

**UNIVERSITY OF PRETORIA**

**GRADUATE SCHOOL OF TECHNOLOGY MANAGEMENT**

**Research Guide  
for  
MEM, MPM, and MTM Students**

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# RESEARCH GUIDE FOR MEM, MPM, and MTM STUDENTS IN THE SCHOOL OF 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**

<ul style="list-style-type: none"> <li>• Theory</li> <li>• Appealing to academics</li> <li>• Basic research - philosophical and theoretical</li> <li>• New theoretical knowledge and theories</li> </ul>		<ul style="list-style-type: none"> <li>• Practice</li> <li>• Appealing to practising managers</li> <li>• Applied research - observations and investigations of actual practice (<i>empirical</i>)</li> <li>• New practical techniques, models &amp; tools</li> </ul>
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**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.

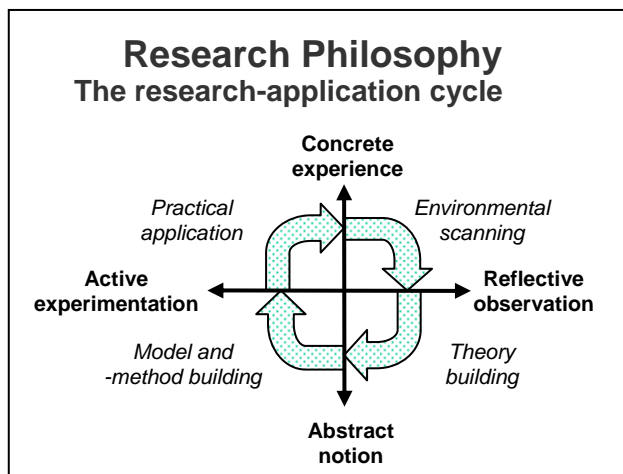
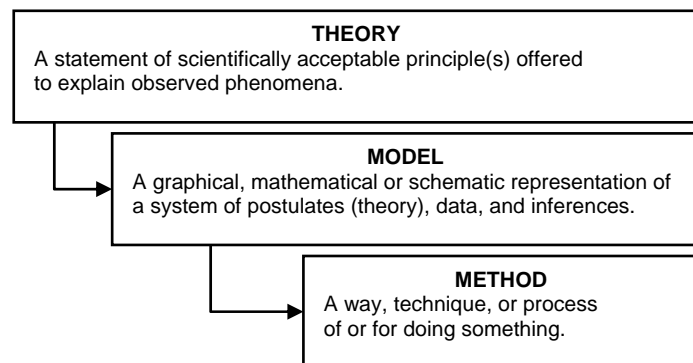
Management investigation	Management research
<ul style="list-style-type: none"> <li>• Application of acquired knowledge</li> <li>• Management subjectivity</li> <li>• Requires insight and judgement</li> <li>• Is specific to the company environment</li> <li>• Company confidential</li> </ul>	<ul style="list-style-type: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

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 generalisable 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 practise 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, MPM and MTM 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/MTM Research Project IGB 898/ISC 898, Instructions for Preparing a Research Project Report”).

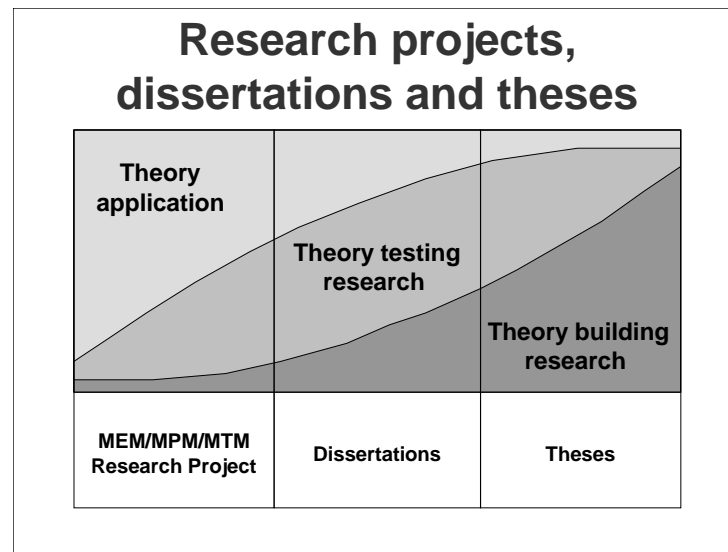
There are therefore three possible aspects to a research study:

