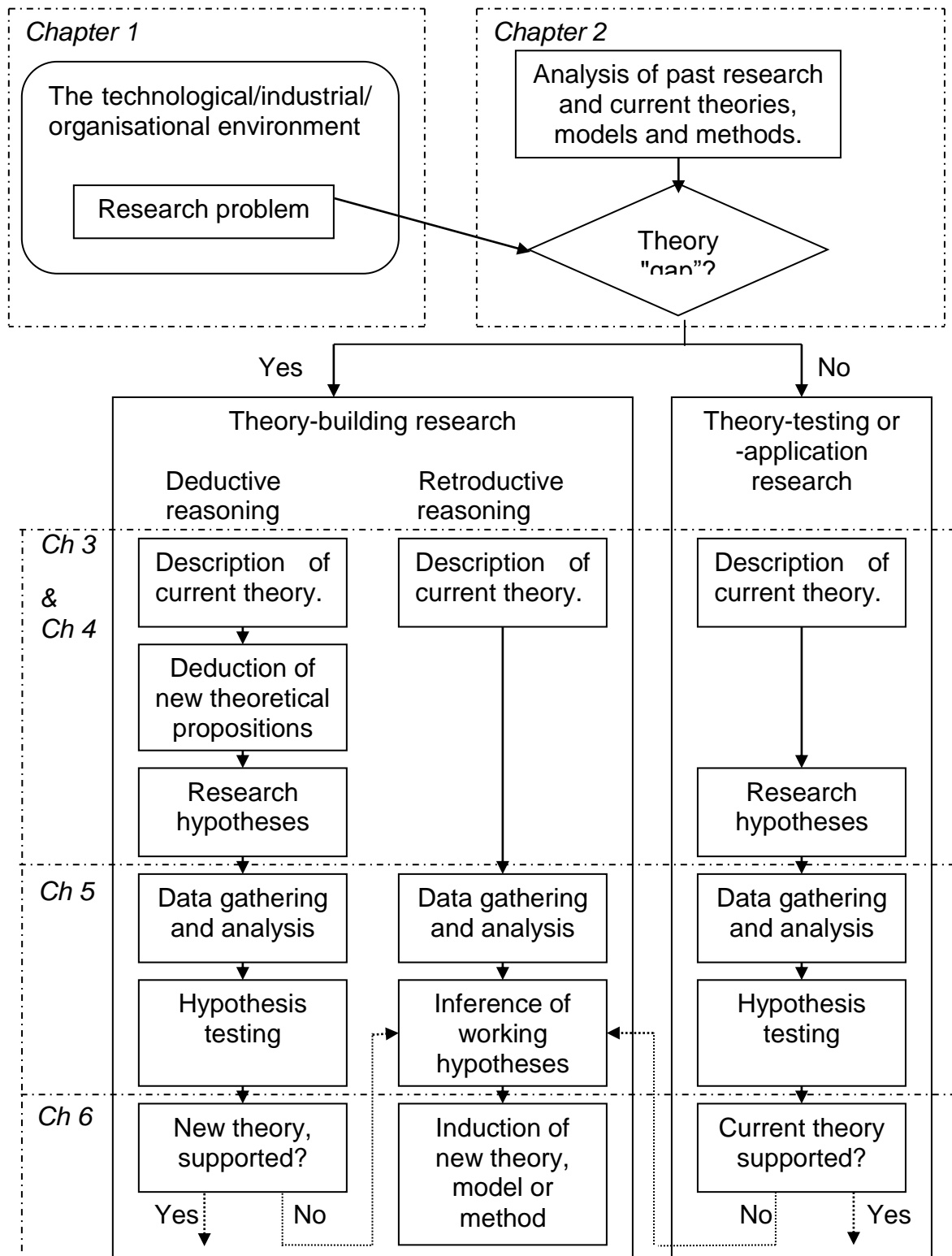
Tacq, J. 1997. *Multivariate Analysis Techniques in Social Sciences Research: From Problem to Analysis*, Sage Publications, London.

Arsham, H. Statistical Thinking for Managerial Decision Making: Revealing Facts from Figures. Fully-online course at:
<http://ubmail.ubalt.edu/~harsham/Business-stat/opre504.htm>

6. Additional resources and references

Additional resources and references on UP regulations, research methodology, literature management, writing, ethics and formatting are available on the following website: <http://upetd.up.ac.za/authors/create/index.htm>

APPENDIX 10: RESEARCH LOGIC FOR THEORY-BASED EMPIRICAL RESEARCH



APPENDIX 11: GSTM HARVARD REFERENCING METHOD

"Academic" (and "Scientific") writing requires that sources be acknowledged EXPLICITLY. References should be given whenever statements are made that originates from another person's work or publications, even if rephrased. If such references are omitted the impression is created that they are the writers own work, thus amounting to **plagiarism** which can have serious consequences for your academic career and eventually for your professional career. Plagiarism is a serious offence. It is not acceptable to give a list of (unreferenced) sources at the end of the document. Material that was read but that is not specifically referred to, can be given in a bibliography.

Please ensure that all referencing in all research reports is according to the GSTM Harvard Referencing Method. There are two tools available which will assist you with the Referencing.

Endnote (has to be installed on your computer)

Should you wish to use the **Endnote** software to assist you with the Harvard Referencing Technique, you should download the software and install it on your computer from: <http://www.endnote.co.za/ENX7UPSL10324>. Complete the form and read the instructions carefully. In order to download the software (82 MB) you have to enter your library username and password. Note: you must use the "Harvard GSTM" style available from clickUP.

Refworks (cloud-based)

To access Refworks, go to <http://0-www.refworks.com.innopac.up.ac.za>. Register and create an account on Refworks, read the instructions carefully and download Write n Cite. When using refworks and endnote, select "**GSTM Harvard**" as your preferred Harvard referencing method.

For more information: <http://www.library.up.ac.za/referencing/index.htm>.

The following method is prescribed for references to source material(s).

1. REFERENCES USED IN THE TEXT

References in the text should be by author(s) (only surnames) with the date of publication, colon and page number in brackets, e.g.

Kash (1989:9) states that ...
... were shown to be important issues (Tidd, Bessant & Pavitt 1997:21).

The second and following references to the same source only indicate the first author's surname, followed by et al, e.g.

Tidd et al (1997:37) recommend that...

When referring to one author quoted by another author, use the following format:

Abell (in Burgelman, Maidique & Wheelwright (2001:6)) stated that...
or Abell, as quoted by Burgelman, Maidique & Wheelwright (2001:6) stated...

2. REFERENCES USED IN TABLES AND FIGURES

References to sources, which relate to information contained in a table or figure, must appear immediately below the table or figure (preceded by "Source(s):"). (Cf. Table 1 as an example.)

Table 1 – The gross domestic product of the Republic of South Africa, 1990 - 1993

Year	Gross domestic product 1)
	R million
1990	247 315
1991	244 549
1992	238 711
1993	242 001 2)

1) Gross domestic product at constant 1990 prices.

2) Estimated value

Source: Central Statistical Service (1994:21).

3. FOOTNOTES

Footnotes can be used to clarify words or items in the text, figures or tables, but must NOT be used as a way of referencing. If any footnotes are required, Arabic numerals are used with one bracket as a superscript. Footnotes³⁾ referring to words or figures in the text must appear at the bottom of the page. However, footnotes that relate to a table or figure must appear immediately below the table or figure. (Cf. Table 1 as an example.)

4. LIST OF REFERENCES

References must be provided at the end of the *dissertation/thesis/report/article* in the form of one consolidated and alphabetical list of all the sources referred to throughout the document.

The order of items in a reference is as follows:

Reference to a book

Author's Surname, Initials. Year of publication. Title. Edition (if not the first).

Place of publication: Publisher.

e.g. Burgelman, R.A., Maidique, M.A. & Wheelwright, E.C. 2001. *Strategic Management of Technology and Innovation*. 3rd ed. New York: McGraw-Hill/Irwin.

Reference to a contribution in a book

Contributing author's Surname, Initials. Year of publication. Title of contribution. Followed by In: Initials. Surname, of author or editor of publication followed by ed. or eds. if relevant. Title of book. Place of publication: Publisher, Page number(s) of contribution.

e.g. Buys, A.J. & Ndrika, V.I.O. 2005. Assessment of the Impact of Intermediate Agricultural Processing Technologies on a Rural Community in South Africa. In: L. Morel-Guimares, T.M. Khalil and Y.A. Hosni, eds. *Management of Technology: Key Success Factors for Innovation and Sustainable Development*, Amsterdam: Elsevier, 153-163.

Reference to an article in a journal

Author's Surname, Initials. Year of publication. Title of article. Title of journal, Volume number and (part number), Page numbers of contribution.

e.g. Buys, A.J. and Malebo, L.M.M. 2004. Managing Rapid Diffusion: The Case of Cellular Communications in South Africa. *South African Journal of Industrial Engineering*, vol. 15, no. 2, pp.67-78.