- 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 MEM/MPM/MTM Research Project, and Dissertations and Theses. This is shown schematically in the



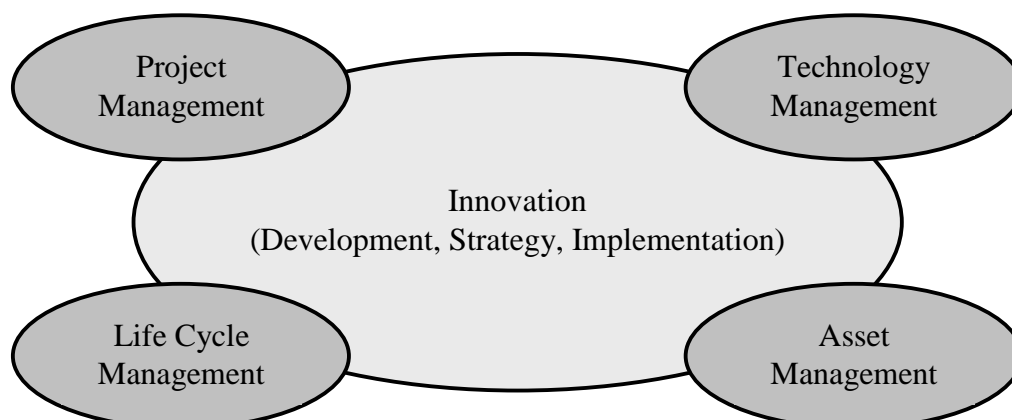
following figure.



## 2. RESEARCH PROBLEM AND FOCUS AREAS

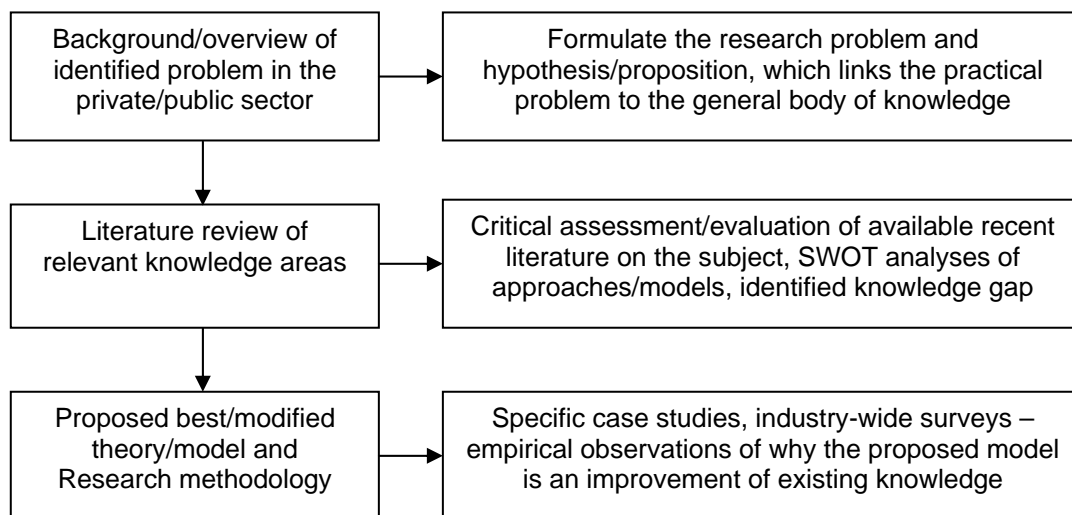
The problem and focus areas that are appropriate for studies in Engineering and Technology Management covers a wide spectrum (see the figure below and the study guide). They can broadly be divided in three broad categories:

- 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 programmes. A list of subjects is attached as **Appendix 2**. For a description of the subjects, **especially those of the second year**, refer to the programme outline. See the following schematic of how the subject matter is typically handled.