Reference to a conference paper

Contributing author's Surname, Initials. Year of publication. Title of contribution. Followed by In: Initials. Surname, of editor of proceedings (if applicable) followed by ed. Title of conference proceedings including date and place of conference. Place of publication: Publisher, Page numbers of contribution.

e.g. Mbewana, P. and Buys, A.J. 2005. Key Success Factors for Incubation in South Africa. In: T.M. Khalil, ed. *14th International Conference on Management of Technology*. 22-26 May 2005 Vienna. Available from: International Association for the Management of Technology, [CD-ROM] Track 7, Paper 92.

Reference to a dissertation/thesis

Author's Surname, Initials. Year of publication. Title of dissertation/thesis. Designation, (and type). Name of institution to which submitted.

e.g. Le Grange, L.I. 2000. *Maintenance Technology Transfer in the South African Aviation Industry*. Dissertation, (M.Eng.). University of Pretoria.

Reference to web pages/sites

Author's /Editor's Surname, Initials. Year. Title [online]. (Edition). Place of publication, Publisher (if ascertainable). Available from: URL [Accessed Date].

e.g. Oerlemans, L.A.G., Pretorius, M.W., Buys A.J. & Rooks, G. 2004. *Industrial Innovation in South Africa 1998-2000*. Pretoria: University of Pretoria. Available from: <http://www.sais2001.up.ac.za> [Accessed 4 November 2004].

APPENDIX 12: GUIDELINES FOR WRITING A JOURNAL ARTICLE

Journals have their own unique prescriptions for the format of the articles they will accept for publication. The technical layout must be as prescribed by the journal. Unless otherwise advised by their study leaders, MEM and MPM student's articles will be submitted to the *South African Journal of Industrial Engineering*. This journal's instructions to authors are given at the end of this appendix.

The basic structure of a research article is the same as for a dissertation, thesis or research report. Typically, the article should start with the research problem, followed by the research design, the empirical evidence and the conclusions. Here are some guidelines for the structure of a research article:

Preliminaries

The article should start with the title, names and affiliations of the authors, and an abstract.

Part 1: Background

Part 1 should contain background information regarding the technological, industrial and organisational setting of the study. It should present the reasons for selecting the particular problem - the rationale for the study - as well as a statement of the research problem and/or research objectives and/or research question/s. Sub-headings for this part could be:

- 1.1 Introduction
- 1.2 Historical development and current state of the industry, organisation/s and technology under investigation
- 1.3 Research problem
- 1.4 Research objectives and/or research question/s

Part 2: Theoretical framework

Part 2 should contain a review of the most authoritative scholarship on the research problem. The referencing method must be as prescribed by the journal. Current theories, conceptual models (graphical, mathematical or schematic descriptions or analogies) and practical methods (procedures or techniques) should be described and it should be indicated if any of them can or have been applied to the research problem. Figures and tables must be as prescribed by the journal. For a theory, model or method -building study, the deduction of new theoretical propositions, models or methods should be presented, as well as any research hypothesis. Sub-headings for this part could be:

- 2.1 Theory and research review
- 2.2 Theories, models and/or methods
- 2.3 Hypotheses

Part 3: Methodology

Part 3 should contain a discussion of the research design and methodology followed in the study, including the presentation and discussion of the data or information collected and analysed in the study. This includes the testing of hypotheses and the derivation of new theoretical propositions, models or methods when using retroductive reasoning. Sub-headings for this part could be:

- 3.1 Research strategy/plan
- 3.2 Research instruments (e.g., survey questionnaires)
- 3.3 Data collection
- 3.4 Data analysis
- 3.5 Hypotheses testing
- 3.6 New hypotheses, theories, models or methods

Part 4: Conclusions

In part 4 the main conclusions of the study are summarised, discussed and interpreted, and where appropriate recommendations are made for further research or practice or policy. Indicate the contribution to the “state-of-the-art” that the research has made. An honest appraisal of what has been accomplished is also appropriate. Sub-headings for this part could be:

- 4.1 Research results
- 4.2 Implications for and/or contributions to theories, models or methods and practise
- 4.3 Recommendations

List of references and appendices

INSTRUCTIONS TO AUTHORS

All papers will be refereed and may be submitted in English or in Afrikaans

Manuscripts must be submitted in **duplicate** to the editor. If accepted, manuscripts modified according to the referee's recommendations must be supplied printed **camera ready**. This copy should be accompanied by an IBM PC-compatible diskette containing the manuscript file in Word Perfect or MS-Word. Authors are required to conform to the instructions and format below

The Times New Roman font at 12 point size, single spacing should be used. A page margin of 25mm along the sides and 30 mm at the top and bottom should be used on A4 paper. Do not number pages.

The **Title Page** should conform to the following centred format. The text of the paper should only start on the next page

TITLE OF THE PAPER IN UPPER CASE

Name of author(s)

Affiliation of author(s) and contact information

ABSTRACT

An abstract in English, of no more than 100 words should appear here. It should not include any mathematical symbols.

OPSOMMING

'n Opsomming in Afrikaans van nie meer as 100 woorde moet hier verskyn. Dit mag nie enige wiskundige simbole bevat nie.

The **Text** of the paper should conform to the following format.

Figures and tables should form an integral part of the paper, according to the author's preferences and should be numbered consecutively in Arabic numerals (Figure 1).

Use full justification.

References in the text should be by author and the reference number in square brackets e.g. Li[1], and the detail should appear at the end of the text as follows:

REFERENCES

[1] Li J C R, 1964. "Statistical Inference", Edward Brothers, Michigan, 300 pages.

APPENDIX 13: GUIDELINES ON AVOIDING PLAGIARISM

UNIVERSITY OF PRETORIA AVOIDING PLAGIARISM: A GUIDE FOR STUDENTS

What is plagiarism?

You commit plagiarism when in any written work you use another person's words, ideas or opinions without acknowledging them as being from that other person. You do this when you copy the work word-by-word (verbatim); or submit someone else's work in a slightly altered form (such as changing a word with one meaning to another word with the same meaning); and you do not acknowledge the borrowing in a way that shows from whom or where you took the words, ideas or reasoning.

You must provide references whenever you quote (use the exact words), paraphrase (use the ideas of another person, in your own words) or summarise (use the main points of another's opinions theories or data.)

It does not matter how much of the other person's work you use (whether it is one sentence or a whole section), or whether you do it unintentionally or on purpose. If you present the work as you own without acknowledging that person, you are committing theft. Because of this, plagiarism is regarded as a very serious contravention of the University's rules which can lead to expulsion from the University.

Even if another student gives you permission to use one of his or her past assignments or other research to hand in as you own, you are not allowed to do it. It is another form of plagiarism. You are also not allowed to let anybody copy your work with the intention of passing it off as his/her work.

While academic staff must teach you about systems of referencing, and how to avoid plagiarising, you too need to take responsibility for your own academic career. Speak to your lecturer if you are at any stage uncertain as to what is required.

Information brochures on this topic are also available at the Academic Information Services.

APPENDIX 14: TECHNICAL EDITING

1. Language and General Requirements

The thesis/dissertation/report must be in either English or Afrikaans. The final thesis/dissertation/report copy must have a ready-for-publication appearance. It must have standardised features and be attractively reproduced. Introductory material, text, and appendices must all be clearly and consistently prepared and must all meet the specifications stated below.

2. Paper size and Layout

Only good quality A4-size (210mm x 297mm) white paper must be used. Manuscripts must be typed in only one column to the page. Use one side only. All text pages must be laid out in "portrait" orientation. As an exception pages containing only an exhibit (table or figure) may be in "landscape" orientation, if so required.

Top, bottom, and right margins must be 25mm. The left margin must be 30mm, to allow for binding.

3. Fonts, Point Sizes, Spacing and Equipment.

Text should be printed in Arial, Times Roman or similar fonts with point size not less than 10 and not more than 12 (used in this document). An exception to this are the chapter headings, which should be in 14 point. One and a half spacing should be used (as shown in this paragraph), except where conventional usage calls for single spacing; e.g. footnotes, indented quotations, tables, etc.

A letter quality printer (laser, impact, or ink jet) or an electric typewriter is required for printing the final manuscript.

4. Bold, Italics, Underlines, and Justification.

Headings should be bold if possible, otherwise underlined (but not both). Book and journal titles should be italicised if possible, otherwise underlined. Text should be left and right justified against the margins (as shown in this document). Text must not be indented under headings.

5. Corrections.

No corrections with correction fluid or any other method are allowed on the manuscript. Use black ink whenever it is necessary to letter mathematical symbols or other copy by hand.