***Identifying the best current theory/model may be adequate, but will not be rated/assessed as a good research project compared to the development of new theories/models, preferably across knowledge disciplines.***

### 4. 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**.

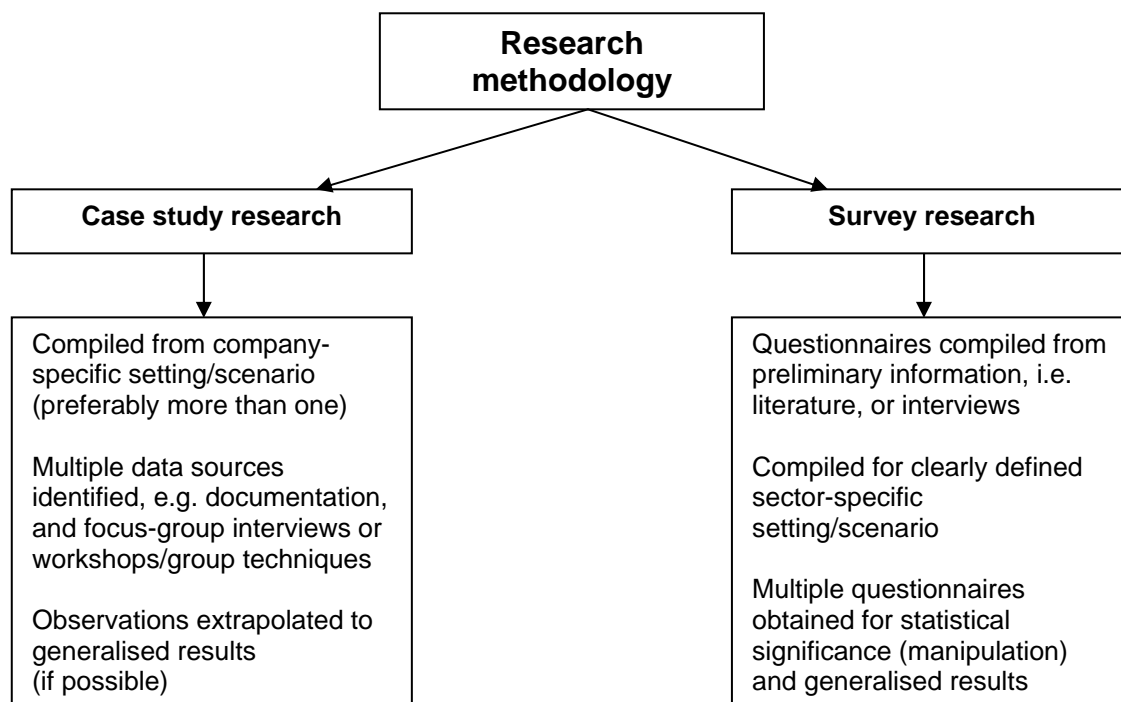
### 5. RESEARCH METHODOLOGY

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 modelling 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-experimental 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 (see section 3).

The following schematic diagram illustrates the typical research methodologies that have been followed for MEM, MPM, and MTM research projects in the past.