6. Tables and Figures.

Tables and figures are exhibits and numbered sequentially. They should be placed as close after their first mention as possible. The table number or figure number as well as heading of each exhibit must appear centred directly beneath the exhibit as in the following example:

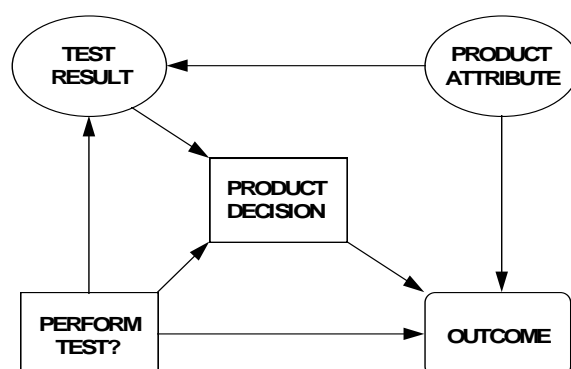


Figure 7: Influence Diagram of Test Problem

Although placement of exhibits directly in the text is preferred, it is also acceptable to place exhibits on separate pages, immediately following the page of first mention. Line drawings and photographs should be reduced to proper size. Ensure that all text, symbols and information in exhibits are clearly legible in the final manuscript. Avoid text or symbols smaller than 10 points.

7. Equation Numbers, Symbols and Abbreviations.

When numbering equations, enclose numbers in parentheses and place flush with right-hand margin of the column. Equations themselves should be centred. See sample below. Use only standard symbols and abbreviations in text and exhibits.

$$\sigma_x^2 = \frac{1}{n} \left\{ \sum_{i=1}^n X_i^2 - n\bar{X}^2 \right\} \quad (12)$$

8. Headings

The thesis/dissertation/report must be divided into chapters, and further into paragraphs and subparagraphs (if so required). Do not use more than 4 levels of indenture. Each chapter must start on a new page. A blank line should be used to separate headings from text above and below them. Blank lines must be used to separate paragraphs. New paragraphs are not indented, but start flush with the margin. In the event of a subparagraph that is numbered but does not require a heading, the text should start immediately next to the number and not on the next line.

9. Word and Text Divisions

Words must be divided correctly at the end of a line and may not be divided from one page to the next. Use a standard dictionary to determine word division. If word-processing is used, it must divide words and text correctly: you may find it advisable to avoid all word division. Avoid short lines that end a paragraph at the top of a page, and any heading or subheading at the bottom of a page that is not followed by text.

10. References

List all references by number at the end of the thesis/dissertation/report in alphabetical order, as shown below. Text references should use the author's name, date of publication and page number. For example, "According to Smith (1991:8)" or "The use of influence diagrams (Howard and Matheson 1984:22)"

Howard, R.A. and Matheson, J.E., 1984. Influence Diagrams. In: Howard, R.A. and Matheson J.E. (eds.), *The Principles and Applications of Decision Analysis*. Strategic Decisions Group: Menlo Park, California.

Smith, J.P., 1991. *The Rise of Engineering Management*. Printers Press: Pretoria.

11. Order and Content

This paragraph describes the required order and content of the thesis/dissertation/report.

11.1 Preliminary Pages

- a. Title page - a sample page is attached. Follow the format exactly; use upper case letters as shown. The title of the thesis/dissertation/report should be a meaningful description of the content of the manuscript. Use word substitutes for formulas, Greek letters, etc. Avoid long titles.

- b. Abstracts - one in English and one in Afrikaans (starting on separate pages), according to the format attached. In the case of an English thesis/dissertation/report, the English abstract should be placed first and for an Afrikaans thesis/dissertation/report, the Afrikaans one. The abstract should be carefully prepared to give a succinct account of the research. It should include a statement of the problem, procedure and methods, results and conclusions. The abstract must follow the style used for the rest of the manuscript.
- c. Acknowledgements, if any.
- d. Table of Contents, with page references.
- e. List of Tables, with titles and page references.
- f. List of Illustrations, with titles and page references.

11.2 Text

- a. Introduction
- b. Main body

11.3 References

- a. Bibliography or list of references.

11.4 Appendices

12. Pagination

Each page of the manuscript, including all blank pages, and pages with tables, figures, computer program printouts should be assigned a number. Consistent placement of pagination (preferably centre at the bottom of the page), at least 12mm from the paper's edge, should be used throughout the manuscript. The following pagination plan must be used:

- For the preliminary pages, use small Roman numerals (i, ii, iii, iv, etc.). The title page does not have a number but counts as page i; the following page is ii.
- For the remainder of the manuscript - continuous pagination for text, illustrations, references and appendices - use Arabic numbers (1, 2, 3, etc.)