***Solving a specific company problem with a proposed theory/model may be adequate, but will not be rated/assessed as a good research project compared to generalised results/conclusions that could fill a knowledge gap.***

## 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 (see the study guide):

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

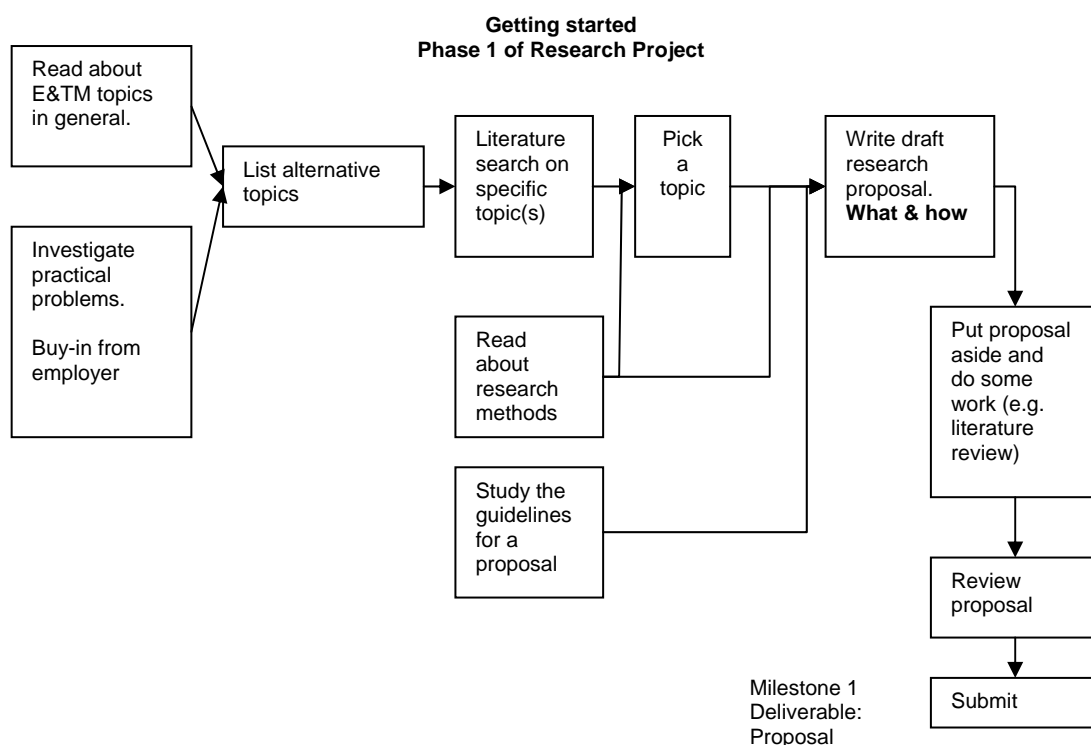
Each phase has a set of actions and outputs as shown in **Appendix 4**. This



process is also shown as a flowchart in **Appendix 4**. **Appendix 5** contains notes on the research process, adapted from Malan, Coetzee & Van Breda (1992, P. 37). **Appendix 6** contains the pro-forma Review Reports, which are used as basis for the evaluation of the different phases (see the study guide).

## 7. RESEARCH PROPOSAL, REPORT AND ARTICLE

Research could mean, “to search again”<sup>1</sup>. 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 7**. Discuss your ideas with friends, colleagues and potential study-leaders.

<sup>1</sup> 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 five literature sources.

(Practical advice: When you read something that is important to your study, photocopy the relevant article or section. Keep your photocopies organized according to categories and sections. And, most importantly, photocopy 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, bring out your photocopied sections, put them into logical and sequential order, and then begin your writing.)

- 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.
- 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.

### 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 8** for guidelines on how to avoid plagiarism.

- 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 five typed pages 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. use the provided proposal template on ClickUP and the module CD. Make use of scientific research terms (see **Appendix 1: Glossary of research terms**).

The research proposal, which is submitted as the first 'assignment' of the module (see the study guide), must contain at least the information provided in the Department's **research proposal template**. Similarly, **templates**, with related content information, are provided on WebCT for: the **research report**, the **symposium article**, and the **symposium presentation**. In all cases make sure that the correct referencing procedures are followed (see **Appendix 9** and **10**).