13. Reproduction and Binding

Final copies of the thesis/dissertation/report must be clear and attractive. Review each copy for evenness and clarity of type, missing pages and crooked text. The final copies must be photocopied to produce consistent print quality without grey or dark casts to the background.

Four bound copies as well as one loose-leaf copy (i.e. not bound in any way) must be handed in after final approval by your research adviser. The quality of the loose-leaf copy must be sufficient to allow microfilming and photocopying. The thesis/dissertation/report must be bound with a hard cover, on which the title of the thesis/dissertation/report as well as your name must be printed in gold capital lettering. Your name as well as the year of submission only must be printed on the spine, using the same lettering.

TITLE PAGE

[TITLE OF THESIS/DISSERTATION/REPORT]

by

[FULL NAMES OF CANDIDATE]

Submitted in partial fulfilment of the
requirements for the degree

[NAME OF DEGREE]

in the

FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION
TECHNOLOGY

UNIVERSITY OF PRETORIA

PRETORIA

November 2004

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van die vereistes vir die graad

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in die

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INLIGTINGSTEGNOLOGIE

UNIVERSITEIT VAN PRETORIA

PRETORIA

November 2004

THESIS/DISSERTATION/REPORT SUMMARY

[FULL TITLE OF THESIS/DISSERTATION/REPORT]

by

[FULL NAME OF AUTHOR]

Supervisor : Prof. S.K. Ripsie
Department : Department of Engineering and Technology Management
UNIVERSITY OF PRETORIA
Degree : [Name of Degree]

[summary of thesis/dissertation/report]

An English summary must be bound into all final thesis/dissertation/report copies.
The summary must not exceed 350 words.

SAMEVATTING VAN PROEFSKRIF/VERHANDELING/VERSLAG

[VOLLE TITEL VAN PROEFSKRIF/VERHANDELING/VERSLAG]

deur

[VOLLE NAME VAN OUTEUR]

Leier : Prof. S.K. Ripsie
Departement : Departement Ingenieurs- en Tegnologiebestuur
UNIVERSITEIT VAN PRETORIA
Graad : [Naam van Graad]

[samevatting van proefskrif/verhandeling/verslag]

'n Afrikaanse samevatting moet in alle proefskrif/verhandeling/verslagte ingebind word. Die samevatting mag nie meer as 350 woorde wees nie.

UNIVERSITY OF PRETORIA
DEPARTMENT OF ENGINEERING AND TECHNOLOGY MANAGEMENT

APPLICATION FOR APPROVAL OF A RESEARCH PROJECT

This application form must be read with the *UP Code of Ethics for Research, Regulations for Research Ethics and Integrity* and the application for *Engineering and Technology Management Research Studies* as approved by the Faculty Committee for Research Ethics and Integrity on 18 April 2006.

1. Applicant's name

2. Title of research project

.....

3. Brief description of research project

.....

DECLARATION

Hereby I declare that

1. I am acquainted with the *Code of Ethics for Research* and subscribe to and will apply the principles contained in this Code in all my research activities.
2. I am aware of the *Regulations* concerning the rules of the Faculty Committee for Research Ethics and Integrity and honour these.
3. My research study will fully comply with the descriptions of *Engineering and Technology Management Research Studies* as approved.
4. Research subjects will be informed, information will be handled confidentially, research subjects reserve the right to choose whether to participate and, where applicable, written permission will be obtained for the execution of the project (example of permission attached).
5. No conflict of interests or financial benefit, whether for the researcher, company or organisation, that could materially affect the outcome of the investigation or jeopardise the name of the university is foreseen.
6. Inspection of any experiments in loco may take place at any time by the Faculty Committee for Research Ethics and Integrity or its proxy.
7. The information I furnish in this application is correct to the best of my knowledge and that I will abide by the stipulations of the Faculty Committee for Research Ethics as contained in the regulations.

Signed:

Date:

UNIVERSITY OF PRETORIA

DEPARTMENT OF ENGINEERING AND TECHNOLOGY
MANAGEMENT

Form for research subject's permission

- 1 Title of research project:

.....

.....

.....

- 2 I hereby voluntarily grant
my permission for participation in the project as explained to me by

.....

- 3 The nature, objective, possible safety and health implications have been explained to
me and I understand them.

- 4 I understand my right to choose whether to participate in the project and that the
information furnished will be handled confidentially. I am aware that the results of the
investigation may be used for the purposes of publication.

- 5 Upon signature of this form, you will be provided with a copy.

Signed: Date:
Research Subject

Witness: Date:

Researcher: Date: