

**DEVELOPING A STRUCTURED
PROFESSIONAL DEVELOPMENT PROGRAM
FOR ENGINEERING PROFESSIONALS WITHIN
THE PUBLIC SECTOR ENVIRONMENT**



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in fulfilment of the requirements for the degree of
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by

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DECLARATION OF OWN WORK

Hereby I, Coenraad Josephus Nel, declare that this research report is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously, in its entirety or in part, been submitted at any university in order to obtain an academic qualification.

CJNEL

SIGNATURE:

19 September 2013

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I would like to thank the coffee for keeping me up during the long nights. I would not have done this without you.

EXECUTIVE SUMMARY

South Africa is currently experiencing a time in which existing infrastructure is reaching its design life end. With a growing economy and the increased level of social development, existing infrastructure is under extreme pressure. South Africa is also facing a challenge in which a need exists for engineering capabilities. These capabilities include engineering skills to maintain and manage existing infrastructure, plan for new infrastructure and construct new needed infrastructure.

This study looks at a possible solution towards the above mentioned challenges. As a solution, the study proposes a professional development program to prepare engineers to work in the environment of infrastructure development. More specifically the program prepares civil engineers to work in public sector organisations responsible for basic service infrastructure.

The research for the proposed professional development program is done by comparing literature with feedback received from various industry professionals. By doing this, the components for the proposed program were researched and identified. The components for the proposed program are professional work experience, professional training and structured mentorship. A further deliverable of the proposed program is to assist candidates taking part in the program to register as professional engineers on completion of the program. The study further showed the proposed program should be structured in such a way that all the components mentioned above work together interactively and should be centrally managed to ensure all the goals for the program are being reached.

It is further stated that if the proposed program could successfully be implemented and if all the stakeholders commit towards the goal of the proposed program, the program could have a significant positive impact towards the challenges mentioned above.

OPSOMMING

Suid-Afrika beleef tans 'n tyd waarin bestaande infrastruktuur besig is om hul ontwerp tydperk te bereik. Met 'n groeiende ekonomie en die verhoogde vlak van maatskaplike ontwikkeling is bestaande infrastruktuur onder geweldige druk. Suid-Afrika staar ook tans 'n uitdaging in die gesig in verband met onvoldoende getalle professionele ingenieurs, veral in die omgewing van die instandhouding van bestaande infrastruktuur, die konstruksie van nuwe infrastruktuur, en die beplanning van verdere nodige infrastruktuur.

Hierdie studie ondersoek dus 'n moontlike oplossing tot bogenoemde uitdagings. As 'n moontlike oplossing stel die studie voor dat 'n professionele ontwikkelingsprogram vir ingenieurs saamgestel word. So 'n program sal dus ingenieurs oplei en voorberei vir werk binne die openbare sektor wat verantwoordelik is vir die ontwikkeling en bestuur van basiese dienste infrastruktuur.

Die navorsing vir die voorgestelde professionele ontwikkeling program is gedoen deur bestaande literatuur te vergelyk met inligting ontvang vanaf verskeie professionele ingenieurs in die praktyk. Deur dit te doen, is die komponente vir die voorgestelde program nagevors en geïdentifiseer. Die geïdentifiseerde komponente vir die voorgestelde program is dus soos volg: professionele werkservaring, opleiding en gestruktureerde mentorskap. 'n Verdere aflewering van die voorgestelde program is om kandidate te registreer as professionele ingenieurs teen voltooiing van die program. Die studie toon ook verder aan dat al die komponente, soos wat hierbo genoem is, geïntegreerd moet plaasvind en dat die program gestruktureerd bestuur moet word vanaf 'n sentrale punt of organisasie.

Dit word dan verder genoem dat indien die voorgestelde program suksesvol geïmplementeer kan word, en indien die verskeie belanghebbendes tot die program hulle self tot die program kan verbind, die program 'n beduidende positiewe impak op die uitdagings hierbo kan maak.

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LIST OF ACRONYMS AND ABBREVIATIONS

ASCE	American Society of Civil Engineers
CBE	Counsel for Build environment
CESA	Consulting Engineers South Africa
CPD	Continuing Professional Development
ECSA	Engineering Counsel of South Africa
GRAP 17	Generally Recognized Accounting Practice, Revision 17
ICE	Institute of Civil Engineers, United Kingdom
IDP	Integrated Development Plan
IMESA	Institute for Municipal Engineers South Africa
MFMA	Municipal Finance Management Act
SAICE	South African Institute for Civil Engineering
SCE	School of Consulting Engineering

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

South Africa is currently experiencing a time in which existing infrastructure is reaching its design life end. With a growing economy and the increased level of social development, the existing infrastructure is under extreme pressure.

South Africa is also facing a challenge in which a need exists for engineering capabilities. These capabilities include engineering skills to construct new infrastructure, to maintain existing infrastructure, and to plan for future infrastructure development. A further need exists for capabilities regarding the rollout of large government projects, thus enabling government to spend allocated funds for infrastructure development.

The above-mentioned needs will be formally motivated and addressed in this study. This investigation will finally suggest a formal program that could form part of a solution towards the mentioned challenges. Such a program could prepare graduated engineers for the tasks of constructing, maintaining and planning infrastructure within the public sector.

1.2 OBJECTIVES

Before the research objective can be identified, it is necessary to focus briefly on the registration process for engineers, as well as on the professional registration requirements in South Africa. The professional registration process for engineers, according to the Engineering Council of South Africa (ECSA), is based on three aspects. Firstly the candidate engineer has to prove that he/she is constantly improving his/her professional knowledge. Secondly, the candidate has to prove that he/she has sufficient exposure to the professional work environment and relevant experience within various engineering environments. Lastly the candidate engineer has to prove that he/she took part in a mentoring program with competent and experienced engineers as mentors.

By having met these minimum requirements, the candidate engineer is potentially ready to be registered as a professional engineer (ECSA new registration system [s.a.], 2012).

Wium (2012) support this system and goes further by stating that any post-graduation professional engineering development program should be supported by the following four pillars: professional registration, training, work experience and structured mentorship. The goal of this study is to develop a program that could be implemented in South Africa. The objectives of this study are therefore to:

- Investigate the Engineering Council of South Africa's (ECSA) requirements to register as a professional engineer and the impact this has on professionals working in the public sector.
- Assess capability needs for engineers working in the public sector and to identify potential training areas.
- Identify and develop an ideal structured experience program that these engineers can participate in.
- Identify the role of structured mentorship within a professional development program.
- Develop a model that can be applied to implement a structured professional development program for engineers working in the public sector.

Figure 1.1 illustrates the relationship between the environment, the proposed program and the research goal, as well as the four knowledge areas this study will be based on.

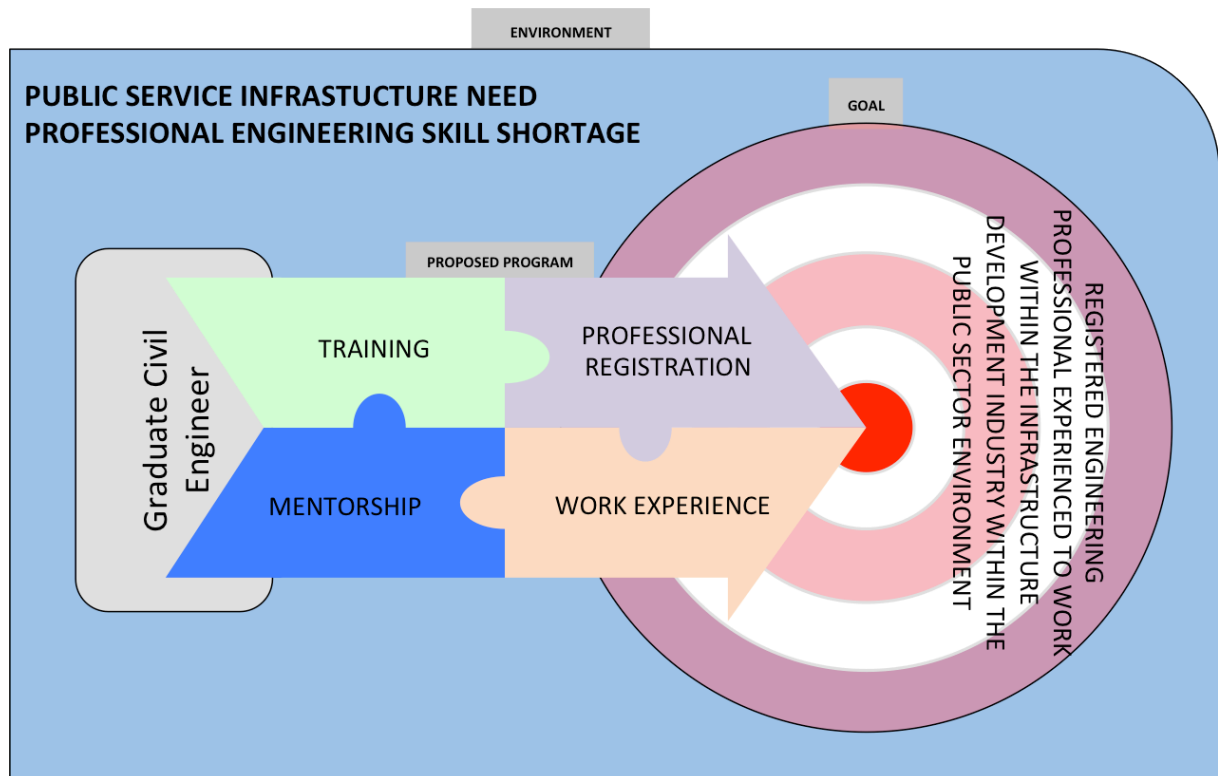


Figure 1.1: Research Framework

1.3 SIGNIFICANCE OF THIS RESEARCH

In order to keep up with the growing population, and to ensure a sustainable economy, a strong need exists for efficient and well-functioning infrastructure. Such infrastructure includes those relating to transport, energy, water management, wastewater management and social infrastructure. This, and the fact that the construction and infrastructure development industry generates more employment per rand spent than almost any other sector in the economy (Naidoo, 2001), are strong incentives for government to drive capital expenditure. By applying this principle government is not only developing infrastructure, but the economy is stimulated in the process.

Herold (2009:1) states that within the civil engineering water sector, South Africa is facing a time in which there is a major mismatch between demand for infrastructure, and supply thereof. He also states other factors, which include the failure to achieve demand management targets, decaying infrastructure, inability to spend government funds, loss of essential skills and a below standard educational pipeline.

The solution offered through this research is unique. The proposed program firstly offers an integrated solution which includes an increased supply of civil engineers into the South African market. Secondly, the program wishes to improve service delivery within the public sector.

1.4 SCOPE AND LIMITATION

To ensure that the objectives of this research are achieved, the scope and limitations of the study need to be clarified. This study is based on needs and challenges currently being experienced within South Africa.

This study is primarily concentrating on the civil engineering sector of engineers working in the public sector. It is understood that mechanical and electrical engineers must be included in engineers responsible for basic service infrastructure. This study will however only focus on the process of planning, construction and maintenance of civil engineering infrastructure. Other engineering disciplines will be excluded from this study.

Similarly, a focus will be placed on civil engineers who graduated from an ECSA accredited university with either a B.Eng or B.Sc.Eng degree. Technical support staff will be excluded from this study. Although this is the case, all levels of civil engineering staff will be assessed when organisational structure and engineering support are being addressed.

It must further be stated that this research includes the compilation of the technical aspects and procedures of a professional development program for public sector engineering professionals. As part of the development of such a program a thorough financial feasibility study should be done. Such a feasibility study or program cost analysis does not form part of this study and will not be included in this document.

As part of the proposed program delegates will register as a professional engineer. Chapter 7 deals with this process. An assumption on this part of the study is that the South Africa requirements, as stipulated by ECSA, to register professionally are according to international standards. This requirement will not be tested or compared to the registration processes of other countries and professional bodies.

1.5 RESEARCH METHODOLOGY

1.5.1 The process

The method used to derive answers towards the research question in this study is based on the following process:

- Obtaining background towards the two major challenges in South Africa namely: infrastructure need and engineering skill shortage;
- Collecting primary data through interviews and secondary data through published documentation, with a focus on professional-training, professional-mentorship, professional-work experience and professional-registration; and
- Applying the data received towards the compilation of a program in answer to the research problem defined earlier.

1.5.2 The data

Different methods are used to obtain data for this study. The following methods and resources are used during this study:

- Peer reviewed journal articles and academic literature are consulted to gain deeper understanding into the various aspects of the study and to support interview correspondence;
- Published articles and technical publications are surveyed to gain better insight on aspects such as skill needs, economic requirements and industry perspective on certain topics;
- Various interviews are conducted with industry role players and engineers working in the public sector. This is done to gain industry perspective and opinions on specific topics; and
- Information captured is analysed, assessed and compared with other information to gain insights, draw conclusions and to make recommendations.

The above-mentioned data, gathered through the various methods, is analysed through qualitative inspection and interpretation.

1.6 PLAN OF DEVELOPMENT

This study is undertaken systematically and consists of various components. Figure 1.2 illustrates how these components are presented in this document towards solving the research question. This figure will be used at the start of each chapter to show the reader how the relevant section fits into the document.

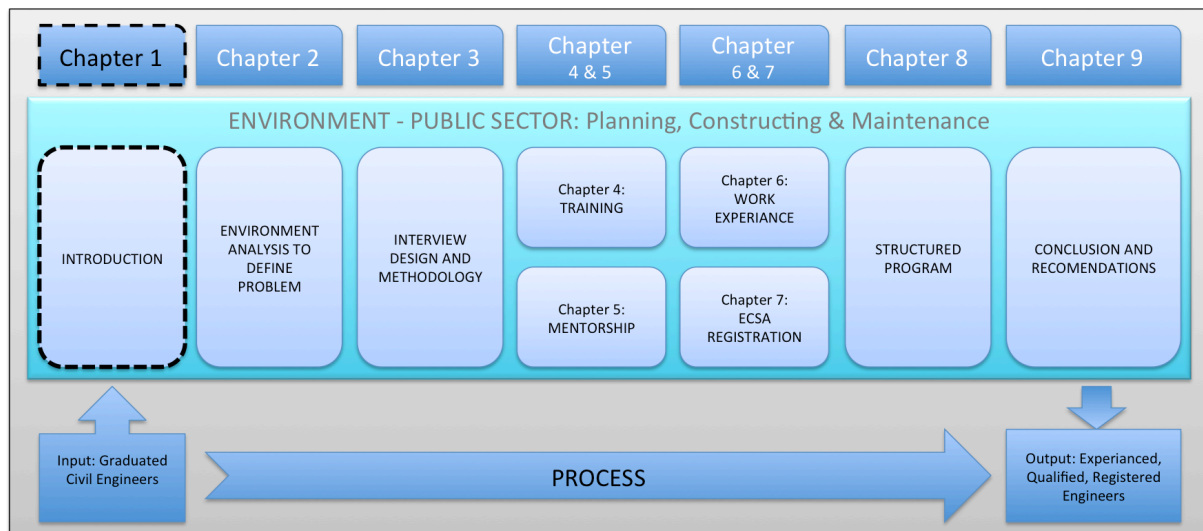


Figure 1.2: Research Framework, Chapter 1

The following sections include an outline and a brief description of the chapters included in this report.

Chapter 1: Introduction

This chapter provides a brief background to the research problem and discusses how the research problem will systematically be solved. The chapter goes further by supplying a brief description of key concepts used throughout this document.

Chapter 2: Environment analysis

This chapter focuses on the two challenges South Africa is currently facing, namely *infrastructure need* and *engineering skill shortages*. The chapter consists of a literature study on these two topics and conclude by putting these challenges in perspective towards the research problem.

Chapter 3: Interview design and methodology

Chapter 3 contains information regarding the interviews executed to collect the primary data (data collected directly by the researcher) for this study. Information such as: information on the interviewees; the reason for the interviews; as well as the feedback received from the interviews are included in this chapter. All the chapters in this document which refer to interviews, refer to the interviews mentioned in this chapter.

Chapter 4: Skills analysis and professional training

As part of the study, it is established that a professional development program must consist of four aspects. Chapter 4 includes the first of the four aspects, namely: *Skills analysis and professional training*. The aims of Chapter 4 are to clarify the role of training in the professional development environment; and to identify a list of course subjects which could be offered in the proposed professional development program.

Chapter 5: Professional mentorship

Chapter 5 includes the second aspect relevant to this study, namely *Professional Mentorship*. The aims of this chapter are to quantify the role and importance of structured mentorship in a professional development environment; to establish how such a mentorship program can be applied; and to identify aspects of the structure of a structured mentorship program.

Chapter 6: Professional work experience

The third aspect of a structured professional development program has to do with the *professional work experience* of an engineering professional. The aims of this chapter are to assess the requirement set by ECSA in terms of professional work experience towards professional registration; and to develop the components of supplying candidate engineers with sufficient work experience to register professionally and to work within the public sector.

Chapter 7: Professional registration

The fourth aspect regarding this study is that of *professional registration*. The aim of Chapter 7 is to capture ECSA's registration requirements and procedures in order to

produce a system which can be applied on the proposed professional development program.

Chapter 8: Proposed program

This chapter is utilised to combine the information of all the preceding chapters and to develop a concept for a professional development program for engineering professionals within the public sector.

Chapter 9: Conclusions, findings and recommendations

A summary of the conclusions and recommendations from the different chapters are provided. As part of this chapter, aspects requiring additional research or investigation are also provided.

1.7 CLARIFICATION OF KEY CONCEPTS

Throughout this document various industry specific concepts are mentioned. This section provides a brief discussion of some of these concepts.

Continuing Professional Development (CPD):

CPD in general is the process in which members of professional organisations, such as associations etc., develop, maintain and improve qualities and skills which are needed within their working environments. More specifically, within the engineering industry, CPD includes courses, self-study, technical conferences, seminars, symposia, organised site visits and meetings of professional organisations. (Guidelines for professional registration, 2003:1)

Candidate Engineer:

According to ECSA, engineering professionals can register with the council within one of the following categories:

- Professional engineers;
- Professional engineering technologist;
- Professional certified engineer; and
- Professional engineering technician.

In preparation for all these categories, ECSA requires engineers to register as a professional in training, or Candidate Professional. To become registered as a *Professional Engineer*, engineers in training should be registered as a *Candidate Engineer*. The requirement for application towards a Candidate Engineer is a recognised or accredited academic qualification (B.Sc.Eng or BEng). (Guidelines for professional registration, 2003:1) (ECSA registration process [s.a.], 2012)

Professional Engineer (or Licensed Engineer, or Chartered Engineer): A Professional Engineer, as described by ECSA, is an engineer concerned primarily with the progress of technology through innovation, creativity and change. According to ECSA, their work involves the following:

“[The] application of a significant range of fundamental principles, enabling them to develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, and pioneer new engineering services and management methods.” (ECSA registration process [s.a.], 2012)

ECSA goes further by stating the following:

“[Professional Engineers] may be involved with the management and direction of high risk and resource intensive projects. Professional Engineers undertake and lead varied work that is essentially intellectual in nature, requiring discretion and judgement. Such work has its base in proficiencies and competencies derived from and extended by experience and research. It is concerned with cost effective, timely, reliable, safe, aesthetically pleasing and environmentally sustainable outcomes.” (ECSA registration process [s.a.], 2012)

In some countries, the term **Licensed Engineer or Chartered Engineer** is used as a synonym to Professional Engineer.

Mentor:

A mentor, within the engineering environment, is an engineering-professional who advises and guides candidate engineers throughout their training period. They focus on professional development and professional registration, and to achieve this in the shortest period of time. ECSA requires all mentors to be professionally registered. (Guidelines for professional registration, 2003:1)

Structured mentorship:

Structured mentorship refers to mentorship within an organisation that is the end result of strategic conscious structured intervention. Structured mentorship is offered through structured programs with clearly defined goals and set schedules. (Holland, 2009) (Marsh, 2012) (Ragins and Verbos, 2006:21)

Engineering Code of Conduct:

The Engineering Code of Conduct is a set of rules on the conduct of professionally registered engineers. The Code of Conduct was compiled and released by government in the form of a Government Board Notice (Rules of Conduct for Registered Persons: Engineering Profession Act, 2000:1) and include the following:

- Apply knowledge and skill in the interests of humanity and the environment;
- Execute work with integrity, sincerity and in accordance with generally accepted norms of professional conduct;
- Respect the interests of fellow beings and honour the standing of the profession;
- Continuously improve professional skills and those of subordinates; and
- Encourage excellence within the engineering profession.

(Rules of Conduct for Registered Persons: Engineering Profession Act, 2000:1)

Counsel for Built Environment (CBE):

The CBE is a statutory body placed by the South African government to protect the interest of the public and built environment. The CBE and the six councils for the profession, of which ECSA is one, maintain and apply standards of built environment professionals conduct and practice in order to effectively protect the interests of the public. The purpose of the CBE as an appeal body is to ensure protection of the interest of the public. (Welcome to CBE [s.a.], 2012)

Municipal Finance Management Act (MFMA):

The MFMA, Act number 56 of 2003 (effective from July 2004) is in place to ensure sustainable financial management in local, provincial and national government in South Africa. The goal of the act is to support the development of a sound financial approach towards governmental services and delivery thereof. The MFMA is

managed and implemented through various policies and reforms. The MFMA aims to revolutionise accounting, budget and financial management practices by incorporating best practice processes throughout all government departments. (MFMA [s.a.], 2013)

Generally Recognised Accounting Practice 17 (GRAP 17):

Generally Recognised Accounting Practices (GRAP) are accounting practices released and proposed by the South African National Treasury. GRAP serves as implementation towards the MFMA. GRAP 17 refers to practices and guidelines toward the management of tangible assets such as property, plant and equipment. (National Treasury. Accounting Guideline, GRAP 17, Property, Plant and Equipment. 2012). (National Treasury. Generally Recognised Accounting Practice, Disclosure/compliance checklist. 2012)

1.8 CHAPTER SUMMARY

The method of the research and the presentation of the document were discussed and clarified in this chapter. The chapter also included a brief background on the research problem as well as the research environment.

It was further mentioned that South Africa is currently facing two major challenges, these challenges relate to *engineering skill shortages* and *infrastructure development*. The next chapter includes a literature study on these two topics, in an attempt to formally identify and address these challenges.

CHAPTER 2: ENVIRONMENT ANALYSES

2.1 INTRODUCTION

Chapter 1 mentioned that South Africa is currently facing two challenges, namely: the current condition of *basic service infrastructure* and a *national engineering skills shortage*. To serve as further background towards the research problem, and to motivate these challenges, a literature study on these two topics is presented in this chapter. Refer to Figure 2.1 for graphical presentation of the structure of this study showing how this chapter fits into the research document.

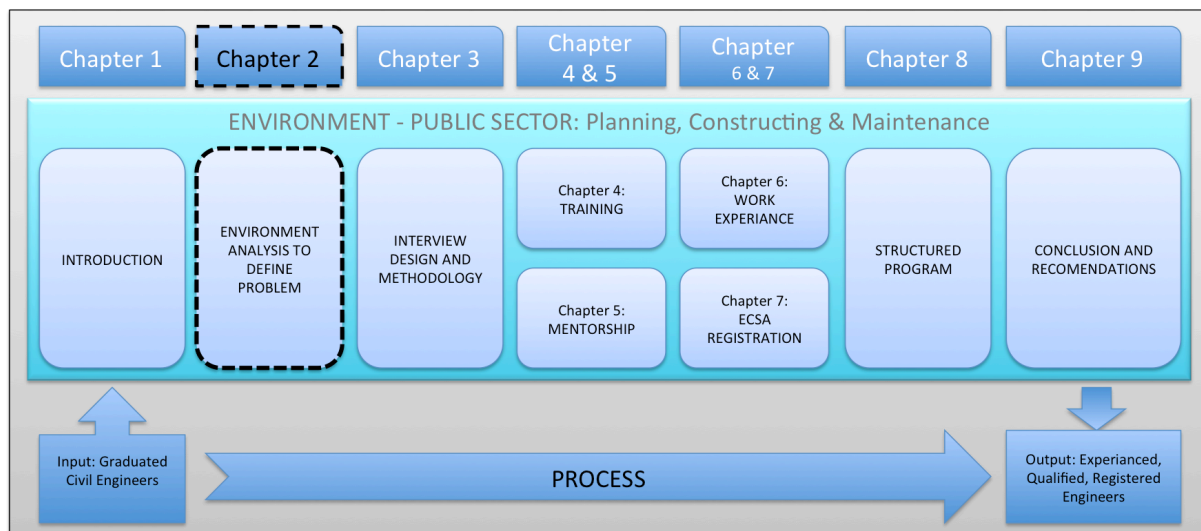


Figure 2.1: Research framework, Chapter 2

2.2 THE CONDITION OF INFRASTRUCTURE WITHIN SOUTH AFRICA

To maintain the growing population, and to ensure a sustainable economy, a need exists for efficient and well-functioning infrastructure (The state of Municipal Infrastructure, 2007:1). Such infrastructure includes those relating to transport, energy, water management, wastewater management and social infrastructure. Another fact is that the construction and infrastructure development industry generates more employment per rand spent than almost any other sector in the economy (Naidoo, 2001). Consequently these are all incentives for government to drive capital expenditure. By applying this principle, government is not only developing infrastructure, but the economy is also stimulated.

To add to this argument, Herold (2009) states that within the water sector, South Africa is facing a time of mismatch between demand for infrastructure, and supply thereof. He likewise states other factors which include the failure to achieve demand management targets, decaying infrastructure, inability to spend government funds, loss of essential skills and a below standard educational pipeline. These factors all translate to decaying infrastructure in the long run.

Infrastructure condition according to the Infrastructure Report Card:

In 2011 the South African Institute of Civil Engineers (SAICE) published the second *Infrastructure Report Card for South Africa, 2011*. This report highlighted observations from professionals responsible for the provision of basic service infrastructure. The report focuses on the areas of planning, construction, operation and the maintenance of infrastructure.

In 2006 the first *Infrastructure Report Card for South Africa, 2006*, was developed. In this report nine built environment infrastructure sectors were examined, namely: water services, sanitation and wastewater services, solid waste management, roads, airports, ports, railways, electricity generation and distribution, and hospitals (which included clinics) (The SAICE Infrastructure Report Card, 2006:6). The report card of 2011, added two new sectors, namely Public Ordinary Schools and Fishing Harbours (The SAICE Infrastructure Report Card, 2011:5).

Table 2.1 shows the trend of either improvement or decrease in condition of South African infrastructure, as captured by the 2006 and 2011 scorecards by SAICE.

Table 2.1: Condition of South African Infrastructure

Source: Infrastructure Scorecard, 2006 & 2011

	SECTOR	TREND Between 2006 and 2011
1	Water services	No change
2	Sanitation services	Decrease
3	Public schools	Decrease
4	Solid waste management	No change
5	Roads	No change
6	Airport	Increase
7	Ports and fishing harbours	Increase
8	Rail	Increase
9	Electricity	No change
10	Hospitals and clinics	Decrease
	OVERALL	Increase

From the above mentioned table, it is evident that although a slight improvement has been made in the condition of total infrastructure since 2006, most infrastructure sectors either remained the same, or experienced a decrease in condition (The SAICE Infrastructure Report Card, 2011:3).

Infrastructure condition according to the CIDB and the CSIR:

A further report was published in 2007 by the South African Construction Industry Development Board (CIDB) and the Council for Scientific and Industrial Research (CSIR) in South Africa. The report was compiled to capture the condition of South African municipal infrastructure in support of government growth objectives set in action in 2006. The findings of this report concurred with the findings mentioned above from the infrastructure report card compiled by SAICE in 2006. The findings from the CSIR study, relating to this research, are summarised in the list below (The state of Municipal Infrastructure, 2007:2):

- Municipalities are lacking performance indicators in regards to infrastructure maintenance;
- Existing infrastructure is unreliable;
- Municipalities are not conforming to the requirements of the Municipal Systems Act, the Municipal Finance Management Act (MFMA) and other legislation that require them to ensure adequate provision for infrastructure and infrastructure management;

- Poor record keeping of existing infrastructure and its maintenance needs and costs;
- Municipalities are not practicing asset accounting, planning and making financial provision for the renewal of infrastructure;
- Municipalities are lacking infrastructure maintenance policies and practices; and
- Capacity problems occur in terms of infrastructure management competence.

The research for the above mentioned study was completed by the CSIR, and the data was captured through conducting interviews with key staff within municipalities and through physical examination of the infrastructure (as well as examination of the infrastructure management systems) within the municipalities (The state of Municipal Infrastructure, 2007:1).

The above mentioned sections clearly show that South African basic service infrastructure are currently in a poor condition. Not only is the infrastructure in a poor condition, but existing infrastructure is in a state of rapid decay.

2.3 NATIONAL ENGINEERING SKILLS NEED

The second challenge to be discussed is that of engineering skills within the public sector. South Africa currently has approximately one registered engineer for every 3100 of it's citizens (ECSA, About ECSA: Transformation [s.a.], 2013). ECSA goes further by comparing this ratio to that of Germany (1:200); and Japan, the United Kingdom, and the United States of America with a ratio of 1:310. It is therefore disturbing to know that South Africa, a developing country, has in the order of 10 times less engineers per capita than these developed countries.

Although this is the case for engineers in general, the situation is not better in the civil engineering and construction industry, as noted by various sources, Allix (2012), Odendaal (2012) and The SAICE Infrastructure Report Card (2011:11). SAICE goes further by stating that this shortage occurs in both the private and the public sector. This implies that a shortage of engineers exist in organisations responsible for planning and implementing new infrastructure as well as those organisations responsible for constructing new infrastructure.

SAICE further states that the South African public sector needs engineers responsible for the management of infrastructural systems and organisations responsible for the development of infrastructure. SAICE also states that a need also exists for engineers who can take strategic and technical leadership to ensure long-term sustainable service delivery within the public sector (The SAICE Infrastructure Report Card, 2011:11). Taking all of this into consideration, it is disturbing to know that in 1990, 40% of professionally registered engineers in South Africa worked for the public sector. Today this figure is approximately 15% (Allix, 2012).

The engineering shortage in South Africa is furthermore highlighted by De Koker (2011:4), when he states that Australia, United States of America, Western Europe as well as other developing countries such as India and China have by proportion of population, more than twenty times more engineers than South Africa. This fact is supported by Odendaal (2012), who states that the number of engineers supporting South African infrastructure are significantly less than the engineers servicing Australia, Brazil and the United Kingdom.

The result of this skill shortage is that infrastructure service providers frequently have inadequate capacity to manage and construct new infrastructure, which in turn implies that the ability to provide basic services becomes a challenge. De Koker (2011:4) further states that the process of delivering and operating new infrastructure includes complex activities and requires competent skilled persons. Engineers in South Africa having these attributes are in the minority.

Adding to this challenge, the process of planning, executing and constructing new infrastructure is complex and needs special engineering skills. This process includes the delivery and operation of new infrastructure and the management, maintenance and refurbishment of existing infrastructure. By implication, this means that engineers working in this environment should be experienced and trained to deal with the challenges of planning, construction and managing infrastructure. It is thus alarming to know that engineers currently working in these environments are either reaching retirement age, or are younger than 35 years of age (Lawless, 2007: 135). Limited transfer of experience and knowledge is therefore facilitated.

Focussing more on the public sector, De Koker (2011:4) states that bold leadership and effective management is of high importance for the maintenance and development of infrastructure within the public sector. With the negative migration of

skilled professional engineers from the public organisations towards the private sector, a major gap has developed within the public sector. Another contributing factor to this is the fact that since this migration took place, engineering departments within the public sector have been mostly managed by financial and general business managers. These managers have little or no technical background on the technical departments they manage (Lawless, 2007).

Further proof of this challenge is that in 2009 the South African government identified engineering as being a scarce skill, which should take priority in skills development (Erasmus & Beier, 2009:75). Government went further by stating that training and mentorship of young engineering professionals are essential on all levels. This is especially the case for engineers that are being prepared to work in the infrastructure environment within the public sector (Lawless, 2007: 138).

To link the challenge of engineering shortages to the previous section on the condition of South African infrastructure, it was mentioned that the ineffective deployment of these scarce skills and the use of unqualified and inexperienced personnel in positions requiring technical ability, are contributing strongly to the current state of management and development of infrastructure within South Africa (Motlanthe, 2011). This is contributing further to the fact that those persons currently looking after and managing service delivery infrastructure within South Africa are currently not competent enough for the work expected of them (Lawless, 2007:46). Accordingly a need exists for technically competent engineers, as well as engineers able to run infrastructure management systems, for this has a direct outcome on the condition of the country's infrastructure.

2.4 CHAPTER SUMMARY

Chapter 1 includes a broad framework for this research as well as a brief background towards the formulation of the problem statement. This chapter continued by motivating the research problem and by supplying more information on the environment in which the research problem is seated.

It is now established that two major challenges is playing an important role in regards to this study, i.e. the *condition of existing basic service infrastructure* (or public sector infrastructure) and the *national need for engineering professionals* within the public

sector. This chapter went further by supplying evidence that these challenges do occur and what the extent of these challenges are.

By confirming these challenges, various factors will now be assessed to develop a structured program to prepare graduate civil engineers for the environment of planning, constructing and maintaining infrastructure within the public sector. The first factor to be assessed is that of identifying the skills needed within the industry. From the information gained from this skills need, a *training program* can be developed, which will ultimately form part of the proposed professional development program.

Before the topic of professional development and training is presented (in Chapter 4), information regarding the research data for this study is discussed. This is done in the next chapter.

CHAPTER 3: INTERVIEW DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This research is based on both secondary (existing) data, as well as primary data (obtained by the researcher). The secondary data is obtained from peer reviewed academic literature, published non-academic technical literature, government publications and other related sources. This secondary data is applied as follows:

- To supply academically founded information and statements for the various themes of the study;
- To support statements made by the press and other publicly available statements; and
- To support information gathered from interviews with industry role players.

The focus of this chapter is not on the secondary data, but rather to supply the reader with information regarding the primary data used throughout this study. Primary data is used to supply the reader with a clear understanding of the current status of the environment as well as to gain more practical knowledge of the secondary data. Primary data is furthermore used to obtain industry sentiment and perception on matters concerning the research themes.

The main source of primary data for this research is obtained through interviews with industry role players. The structure and background of these interviews are explained in this chapter; in addition to that, this chapter will provide the raw data collected throughout the interview process. Further discussion of the collected data will not take place in this chapter. Whenever reference is made to the interviews in the remainder of this document, the interviews described in this chapter are referred to. To provide the reader with a clear understanding of how this chapter adds to the research, a graphical presentation of the document structure is presented in Figure 3.1.

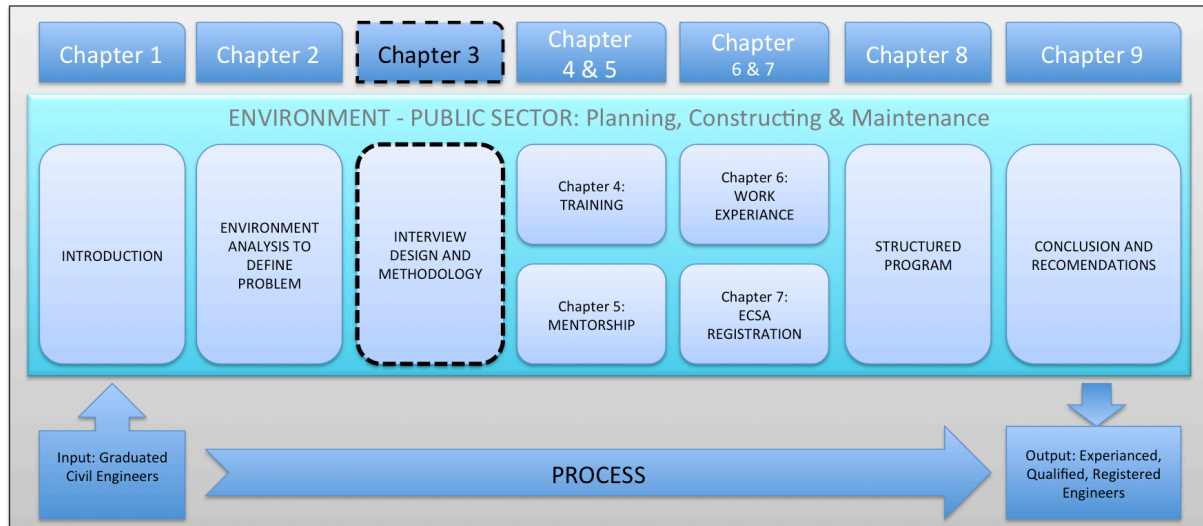


Figure 3.1: Research framework, Chapter 3

3.2 INTERVIEW QUESTIONS

The goal of this study is to address two challenges currently being experienced in South Africa. The research for this study revolves around assessing the environment, as defined in Chapter 2, and developing a structured program that could potentially be implemented to address these challenges. To achieve this goal sources were consulted (in the form of published literature and related research) in order to develop the components of the proposed professional development program (developed in Chapter 8).

In an attempt to ensure that the proposed program is not merely based on academic and published literature, interviews were conducted with engineering professionals in the industry. Interviews were conducted via telephone or personal appointments. In some cases email was used to gain feedback from interviewees. To ensure an unbiased environment and evoke conversation for maximum information gain, the format of the interviews were semi-structured.

The hypothesis of this research is based on the fact that improvement to service delivery and basic service infrastructure (challenge number one) can only happen by improving the skills of the persons involved in the planning, developing and managing processes of basic service infrastructure (challenge number two). The interview questions were therefore structured around the following two main questions:

Question 1

What are the skills needed for engineering professionals working in the environment of infrastructure development and maintenance? And

Question 2

What work experience is needed to become an engineering professional working in the environment of infrastructure development and maintenance?

From these two main questions, the following questions were developed, and used as a guideline for discussions with industry professionals:

1. What are the key technical skills required from engineers working in the public sector?
2. What are the key strategic/management skills required from engineers working in the public sector?
3. What would you consider to be appropriate post-graduation engineering work-experience for engineers within the specific challenges in the public sector?
4. Do you think that engineers should be exposed to “contractor-experience” and “consultant-experience” before working in the public sector (or even private client organisations), or is “in-house experience” sufficient to work as engineering professionals within this environment?

A fifth question was set up to capture any further information from the industry professionals which could add value to the study, this question is as follows:

- If you have any notes, input or feelings that you would like to share in terms of the following key-words or problems, please feel free to do so:
 - Engineering skill shortage within the public sector.
 - Development/training/challenges/standard of municipal engineers.
 - Mentorship and training within the public sector/municipalities.

3.3 INFORMATION ON INTERVIEWEES

The program developed in Chapter 8 is based on secondary qualitative data, i.e. peer reviewed academic literature, published non-academic technical literature, government publications and other related sources. To test the validity of this data

and to measure it against practice, industry role players were interviewed. Further reasons for the interviews are to gain more insight on industry sentiment and obtain more knowledge on the extent of the research problem, which was defined in chapters one and two.

It must again be clearly stated that the proposed program will be based on the secondary data. The researcher will also use primary data, in the form of the results from the interviews with a selected number of industry role players to add further value to the outcome of this research. Although a small sample size for the interviews suggests obvious limitations to the data collected, the information, and the degree of selectiveness add value to the research which can not be disregarded. Taking this into account, the information gained from interviews is therefore not applied in isolation, but rather to substantiate literature used for the development of the program.

Twenty-five interviews were conducted and can be divided into two groups:

Group 1: The first group consist of engineers working in the environment of infrastructure development, but who are not directly employed by public sector organisations. Engineering professionals in this group are all senior representatives of various organisations, and with sufficiently high level of experience in the industry to provide information of strategic nature and not merely of a technical engineering nature, as can be expected from the next category described below.

Group 2: This group interviewed are all engineering professionals who are either currently working within a public sector organisation, or engineering professionals with some experience in working as an engineering professional for a public sector organisation. To gain quality information and to ensure un-biased feedback, engineers chosen for interviews in this group were represented by the three organisational levels typically found in the municipal environment. These levels are: directorate-, department and division/sectional levels. Figure 3.2 shows a typical public organisational structure as can be found within the municipal environment of South Africa.

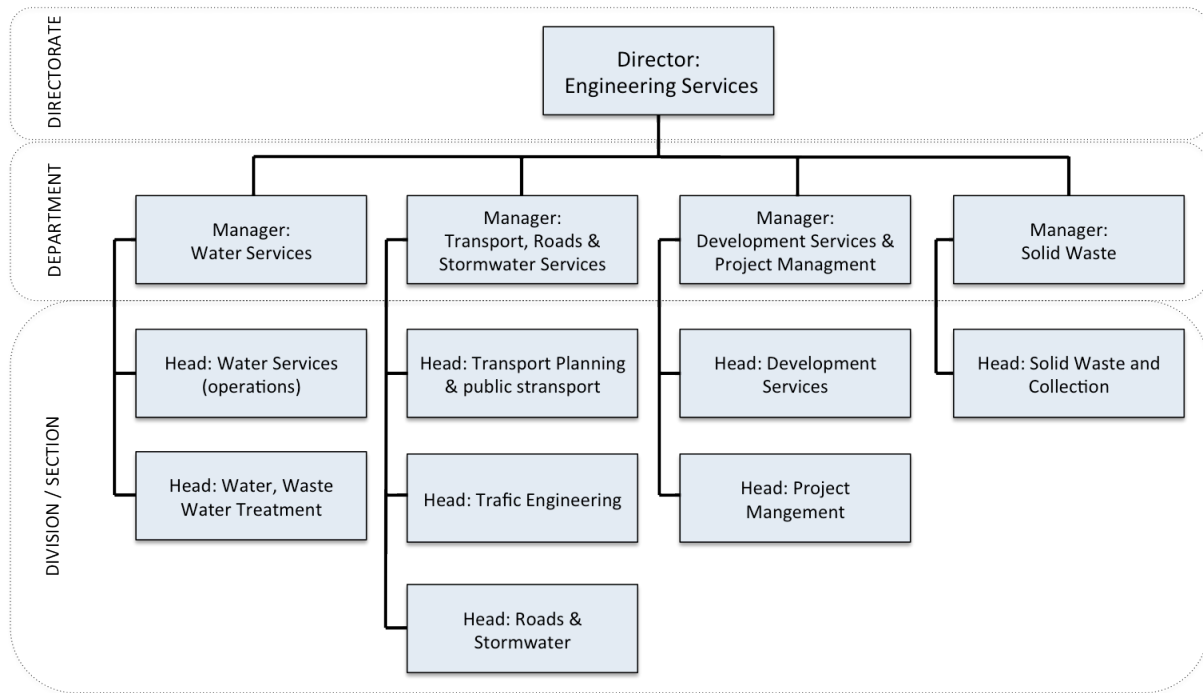


Figure 3.2: Public sector (municipal) organisational structure

Source: Harris, 2012

Table 3.1 provides information on the individuals interviewed. On request by some interviewees, information regarding the organisation and name of interviewees are withheld. All interviews were conducted during 2011 and 2012.

Table 3.1: Interviewee information

	NAME	ORGANISATION	INFORMATION
INTERVIEWEE GROUP 1			
	Martin van Veelen	SAICE	2012 President of SAICE
	Dawie Botha	SAICE	Retired: CEO of SAICE for 20 years
	Jannie Pietersen	IMESA	2012 CEO of IMESA
	Romano Del Mistro	IMESA	Director of training and skills development, IMESA
	Manglin Pillay	SAICE	2013 CEO of SAICE
	Fred Hugo	University of Stellenbosch	Professor in transportation engineering, 30 years
	Danie Wium	Aurecon	Sector Leader: Community Development & Infrastructure, Aurecon
INTERVIEWEE GROUP 2			
Directorship Level			
	Japie van Eeden	SSI Engineers	Previous town engineer for the Municipality of Mossel Bay, 20 years
	Eddie Delpont	Private Consultant	Previous town engineer for the Municipality of Stellenbosch, 15 years
	Hendrik Groenewald	City of Ekurhuleni	Waste management service, 25 years (operations)
Department Level			
	Nico Liebenberg	George Municipality	Manager: Water services, 20 years
	Vincent Harris	Stellenbosch Municipality	Manager: Development services and project management
	Saliem Haider	Stellenbosch Municipality	Manager: Solid Waste
	<i>Anonymous</i>	Northern Cape ^(a)	Manager: Water and sanitation
	Tsidiso Chaka	City of Ekurhuleni ^(b)	Waste management service, <10
	Andries Kruger	City of Ekurhuleni ^(b)	Waste management service, 20 years
	Francis Bacon	City of Ekurhuleni ^(b)	Public Transport, 21 years
Divisional / Sectional Level			
	Altus Eitner	Mossel Bay Municipality	Head: Roads and storm-water
	<i>Anonymous</i>	Northern Cape ^(a)	Head: Roads and storm-water
	<i>Anonymous</i>	Northern Cape ^(a)	Head: Water and sanitation
	<i>Anonymous</i>	Northern Cape ^(a)	Head: Housing
	Ettienne Breytenbach	City of Ekurhuleni ^(b)	Waste management
	John Maclean	City of Ekurhuleni ^(b)	Waste management
	Johan Voster	City of Ekurhuleni ^(b)	Public transport

Notes on Table 3.1: ^(a)Interviewees requested anonymity regarding their names and organisation. Information obtained from a Municipality in the Northern Cape Province.

^(b)The City of Ekurhuleni is a metropolitan municipality, the organisational structure of metropolitan municipalities differ slightly from conventional municipalities, hence no

information is supplied showing whether the interviewees were managers, heads or directors.

3.4 DATA OBTAINED

After completion of the interviews, the researcher condensed the information received. This section contains the data received from the various interviews.

3.4.1 Feedback from Question 1

Question 1: *“What are the key technical skills required from engineers working in the public sector?”*

The following list represents a list of skills as recorded from the interviews. The feedback was ranked by the researcher according to the most frequently mentioned by the interviewees, to the least mentioned. The numerical value of “1”, being mentioned the most, and “9” being a re-occurring answer but mentioned less than the preceding answers. Table 3.2 shows the percentages of total respondents who mentioned (in some way or another) the skill in question.

Table 3.2: Proposed technical skills

	SKILL	FREQUENCY (% of total respondents)
1.	Technical writing skills ⁽¹⁾	96%
2.	Verbal skills	92%
3.	Project management skills	88%
4.	Infrastructure asset management skills	75%
5.	Infrastructure maintenance skills	75%
6.	Financial management skills	67%
7.	Traditional technical civil engineering skills ⁽²⁾ water, waste-water, transportation, structures	67%
8.	Engineering contracts management skills	63%
9.	City planning and town layout skills	56%
10.	Urban engineering skills, design and management	53%
11.	Design management skills	42%

⁽¹⁾ The general feedback from all interviews was that a severe lack exists within young engineers to communicate professionally, in writing and verbally.

⁽²⁾ Water, waste-water, transportation, structures

The following list represents additional feedback received when this question was asked. These points are worth mentioning (relevant to the study), but do not directly translate into skills needed for engineering professionals working within the public sector:

- Engineers should have sound knowledge of municipal or government grant and funding regulations and policies.
- Engineers should have a sound knowledge of the Municipal Finance Management Act (MFMA) and GRAP 17 regulations (refer to Section 1.7 for explanation of MFMA and GRAP 17). According to the interviewees, this could form part of developing the financial management skills of engineering professionals.
- Engineers working in public sector organisations should be able to translate infrastructure planning and budgeting into capital budget spending capabilities.
- It was noted by various interviewees that engineers working for municipalities are not directly responsible for designing infrastructure, but the skill of checking, understanding and sharing input on engineering designs are all important skills for municipal engineering professionals.
- Occupational health and safety regulations and responsibilities is a vital part of the work done by public sector engineering professionals.

- Work within the public sector is multi-disciplinary in nature. Engineering professionals working in this environment should have a sound understanding of the processes and constraints of engineering disciplines other than their own.
- The municipal Integrated Development Plan (IDP) and the management thereof are becoming very important as a government deliverable for municipalities in South Africa. Knowledge of the IDP, the compiling thereof and the execution of the IDP are of vital importance for public sector engineering professionals.
- It was noted that before an engineer can become a municipal engineer, he/she should firstly be a well-rounded technical professional engineer, which implies that engineering professionals need sound technical experience before starting to work for public sector organisations.

3.4.2 Feedback from Question 2

Question 2: *“What are the key strategic/management skills required from engineers working for the public sector?”*

The following list represents a list of strategic or management skills as recorded from the interviews. The same ranking method was used for this list as for the feedback from question 1, mentioned above. Table 3.3 shows the percentages of total respondents who mentioned (in some way or another) the skill in question.

Table 3.3: Proposed strategic skills

	SKILL	FREQUENCY (% of total respondents)
1.	Leadership skills	97%
2.	Interpersonal skills	95%
3.	Professional communication	95%
4.	Government procurement systems management	93%
5.	Municipal systems management / municipal institutional management skills	93%
6.	Municipal bylaws and ordinances knowledge	89%
7.	Professional ethics	78%
8.	Capital spending skills	73%
9.	Public communication skills	62%
10.	Community liaison	58%
11.	Conflict management	56%
12.	Human resource management	48%
13.	Resource management	42%
14.	Systems thinking	42%

The following list represents further feedback received through this question that is worth mentioning, but does not directly translate into skills needed for engineering professionals working within the public sector. This list is not ranked:

- Public sector engineering professionals should possess the ability to facilitate successful mentorship programs.
- Individuals in this environment have to be able to identify training needs and construct and facilitate strategic training programs.
- Networking skills and the ability to facilitate networking within the organisation, between public sector organisations, and between public sector and private organisations are very important in this environment.
- It was noted by various interviewees that all engineers working for municipalities on department level or higher need abilities to think and act strategically. Interviewees noted that engineers with a four-year degree (B.Eng) and professional engineers, in general, possess such abilities.
- Engineering professionals working in the public sector should understand the “business” of providing services, i.e. budgeting, cost control, and contracting for services.
- The ability to foresee what is required before it becomes a problem, in other words must be very strong on planning and proactive decision-making.

- Good people skills to interact with non-technical people who control budgets.

3.4.3 Feedback from Question 3

Question 3: *“What will be appropriate post-graduation engineering work-experience you would propose for engineers to have relevant experience for the specific challenges within the public sector?”*

The following list represents a list of engineering post-graduation work experience as recorded from the interviews. The same ranking method was used for this list as for the feedback from questions one and two, mentioned above. Table 3.4 shows the percentages of total respondents who mentioned (in some way or another) the skill in question.

Table 3.4: Proposed work experience

	Experience	FREQUENCY (% of total respondents)
1.	Engineering design experience	89%
2.	Project Management	83%
3.	Contract Management	76%
4.	Financial Management ⁽¹⁾	73%
5.	Experience in people management	62%
6.	Public participation	57%

⁽¹⁾ Experience in project budgets and control management.

3.4.4 Feedback from Question 4

Question 4: *“Do you think that engineers should be exposed to “contractor-experience” and “consultant-experience” before working in the public sector (or even private client organisations), or is “in-house experience” sufficient to work as engineering professionals within this environment?”*

The same ranking method was used for this list as for the feedback from questions one, two and three mentioned above. The following represents feedback received from the interviews:

- 22 out of the 25 interviewees indicated that it is very important to have at least a year’s experience in both a contractor- and a consultant environment before working in the public sector as an engineering professional.

- It was noted that, previously, large public sector organisations such as ESKOM, TRANSNET, Department of Water Affairs and large municipal environments offered sound basic experience as a foundation for public sector engineering professionals, but these organisation seized to offer this type of experience or training programs.
- It was further noted by all interviewees that the municipal environment currently does not offer the technical depth to prepare engineers with the skills needed on the early stages of work experience to prepare engineers for working in the public sector.

3.4.5 Feedback from the extra question

Question: *“If you have any notes, input or feelings that you would like to share in terms of the following key-words/problems, please feel free to do so:*

- *Engineering skill shortage within the public sector.*
- *Development/training/challenges/standard of municipal engineers.*
- *Mentorship and training within the public sector/municipalities.”*

The following list contains important elements received from interviewees worth noting under this heading:

- All interviewees concurred that there are not enough engineers working in municipalities and that the existing engineers are responsible for more work they can manage.
- Remuneration packages within the public sector, especially within smaller municipalities, are significantly less than that of private organisations. This makes it even more unattractive to work for public sector organisations.
- Interviewees concur that no professional mentoring is currently taking place in any of the municipalities that was represented by interviewees, and that a large need exists to add value to junior positions by means of structured mentoring programs.
- As a result of increased compliance responsibility, engineering professionals within the public sector are required to spend most of their time doing administrative and regulatory work, giving no attention or energy to strategic planning and technical design and management work.

- It was noted by some interviewees that engineers working in the public sector should have the following values: honesty, integrity, accountability, service delivery, and work pride.

The following are specific statements quoted directly from some of the interviewees as general comments that add significant value to the study:

“The municipal environment is very difficult to work in as a result of the restrictive and prescriptive [bureaucracy] associate with it as well as political interference.” (Liebenberg: 2012)

“I believe municipalities need to appoint intern engineers for a three year period and then second them to a contractor for a year, a consultant for a year and expose them to operation and maintenance in the municipality for a year. Thereafter they can be appointed in a junior position in the organisation and need at least 8 years experience before they can be appointed in a senior position. I have seen it too much where a recently qualified technician has been appointed at a municipality in a managerial role without having the necessary experience and without the necessary support from within the municipality. Nobody to mentor them.” (Van Veelen: 2012)

“It is important that each young municipal engineer has an experienced municipal engineer as a mentor. I also believe it is time that a course in municipal engineering presented by experienced municipal engineers be developed and becomes mandatory for anybody working as a municipal engineer/technologist or technician. This course can give a post-graduate diploma or degree rather than a certificate to candidates. The contents of the course to be compiled by a committee of experienced municipal engineers of whom there are more than enough in this area. I am thinking of Alwyn Laubsher, Eddie Delpont, Martiens Victor and I, to name a few. Such a course could be presented by University of Stellenbosch or University of Cape Town. It can be modelled on the financial course which is now mandatory for all senior municipal employees.” (Van Eeden: 2012)

3.5 LITERATURE ON MUNICIPAL TASKS

The above mentioned information was gained by conducting interviews with chosen engineering professionals to obtain information on skills required from public sector engineering professionals. In this section the identified skills are compared to

municipal engineering tasks. For this purpose a study conducted by Cooper (2011) will be considered. This research, Cooper (2011), was done in the United Kingdom, and amongst others, it was conducted to quantify the current tasks of a municipal engineer.

Cooper's (2011) study shows that on average from all the respondents asked, in the technical environment, engineers are spending their time as follow:

- Feasibility studies and planning: 23%
- Detail design: 27%
- Project management & Procurement: 20%
- Construction management: 23%
- Other technical tasks: 6%

When comparing this list to the list compiled through the interviews, it can be seen that the first four tasks in this list are all present in the technical tasks identified earlier through the interviews, see Table 3.5.

Table 3.5: SKILLS CORRELATION

SKILLS FROM COOPER	SKILLS FROM INTERVIEWS
Feasibility studies and planning	<ul style="list-style-type: none"> • Project management skills • Infrastructure asset management skills • Infrastructure maintenance skills
Detail design	<ul style="list-style-type: none"> • Traditional technical civil engineering skills ⁽²⁾water, waste-water, transportation, structures • Urban engineering skills, design and management
Project management & Procurement	<ul style="list-style-type: none"> • Financial management skills • Design management skills
Construction management	<ul style="list-style-type: none"> • Engineering contracts management skills
Other technical tasks	<ul style="list-style-type: none"> • City planning and town layout skills
	<ul style="list-style-type: none"> • Verbal skills
	<ul style="list-style-type: none"> • Technical writing skills

From this correlation is thus evident that the technical public sector engineering tasks identified through the interviews are accurate.

The Cooper study then goes further by identifying the following non-technical tasks within the municipal engineering environment:

- Local authority finance;
- Carbon capture;

- Legal matters;
- Negotiating skills;
- Computing;
- Town planning;
- Presentation skills; and
- Cost benefit study.

Cooper (2011) takes this list of non-technical tasks and requires from the respondents to state whether the specific task forms a large part of their professional responsibilities. The output of this part of his research is listed below. The percentage shows the frequency of the respondents who indicated that the task forms a large part of their responsibilities.

- Local authority finance: 70%
- Carbon capture: 8%
- Legal matters: 47%
- Negotiating skills: 74%
- Computing: 80%
- Town planning: 8%
- Presentation skills: 57%
- Cost benefit study: 37%

Although the correlation in the strategic tasks is not as evident (between the interviews conducted earlier and Cooper's study) as in the technical environment, some themes are being repeated, i.e. *Local authority finance, Legal matters and Presentation skills*. The reason for this might be that South Africa is currently in a different development phase than the United Kingdom. The strategic tasks needed in these environments will therefore differ significantly.

3.6 CHAPTER CONCLUSIONS

This research and the development of the professional development program (in Chapter 8) are based on existing information from various sources. These sources cannot be used in isolation. It is for this reason that primary data is collected through interviews with industry professionals. The above sections supplied information on the process of the interviews, the interview structure as well as the data extracted

from the interviews. This chapter thus supports the purpose of the study in that it supplies data from the industry on research matters which are later in the document used to quantify and confirm secondary data.

Before moving on to the next chapter, certain comments need to be made in regards to some of the feedback received from the interviews. In section 3.4.5 it was noted that general feedback from industry professionals included the fact that public sector engineering professionals are being paid less than those working for the public sector. The implication of this is that the public sector becomes less attractive for experience engineering professionals to work in. Although this information was received as part of the feedback from interviewees, it is not academically tested. To gain assurance on this matter, a full study is to be executed to assess the remuneration comparison between engineers working in the public sector verses engineering professionals working in the private sector. This does not form part of this study.

Another point which needs further justification is that of engineering professionals in public sector organisations spending time on administrative and regulatory work. It sounds obvious that senior engineering professionals would spend more time on administrative, planning and regulatory work. It seems logic that this would also be the case for engineers working in the private sector. Again, this needs to be justified academically and does not form part of this study.

In this report the first chapter supplied the reader with information regarding the study and the structure thereof. The second chapter captured information regarding the environment to substantiate the research problem and quantify the research problem statement. The next four chapters will be structured around the four components of a structured professional development program as identified in Chapter 1. The next chapter will start this process by presenting information regarding professional development through training programs.

CHAPTER 4: SKILLS ANALYSIS AND PROFESSIONAL TRAINING

4.1 INTRODUCTION

In chapters one and two, it was established that professional development consists of *work experience, professional training and mentorship*. It was further established that engineering professional numbers are decreasing in South Africa and that there is a need for professionally registered engineers in the public sector. The fourth aspect, one to three being *experience, professional training and mentorship*, should therefore be to deliver professional registered engineers. The four aspects investigated in this study are therefore professional development through *Training, Mentorship, Work Experience and Professional Registration*. This chapter focuses on the aspect of professional development through training. Refer to Figure 4.1 for graphical presentation of the structure of this study and to show the role this chapter plays in accomplishing the research question.

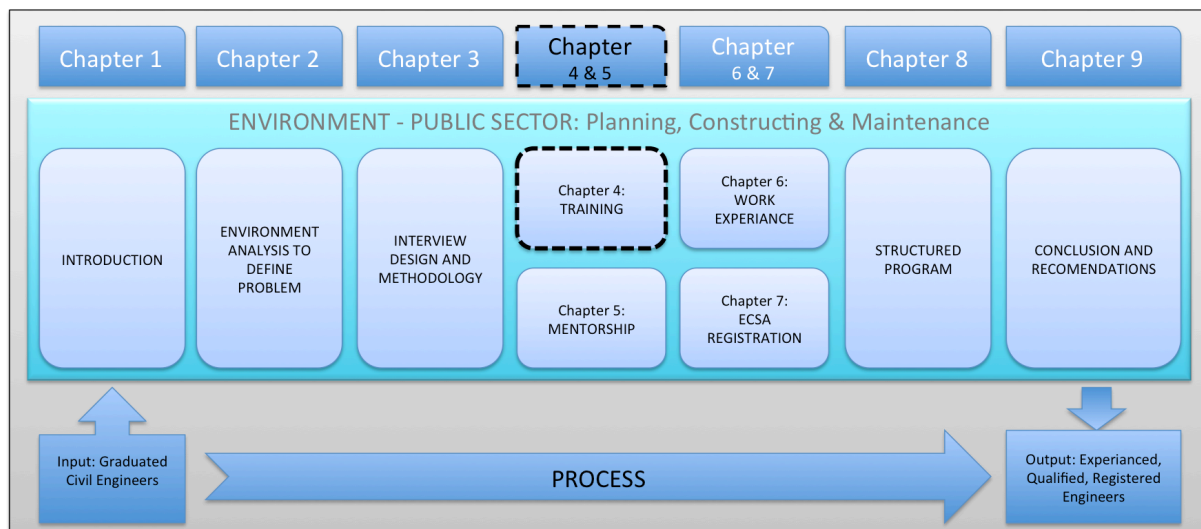


Figure 4.1: Research framework, Chapter 4

The aims of this chapter are twofold. The first is to evaluate the role and reason for training in the professional development environment. This is done by assessing ECSA's view on professional registration and training. The second aim is to identify a possible list of course subjects which could form part of the training content of a professional development program. These aims will be reached by following the steps listed below:

- Find out what is ECSA's view and requirements on professional training in South Africa (International viewpoints on the role of professional training and international professional registration possesses will be evaluated in Chapter 6);
- Compile a list of existing CPD courses offered both nationally and internationally;
- Use the information obtained from industry role players to evaluate which of the listed courses, from two steps mentioned above, are important for the engineers working in the public sector;
- Ask industry role players for further input on courses which might be of importance for public sector engineering professionals; and
- Compile a final list of courses which could be offered as part of a training program in the proposed professional development program.

This chapter consists of three main sections and a chapter summary. The first section consists of a literature study on continuous professional development and the involvement of ECSA in this process. The second section assesses existing CPD courses, both nationally and internationally to identify courses which could be used for a proposed professional development program. The third section is utilised to identify further input from industry role players in regards to identifying a course list.

4.2 ECSA AND CONTINUOUS PROFESSIONAL DEVELOPMENT

According to ECSA, a professional engineer can be defined as someone offering professionalised engineering services to the public (ECSA Policy on Continuing Professional Development, 2007: 3). These services are stipulated by government and enforced by the Engineering Council of South Africa (ECSA).

Registered engineers in South Africa are bound by an Engineering Code of Conduct. This code stipulates two major aspects. The first aspect is that registered engineers can only carry out work within their field of competency. The second is that engineers in South Africa should continuously enhance and maintain that competency or field of expertise (ECSA Rules of Conduct for Registered Persons, 2006:1). Accordingly, it is expected from professionally registered engineers to stay up to date with the latest techniques and technologies that influence their field of engineering practice.

According to the South African Engineering Profession Act (2000:12), ECSA has the following responsibilities: To ensure the health and safety of the public by maintaining standards of practice, knowledge and skills of registered engineers and to ensure the standard of professional ethics amongst engineers. The act goes further by stating that engineers are to renew their professional status once every five years. This renewal entails that they have to prove that they have continuously improved their knowledge and skills in the area they practice in. This process of continual development is called Continuing Professional Development. On this basis ECSA appoints voluntary associations and accredited tertiary educational institutions to offer CPD courses (ECSA Policy on Continuing Professional Development, 2011:10). These courses are utilised by registered professional engineers to demonstrate continuous improvement and competency as professional engineers (South African Engineering Profession Act, 2000:10).

The result of the above mentioned procedure is that the South African government is channelling the responsibility of developing graduate engineers through ECSA. It is thus not only a vision or objective of ECSA to train and maintain the competency of engineers, but they are required to do so by law.

Accordingly, it can be derived that training in the professional environment is not merely an initiative to personally develop engineering professionals, but it is a legal requirement set in place by government. The goal is therefore twofold; firstly develop individuals professionally and secondly to maintain the engineering industry. On this basis it is clear that the choice of professional development courses within a specific professional development program, in this case preparing engineering professionals for the public sector, are of vital importance. The next two sections focus on identifying these relevant courses for a professional development program in this environment.

4.3 EXISTING TRAINING INITIATIVES

It was mentioned above that ECSA appoints voluntary associations and accredited tertiary educational institutions to offer CPD courses for the engineering industry. From the currently available CPD courses, offered by these service providers, a collection of courses is identified. This collection of courses will then be measured against industry opinion, to identify courses which could be offered in a professional

development program, supplying engineering professionals to the public sector. It should be noted at this stage that, as far as possible, existing industry courses would be used to form part of the courses offered within the proposed professional development program. Both national and international courses will be looked at in the process of identifying courses.

For the purpose of this study, the researcher selected three South African voluntary associations, currently offering CPD courses within the civil engineering environment, namely: Consulting Engineers South Africa (CESA), South African Institute of Civil Engineers (SAICE) and PDNA Consulting Engineers. To gain an insight on international initiatives, courses from a British and an USA supplier of CPD courses are assessed.

4.3.1 South African courses and initiatives

Initiatives offered by the civil engineering voluntary associations are offered through the following programs:

1. The School of Consulting Engineers, offered by CESA;
2. The Candidate Academy, offered jointly by SAICE and CESA; and
3. The Da Vinci Academy, offered by PDNA Consulting Engineers.

Although various other suppliers of CPD courses are available within South Africa, the researcher focuses only on the above mentioned three organisations as well as the courses offered by them.

4.3.1.1 The School of Consulting Engineers offered by CESA

The South African Association of Consulting Engineers (SAACE) was formed in 1952. The primary goal of the association was to form a voluntary association consisting of independent consulting engineers within the private sector of South Africa. The association was transformed in 2008 to Consulting Engineers South Africa (About CESA [s.a.], 2012).

CESA's members consist of consulting engineering firms from all the engineering disciplines. The current goal of the organisation is to represent its members as a collective group and their joint interest in the consulting engineering environment. A further goal is to provide a vehicle for quality assurance for its clients. In 2011 CESA

consisted of 480 firms which employed approximately 22 000 employees. CESA is currently recognised by the Engineering Council of South Africa (ECSA) as a Voluntary Association in terms of the Engineering Profession Act, 46 of 2000, (Section 25(3) and 36(1))

According to CESA's mission statement, they are committed to the following aspects of the consulting engineering environment (CESA Mission Statement [s.a.], 2012):

- Enhance the professional and business interests of its members;
- Improve the quality of life for all South Africans by the promotion of engineering excellence; and
- Serve clients with professionalism, integrity and independent judgement.

Furthermore, CESA is committed towards two further aspects within the engineering industry. Firstly, to be committed towards the maintenance of engineering and professional standards; and secondly, to ensure the quality of its members, as seen from the client's perspective. It is thus clear that training and civil engineering professional development form a fundamental part of the organisation. From this core objective the School of Consulting Engineering was established.

The School of Consulting Engineering:

In 2000 CESA identified a national need to enhance the consulting engineering way of doing business and enhance professional and entrepreneurial skills of its member firms. From this need the School for Consulting Engineering (SCE) was developed and founded. The aim was identified to develop these skills not only amongst the memberships firms, but to offer the service to client organisations as well as other interested parties within the national built environment of South Africa (About the School of Consulting Engineers [s.a.], 2012).

Training and development within the SCE is both interactive and participative. During these programs and training sessions, a strong focus is placed on developing skills that can be utilised practically in the working environment. Furthermore, all training material is based on sound theoretical knowledge developed in-house by CESA. Training offered includes seminars, workshops, short courses and skills development programmes. The content of these programs and courses are tested regularly

against industry requirements to assure that the content stay relevant (About the School of Consulting Engineers [s.a.], 2012).

The following is a list of topics which are presented through various courses offered by the SCE (CESA Course offered [s.a.], 2012):

- Business Integrity Management Systems;
- Public Sector Integrity Management Systems;
- Environment Management and Sustainable development;
- FIDIC Contract;
- Financial matters for Consultants and Administration staff;
- Human Resource Development and Labour Legislation;
- Information Technology – Word, Excel, Power Point;
- Legal Risk Management;
- Business Management;
- Negotiation Skills for Consultants;
- Professional Registration preparation;
- Procurement;
- Project Management;
- Quality Management for small and large firms;
- Risk management Implementation; and
- Secretarial and Administration aspects.

4.3.1.2 The Candidate Academy offered by SAICE and CESA

SAICE is a society formed for civil engineers within South Africa to represent their interests. Its members are civil engineers, technologists and technicians. The current membership is approximately 10 000 civil engineering professionals (SAICE Structure [s.a.], 2012).

SAICE provides the following services (SAICE Services [s.a.], 2012):

- Continued professional development for its members;
- Develop technical guidelines and documentation;
- Community outreach programs to the South African society;
- Support and input to central government regarding legislation concerning aspects of civil engineering; and

- Promoting standards and ethical approach within the civil engineering environment.

SAICE's mission is to advance professional knowledge and improve the practice of civil engineering. Furthermore, SAICE strive towards the following goals (SAICE Mission Statement [s.a.], 2012):

- To be a learned society for all those associated with civil engineering;
- Enabling members to provide the community with environmentally and economically sustainable infrastructure;
- Creating effective communication channels in a strong, dynamic and stable organisation;
- Providing their members with continuing education in technical, managerial and communication skills;
- Advising and uphold the professional ethics of the civil engineering profession;
- Enhancing the recognition of civil engineers as a highly respected profession and career; and
- To encourage members to strive for excellence in civil engineering.

The Candidate Academy:

In 2007 Allyson Lawless, then president of SAICE, conducted a study in which the needs for civil engineering professionals were identified within the public sector. The study highlighted the lack of civil engineers in both the public and private sector. (Lawless, 2007).

As a result of Lawless' study, SAICE and CESA jointly launched the Candidate Academy in 2010. The goal of this academy was to provide structure and content towards assisting young graduate engineers to develop workplace competencies within the civil engineering environment as a whole. The academy is structured to develop competencies through training which is exercise-based and practically relevant (Candidate Academy to be Launched, 2010: 57).

Training within the academy is accomplished through applied workshops and courses in specific areas of expertise. The workshops focus on technical and professional skills development. All aspects of the offering are in line with the

professional development guidelines as prescribed by ECSA (Candidate Academy to be Launched, 2010: 57).

The technical training offering not only exposes delegates to traditional engineering aspects such as preparing basic plans, designs, documents and processes, but delegates take part in activities such as site visits, project presentations, and group discussions as well. The professional offering will include themes such as legislation, financial management, procurement, resource management and general management constraints. The professional offering will be offered to the students in context of their responsibility within the civil engineering environment (Candidate Academy to be Launched, 2010: 58).

Candidates are expected to commence participation in the program directly after graduation, as this will form a basis for their professional and technical development. The program is furthermore aimed towards professional registration. To assist the candidate engineer with the registration process, the academy offers a range of training to help planning for the registration process and to capture all experience and training through a structured portfolio of evidence (Candidate Academy to be Launched, 2010: 58).

From the information available, the researcher identified the following courses which form part of the academy's formal program (SAICE Course Calendar [s.a.], 2012):

- Road to registration for candidates;
- Road to registration for mentors, supervisors and human resource managers;
- Pavement rehabilitation and maintenance;
- Basic contract administration and quality control;
- Introduction to sewer design; and
- Basic pressure pipeline design.

Apart from the official course content offered through the Candidate Academy, SAICE also offers a variety of other professional development courses. These courses are listed below: (SAICE Course Calendar [s.a.], 2012).

- Basic coastal and harbour engineering;
- Basic road construction principles;
- Basics of track engineering;

- Bridge maintenance;
- Business finances for built environment professionals;
- Concrete Structures - Analysis and Design;
- Durability of Concrete;
- GCC contract;
- Handling projects in a consulting engineer's practice;
- HDM-4;
- Network analysis and introduction to surge analysis;
- Practical concrete surface beds;
- Practical geometric design;
- Pre-stressed concrete design and practice;
- Properties of concrete for the structural designer and constructor;
- Rail transport;
- Reinforced concrete design to SANS 10100-1;
- Structural masonry design and masonry materials;
- Structural steel design code to SANS 10162:1-2005; and
- Technical report writing.

4.3.1.3 The Da Vinci Academy offered by PDNA

In 2006 a South African consulting engineering firm, PDNA Consulting Engineers, formed a training academy within their existing consulting engineering business. The training academy was put in place to accelerate the skills and development of their own staff. Although this initiative started as a means to develop internal staff, the vision was always to launch a program that could help the development of all South African engineers as a means to confront the national skills shortage within the engineering environment (PDNA Da Vinci Academy develops local talent, 2012).

After the academy reached four years of success, PDNA partnered with a private university, the Da Vinci University, to form the PDNA Da Vinci Academy. The Da Vinci Academy is open for all South Africans and offer training and qualifications on Certificate, Diploma, Masters (MSc) and Doctorate (PHd) levels. Education is offered in the fields of engineering, construction and manufacturing. The aim of these programs are to address the critical skills shortage on SA (About DaVinci Academy [s.a.], 2012).

The Da Vinci Academy currently offers tailor made courses addressing skills and development in the technical, managerial and leadership fields of engineering. This offering includes the following programs (DaVinci Course Catalogue [s.a.], 2012):

- Certificate in Contract Management;
- MSc Degree in Urban Development Practice;
- MSc Degree in Integrated Transport Planning; and
- MSc Degree in Power and Energy Management.

4.3.2 International Initiatives

In addition to the above-mentioned South African programs, the course content of two international service providers is assessed. The first is from Britain, the Tomas Telford Training initiative and the second is the Continuous Education Unit from the USA.

4.3.2.1 Tomas Telford Training offered by Institution of Civil Engineers, UK

The Institute of Civil Engineers (ICE) is a British organisation that strives to promote and progress civil engineers and the environment they are working in. The ICE was founded in 1818 and granted a royal charter ten years later declaring that their aim was to “foster and promote the art of science of civil engineering” (About the ICE [s.a.], 2012). This original aim is still being used today. On their website, the ICE states that they are a qualifying body, a centre for the exchange of specialist knowledge, and a provider of resources to encourage innovation and excellence in the civil engineering profession worldwide (About the ICE [s.a.], 2012).

The ICE does all its training through the Tomas Telford Training (TTT) institute. The TTT handles all the ICE’s professional training courses and development programs and is entirely owned by the ICE. All the profits made by the TTT are invested back into the ICE for further development of its goals and objectives (ICE Training Courses [s.a.], 2012).

The TTT provides specialist training for civil engineers, project managers, construction professionals and other professionals within the civil engineering environment. All the training contributes towards continuing professional development for registered engineers (or Chartered engineers as it is called in the

UK). Training also contributes towards other professional bodies such as the IStructE, RICS, CIOB and IHE, amongst others (ICE Training Courses [s.a.], 2012).

Training within the TTT covers more than 100 course titles. Course topics fall within the following areas of knowledge: structural design, bridges, highways, geotechnical and ground engineering, construction law and contracts, Euro-codes, health and safety. Business skill training also forms part of the course offering. Business courses offered by the TTT are as follow: Graduate development, Leadership, Mediation, Negotiation, Project management and Dispute resolution (ICE Training Courses [s.a.], 2012).

The researcher analysed the more than 100 courses offered by the TTT and categorised them into the following 12 categories (refer to Annexure A for a full list of courses offered by TTT):

- Business and personal skills;
- Environment and sustainability;
- Euro-codes;
- Graduate development;
- Ground engineering;
- Health, safety and welfare;
- ICE Membership;
- Law and contracts;
- Project and design management;
- Structural design;
- Transportation; and
- Water.

4.3.2.2 The Continuous Education Unit offered by ASCE

The American Society of Civil Engineers (ASCE) was founded in 1852 with the purpose of adding value to its members. Its members consist of professionals belonging to the civil engineering profession. Today the society has approximately 140 000 members (About ASCE [s.a.], 2012). According to ASCE's mission, they are committed towards adding value to the civil engineering profession by means of the following:

- The advancement of technology;
- Encourage lifelong learning and development;
- Promote professionalism and the civil engineering profession;
- Develop leaders in the civil engineering profession;
- Look after infrastructure; and
- Being the custodians of the physical environment.

For 39 years, ASCE has been providing training and education through its Continuing Education Centre (CEC). The International Association for Continuing Education (IACET) accredited the CEC as a CPD accredited centre. The purpose of IACET is to ensure quality of continuous education training throughout the USA (IACET Who are we [s.a.], 2012).

According to the ASCE, participants can expect the following benefits when taking part in one of their continuous education programs (ASCE Continuing Education Catalogue, 2012:2):

- Programs offered are accredited internationally via the IACET;
- Delegates have the chance to refresh their knowledge and skills according to current trends in the industry;
- Leadership and management skills can be enhanced within the civil engineering environment;
- Create networking opportunities amongst other role players in the industry;
- Delegates can earn accredited Continuous Education Units (or CPD points); and
- All programmes support the mission of ASCE, which is to strengthen the civil engineering discipline and to contribute towards a sustainable world.

Education and training are offered in the following areas: Construction & Development, Environmental, Geotechnical, Hydraulics & Water Resources, Management & Leadership, Structural Engineering, Sustainability and Transport/Highway Engineering (ASCE Continuing Education Catalogue, 2012:3).

The curriculum for training and development in the Management and Leadership area is as follows (ASCE Continuing Education Catalogue, 2012: 23):

- Financial management for the professional engineer;

- How to start, build and run a forensic engineering practice;
- How to successfully use value engineering on capital projects;
- Law school for engineering;
- Leadership development for the engineer;
- Liability of engineers: How to stay out of trouble;
- Managing the design process: Keeping on schedule, within budget and selecting the right resources;
- Ownership transition planning, company valuation and strategic planning;
- Project Management;
- Testifying and forensic report writing skills for civil engineers;
- Ethics for engineers;
- Financial management for the professional engineer;
- Accounting for the non-accountant;
- Leadership development;
- Perfect your negotiating skills: Increase your profitability; and
- Successful marketing of engineering services: From finding prospects to generating repeat business.

4.3.3 CPD Course groupings

The preceding sections presented courses offered by various national and international CPD-course training providers. Together these organisations offer a collection of 225 individual courses. From the 225 individual courses, identified earlier, it is evident that courses could be grouped into 15 distinct course grouping. These groupings are as follow:

- Administrative and personal;
- Business management;
- Environment management;
- Design codes;
- Graduate development and professional registration;
- Ground and Geology engineering;
- Health, safety and employee welfare;
- Construction law and contract management;
- Project management;

- Structural engineering;
- Transport engineering;
- Water engineering;
- Construction management;
- Public sector systems (and public sector systems management); and
- Design management.

Table 4.1 provides a summary of the grouping of the courses as presented by the three South African and two international course service providers.

Table 4.1: Course grouping analysis

		Administrative & Personal skills	Business Management	Environmental & Sustainability	Design-Codes	Graduate Development & Prof Registration	Ground & Geology Engineering	Health, Safety & Welfare	Law Contract Management	Project Management	Structural Engineering	Transportation Engineering	Water Engineering	Construction & Construction Management	Public Sector Systems	Design Management	Total
		Number of Courses per Category															
School of Consulting Engineers	SA	2	8	1	0	1	0	0	2	1	0	0	0	0	2	0	17
Candidate Academy	SA	1	1	0	2	0	0	0	2	1	9	4	2	1	0	0	23
De Vinci Academy	SA	1	4	3	0	0	0	0	3	3	0	2	1	1	2	0	20
Tomas Telford Training	UK	9	14	7	26	1	6	4	3	10	27	3	3	8	0	13	134
Continuous Education Unit	USA	3	14	3	0	2	18	0	3	3	29	2	21	8	0	7	113
Total		16	41	14	28	4	24	4	13	18	65	11	27	18	4	20	

Table 4.2 provides a further analysis of the data collected above. In this table the courses were grouped into three categories, namely: *technical*, *technical management* and *business management*. The data is further presented as totals, for the South African and international service providers.

Table 4.2: Course topic analysis

		Administrative & Personal skills	Business Management	Environmental & Sustainability	Design-Codes	Graduate Development & Prof Registration	Ground & Geology Engineering	Health, Safety & Welfare	Law Contract Management	Project Management	Structural Engineering	Transportation Engineering	Water Engineering	Construction & Construction Management	Public Sector Systems	Design Management	Total	
SA, USA & UK																		
Technical	Number of Courses	0	0	14	28	0	24	0	0	0	65	11	27	0	0	0	169	55%
Technical Management		0	0	0	0	4	0	4	0	0	0	0	0	18	0	20	46	15%
Business Management		16	41	0	0	0	0	0	13	18	0	0	0	0	4	0	92	30%
% of Total	%	5	13	5	9	1	8	1	4	6	21	4	9	6	1	7	307	
South Africa																		
Technical	Number of Courses	0	0	4	2	0	0	0	0	0	9	6	3	0	0	0	24	40%
Technical Management		0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	3	5%
Business Management		4	13	0	0	0	0	0	7	5	0	0	0	0	4	0	33	55%
% of Total	%	7	22	7	3	2	0	0	12	8	15	10	5	3	7	0		
UK																		
Technical	Number of Courses	0	0	7	26	0	6	0	0	0	27	3	3	0	0	0	72	54%
Technical Management		0	0	0	0	1	0	4	0	0	0	0	0	8	0	13	26	19%
Business Management		9	14	0	0	0	0	0	3	10	0	0	0	0	0	0	36	27%
% of Total	%	7	10	5	19	1	4	3	2	7	20	2	2	6	0	10		
USA																		
Technical	Number of Courses	0	0	3	0	0	18	0	0	0	29	2	21	0	0	0	73	65%
Technical Management		0	0	0	0	2	0	0	0	0	0	0	0	8	0	7	17	15%
Business Management		3	14	0	0	0	0	0	3	3	0	0	0	0	0	0	23	20%
% of Total	%	3	12	3	0	2	16	0	3	3	26	2	19	7	0	6		

By comparing the numbers above for the spread between *technical*, *technical management* and *business management*, it is evident that South Africa has a significantly larger percentage of courses in the *business management* category, i.e. 55% comparing to the UK, 27%, and the USA, 20%. A possible reason for this might be that ECSA is placing a higher weight to understanding and managing the business processes in the engineering environment through its continuous

professional development requirements than the UK or the USA. What is interesting about these figures is the fact that the two international figures are so closely equal.

Another fact to note from the above mentioned figures are that the highest presented course subject for the two international organisations is that of *Structural Engineering* (20% UK and 26% USA). This course subject is the second highest for South African with a figure of 15%. A possible reason for this is that developed countries such as the UK and the USA spend significantly more resources on the development of large and complex structures such as high-rise buildings. The largest presented course subject in South Africa is that of *Business Management* with a figure of 22%. The top four course topics for the three countries are listed below:

South Africa:

- Business Management 22%
- Structural Engineering 15%
- Law & Contract Management 12%
- Transportation Engineering 10%

UK:

- Structural Engineering 20%
- Design Codes 19%
- Business Management 10%
- Design Management 10%

USA:

- Structural Engineering 26%
- Water Engineering 19%
- Ground & Geology Engineering 16%
- Business Management 12%

The reason why the four South African service providers and the two international service providers in the sections 4.3.1.1, 4.3.1.2, 4.3.1.3, 4.3.2.1 and 4.3.2.2 were chosen is twofold. The first is that all these organisations are accredited by their respective engineering governing bodies. This implies that, by means of their quality control system, the standard and offering of these organisation are evident. The

second reason is that these service providers are all established institutions with a long track record in offering professional development courses. The assumption here is thus that the combined offering of these organisations are a representation of the need for professional development in the civil engineering industry.

This list of course offerings is based on the need for civil engineering professional development courses. To understand which of these courses are applicable to civil engineers working in the public sector, this list was presented and discussed with industry role players, as discussed in Chapter 3. The next section contains the feedback from industry role players on the data developed and shown in Table 4.2 and Table 4.3. This is therefore done to identify and develop a final list of courses, or course topics, which will form part of the proposed professional development program.

4.4 INDUSTRY INPUT

In Section 4.2 it was said that the role of professional development is to professionally develop individuals as well as maintaining the standard of a specific engineering industry. It was also mentioned that the choice of professional development courses are important to develop specific skills within a specific industry.

Accordingly, Section 4.3 was used to compile a list of CPD course topics currently being offered, nationally and internationally, for professional development within the wider profession of civil engineering. The aim of this section is to identify topics, and ultimately course subjects, which will form part of a professional development program for engineering professionals within the public sector. This aim is accomplished by presenting the information gathered in the previous section to industry professionals and asking input as to which of these topics are relevant for civil engineers in the public sector.

4.4.1 Industry input on existing training topics

The list of civil engineering CPD course topics, developed in the previous section, were presented to the industry role players taking part in this study (refer to Chapter 3). The reason for this was to determine which of the course topics currently

begin offered has a relevance to the professional development of engineers working in the public sector. During the same interviews mentioned in Chapter 3, the interviewees were thus asked to rate the relative importance of these course topics to the responsibilities of an engineering professional working in the public sector. The interviewees could choose between four categories of relevance, namely: “highly relevant”, “medium relevant”, “low relevant” or “not relevant”.

The interviewees were categorised in two groups, the first group is engineering professionals having a direct influence (or is directly involved with) the public sector, but are not employed by the public sector. The second group is engineering professionals directly employed by the public sector. The feedback from this process is summarised in Table 4.3. The table also shows separate data for the two groups of interviewees mentioned. The value of having the separate data as shown, is that it gives a good indication of how the two groups (one being from public sector organisations, and the other from public sector organisations) perceive which skills are needed in public sector organisations.

Table 4.3: Industry input on course subjects

	COURSE SUBJECT	INDUSTRY ROLE PLAYERS FEEDBACK (GROUP 1)	INDUSTRY ROLE PLAYERS FEEDBACK (GROUP 2)
1	Administrative & Personal skills	High relevance	High relevance
2	Business management	High relevance	High relevance
3	Construction management	High relevance	High relevance
4	Design management	Medium relevance	High relevance
5	Environmental and Sustainability management	Low relevance	Low relevance
6	Graduate development and prof. registration	No relevance	No relevance
7	Ground & Geology engineering	Low relevance	Low relevance
8	Health, safety and welfare	Medium relevance	Medium relevance
9	Law & Contract management	High relevance	High relevance
10	Project management	High relevance	High relevance
11	Public sector systems management	High relevance	High relevance
12	Structural engineering	Low relevance	Low relevance
13	Transport engineering	Medium relevance	High relevance
14	Water engineering	Medium relevance	High relevance

From the list of course topic currently being offered, the interviewees deemed the following course subjects to be of high relevance to the professional development of a public sector engineer:

- Administrative & Personal skills;
- Business Management;
- Construction Management;
- Law & Contract Management;
- Project Management; and
- Public sector systems Management.

These topics should therefore be included in the proposed professional development program. The interviewees deemed the following of medium relevance to the professional development of a public sector engineer:

- Design Management;
- Health, safety and welfare;
- Transport Engineering; and
- Water Engineering.

It is proposed that these course topics also form part of the curriculum of the courses which will form part of the proposed professional development program. The following list was regarded as low, or no relevance, to engineers working in the public sector:

- Environmental and Sustainability Management;
- Graduate development and Professional registration;
- Ground and Geology Engineering; and
- Structural Engineering.

It is interesting to find that a topic such as *Environmental management* and *Sustainability* are not regarded as an important course topic for engineers in the public sector. A possible reason for this is that topics such as these are normally subcontracted to external consultants and that functions such as this does not form part of the core tasks of engineers in the public sector. The same can be said for topics such as *Structural engineering* and *Geology*.

The next step in the process of developing a list of professional development courses for engineers working in the public sector is to link these relevant, existing course offerings, to the identified require skillset identified by engineers currently working in the environment of public sector engineering. This will be done in the next section.

4.4.2 Industry proposal on further course topics and final course list

The previous section reported on what the industry view is on existing CPD course topics and the relevancy thereof within the public sector environment. The aim of this section is to gain more insight into what industry role players think engineering professionals within the public sector should be exposed to with regards to training and CPD course topics.

Chapter 3 supplied information on interviews done with industry role players. Within these interviews, amongst others, the following two question were posed towards the interviewees:

Question 1:

- What are the key technical skills required from engineers working in the public sector?

Question 2:

- What are the key strategic/management skills required from engineers working for the public sector?

These two questions were specifically asked to stimulate conversation, and to gain feedback on what these industry participants think should be included in the course offering, or skills need, for engineers working within the public sector. The feedback from the first question, mentioned in Chapter 3 (Table 3.1), is as follow:

- Technical writing;
- Verbal & Communication;
- Project management;
- Infrastructure management;
- Infrastructure maintenance;
- Financial management;
- Traditional technical civil engineering skills: water, waste-water, transport, structures;
- Engineering contracts management;
- City and town planning;
- Urban engineering, -design and –management; and

- Design management.

The feedback from the second question above, mentioned in Chapter 3 (Table 3.2), is as follow:

- Leadership;
- Interpersonal;
- Government procurement systems management;
- Municipal systems management / municipal institutional management;
- Municipal bylaws and ordinances knowledge;
- Professional ethics;
- Capital spending;
- Public communication;
- Community liaison;
- Conflict management;
- Human resource management;
- Resource management;
- Systems thinking; and
- Professional communication.

Aside from these two questions the interviewees were further asked to supply any additional information which might add value to the process of compiling a list of course topics which will form part of the training content for the proposed professional development program. This list was presented in Chapter 3 (end of Section 3.4.1), and is presented again below:

- Engineers should have specific knowledge of municipal and government grant and funding regulations and policies.
- Engineers should have a sound knowledge of the Municipal Finance Management Act (MFMA) and Grap 17 regulations.
- Public sector engineering professionals must be able to translate infrastructure planning and budgeting into capital budget spending.
- Public sector engineering professionals should have a sound knowledge of the technical aspects of designing, and the designing process, although this does not form directly part of their day-to-day responsibilities.

- Sound knowledge and understanding of occupational health and safety regulation.
- Working in, and working with multi-disciplinary teams.
- Sound understanding of setting up and management setting up of the municipal Integrated Development Plan (IDP).

From the three sets of data supplied above, and the input from industry role players, the researcher propose that the course topics be further subdivided into three groups, namely: *traditional technical engineering knowledge*; *general management and engineering systems management knowledge*; and *municipal/government specific knowledge*. It is further proposed that these three groups form a logical progression as an engineer progresses from a junior graduated engineer to a more experienced engineer. By forming a combination of the following sets of data, a final list of course topics is presented in Table 4.4:

- Existing relevant professional development course topics, both national and international;
- Industry skill proposal for engineering professionals working in the public sector; and
- Extra feedback received by industry role player regarding professional development course topics.

Table 4.4: Proposed course subjects

	TECHNICAL	MANAGEMENT	MUNICIPAL
1	Technical writing and Professional Communication	Project Management	Government Procurement Systems Management
2	Urban engineering	Engineering Contracts Management	Municipal Institutional Management and Bylaws
3	Introduction to city planning	Design Management	Municipal Finance Management
4	Courses in civil, water, waste-water, transport and structures engineering	Infrastructure Management and Maintenance	Community Liaison and Public Communication
5		General Financial Management	
6		Capital Spending Management	
7		Resource and Supply Management	
8		Human Resource Management	
9		Occupational health and safety	
10		Conflict management	
11		Professional ethics	
12		Leadership & Leadership development	

*Note on course content: The detailed content of the proposed courses does not form part of this study. It is proposed in Chapter 9 that the details of the course content be developed in detail as part of a further study.

Through the process of developing course subjects for the proposed program, it became clear that municipal, or public sector, engineering professionals are responsible for more than merely the traditional engineering knowledge areas and skills. In the study completed by Cooper (2011), the future skillset of the municipal engineer was researched. The research was conducted by completing interviews with various engineers working for municipalities throughout England. In this study Cooper identified various traditional technical skills such as design in the water supply, transport, waste-water, structures and waste management, but goes further by listing non-technical skills that are becoming more important in this environment. Amongst others, this list include skills such as: Local authority finance, Legal matters, Negotiating skills, Town planning, Presentation skills and Cost benefit studies. The similarities between the finding earlier in this chapter and the study according to Cooper are evident.

Cooper furthermore states that although the traditional technical skills are important as a knowledge base for the municipal engineer, there needs to be a focussed effort

to develop the non-technical skillset which is becoming more important in this environment. This concurs with the findings from the interviews and the proposal generated for the training section for the public sector professional development program.

4.5 CHAPTER SUMMARY

The first aim of this chapter is to clarify the role of training in the professional development environment. The second aim is to identify possible course subjects which could be used in a formal professional development program.

It was found that professional training forms part of a CPD process. It was further established that government enforces this CPD process. The responsibility of this enforcement is channelled through ECSA towards the public. Professional development, through CPD training, is thus not merely important for the development of engineering professionals, as found by the industry interview process, but is a legal requirement to continue practicing as a professional engineer. It was further established that the CPD process is set in place to continuously promote and develop the engineering industry.

Course subjects for the proposed professional development program were identified in this chapter. This was done by comparing data from existing course offerings, both nationally and internationally, industry feedback on course topics needed and a literature study on skills needed in the environment of public sector engineering.

These identified course subjects will be integrated into the proposed program to offer the full extent of the professional training offered by the program. The next chapter focuses on the importance of structured mentorship within the professional development environment.

CHAPTER 5: PROFESSIONAL MENTORSHIP

5.1 INTRODUCTION

It was established earlier in this study and mentioned numerously that the *professional development process* consists of professional *training*, *mentorship* and *work experience*. The previous chapter focuses on the first of these factors, namely training within the professional development environment. Figure 5.1 presents the graphical presentation of the structure of this study and highlights how the topic of this chapter fits into the study.

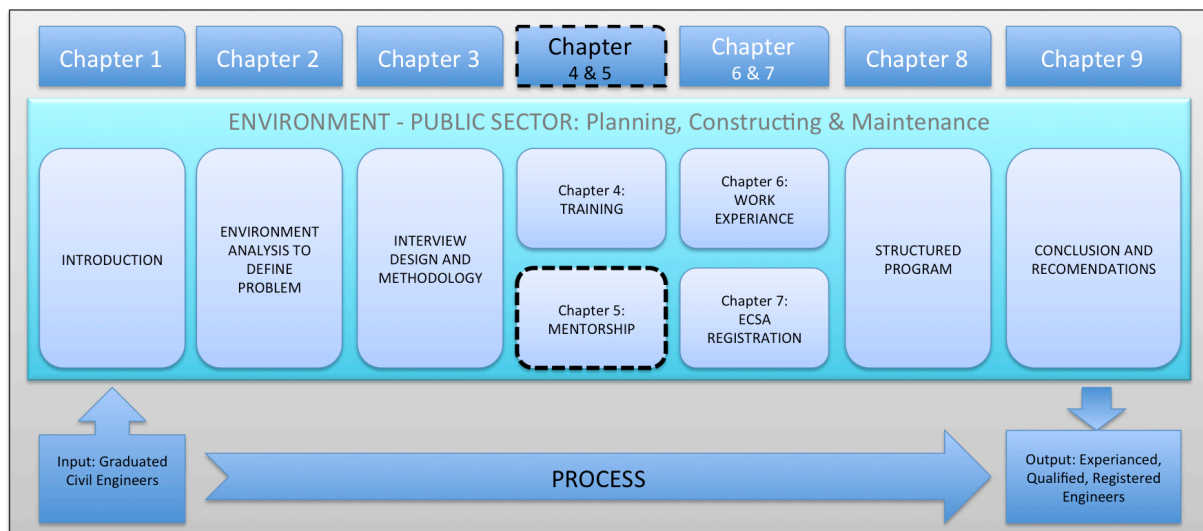


Figure 5.1: Research framework, Chapter 5

The aim of this chapter is to quantify the role and importance of structured mentorship in the professional development process. A second aim is to establish how such a mentorship program can be applied to the environment of infrastructure development and incorporated into a professional development program. A third aim is to identify aspects of the structure of a formal mentorship program which can be applied to the professional development program proposed in Chapter 8. These aims are achieved by:

- Understanding the concept of structured mentorship;
- Understanding the benefits of structured mentorship;
- Understanding how the structured mentorship can be applied to the environment of developing engineering professionals; and
- Interviewing organisations which completed successful mentorship programs.

This chapter will thus consist of four main sections. The first section will consist of an introduction towards mentorship. The second section will discuss the benefits of a structured mentorship program. The third section will look at the application of structured mentorship. The fourth section will include information received from industry regarding aspects of the structure of structured mentorship.

5.2 INTRODUCTION TO MENTORSHIP

Learning within the professional environment takes place both formally and informally (Holland, 2009). Formal learning can take place through courses and training offered internally by the organisation, or externally by a third party training provider. Informal learning takes place when individuals within a community of practice learn through exposure to the workplace and professional environment. Holland goes further by stating that this informal learning is a function of internal confidence that is affected by social interaction, levels of power sharing and trust, which also form the bases of mentorship.

Formal mentorship is also known as structured mentorship (Ragins and Verbos, 2006:21). Informal mentorship arises when mentoring happens spontaneously and informally. The process of informal mentorship starts when junior or inexperienced staff observe actions of senior staff and start applying these aspects in their own working environment.

The opposite situation can also arise. In such a case managers or technical leaders start teaching aspects of the work environment to junior staff spontaneously in an unstructured manner. In many cases this type of mentorship happens unconsciously. Organisational culture plays an important role in the process of informal mentorship. This automatically suggests that positive as well as negative development can be transferred through these informal mentorship processes, depending on the culture of the organisation. Consequently, informal mentorship is not always ideal in the professional work environment.

Structured mentorship, on the other hand, happens as a result of a conscious structured intervention. Such interventions are identified on strategic level within organisations, and are executed through structured mentoring programs. These programs are clearly defined with concise and clear goals in mind. Mentorship, in its

structured form, is a solution towards offering benefits to both the employee and the organisation (Holland, 2009). It must be further mentioned that, within structured mentorship, a cycle exists. Such a cycle consists of attracting, developing, motivating and retaining staff, in line with the organisation's strategic goals. This process is iterative and progressive, and should constantly be updated and renewed (Marsh, 2012).

5.3 BENEFITS OF STRUCTURED MENTORSHIP

Structured mentorship offers various benefits. According to Marsh (2012:6) these benefits can either be directed towards the organisation or the individual within the organisation. Marsh goes further by listing the following organisational benefits:

- Increased ability to attract, develop, motivate and retain quality employees;
- Improvement of succession planning and talent management within the organisation;
- Retention and sharing of critical business knowledge and intellectual capital;
- Enhancement and transfer of scarce skills;
- Improve employee productivity; and lastly
- Enhance employee engagement within the organisation.

Further research by the American Society for Training & Development (1998) shows that when training interventions are introduced to organisations, it produces an average productivity improvement of 24%. When the same training interventions are introduced with a structured mentoring program, the average productivity improvement can rise up to 88%.

Marsh goes further by stating that structured mentoring poses clear benefits towards the individual. These benefits are listed below:

- It has an effect of "fast tracking" graduate development and integration into new organisations;
- It empowers employees through effective and objective processes;
- It facilitates effective and measurable job specific competency development; and
- It improves employee performance and job satisfaction.

The above mentioned information clearly states that the benefits of mentorship take place on the individual as well as the organisational level. In the engineering industry, within the public sector, the constant transferring of knowledge and skill from more senior engineers to junior engineers are of vital importance to ensure sustainability of municipal organisations. The current lack of good mentorship within public sector environments is evident. It is thus of vital importance that any professional development program proposed to this industry includes a good mentorship program. As mentioned above, this will not only be of benefit to engineers working in this environment, but in the long run the organisations will reap the benefits as well.

5.4 APPLICATION OF STRUCTURED MENTORSHIP

Managers are forced to be output driven and they are expected to ensure that employees perform accordingly. Junior staff are not necessarily sensitive towards the organisation's goals and aspirations. In many cases junior staff perform out of fear as a result of performance ratings and staff evaluation (Hutchins, 1996). This has a negative effect on the organisation and the culture of such an organisation. A need thus exists for the development of a process which not only focuses on the needs of the individual, but which keeps the organisation's goals and strategy in mind throughout this process.

According to Hutchins (1996), structured mentorship offers a solution towards this problem. He derives this conclusion by stating that structured mentorship is based on a sound relationship and trust between the mentees and mentors within an organisation. Hutchins goes further by stating that such a mentee-mentor relationship is based on the process of sharing passion, personality and potential development. In his research, he further states that this relationship must not be confused with the manager-mentee relationship, which deals with the technical aspects of performance and productivity processes. According to him it is therefore unfavourable for a manager to be a mentor. In some special cases the manager can also be the mentee, in those cases very clear relationship boundaries must be set before the process of mentorship commences.

To better understand this relationship between the mentor, mentee and manager a model was developed by *Mentoring for Success*TM (Understanding structured mentorship, 2011). This model is illustrated in Figure 5.2 and discussed below.

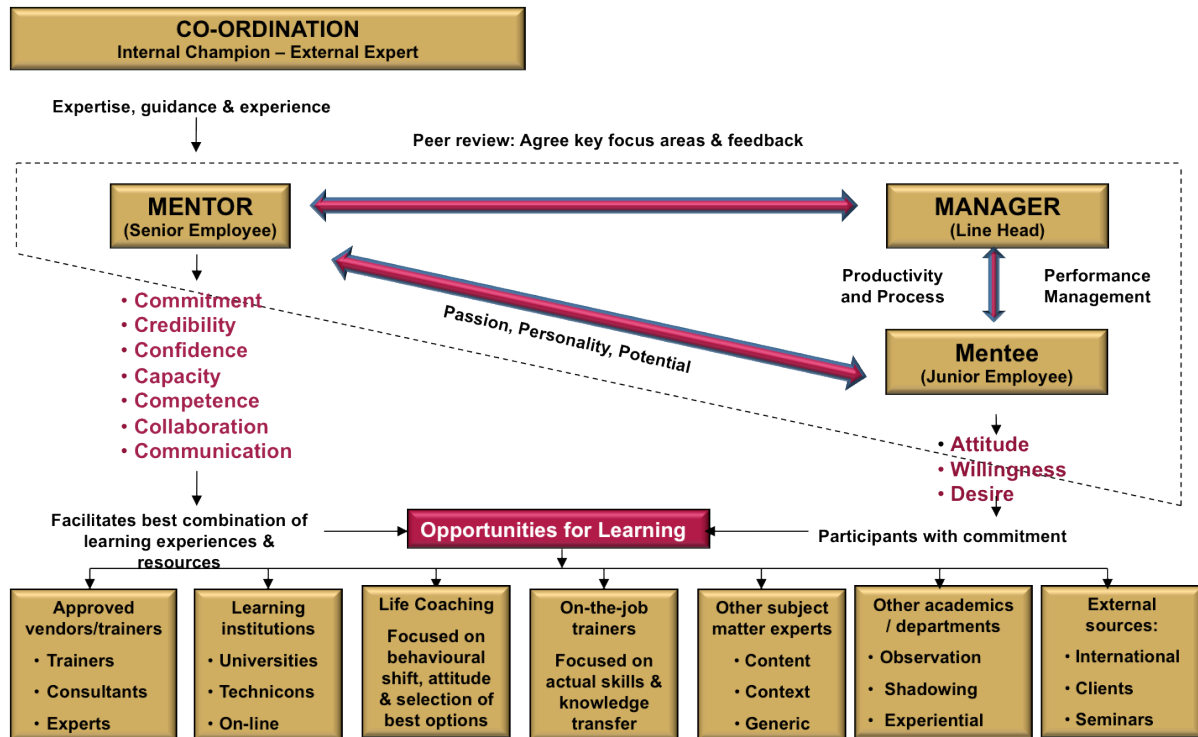


Figure 5.2: Mentee, Mentor, Manager Relationship

Source: Understanding structured mentorship, 2011

According to this model three relationships exist within the structured mentorship process. They are the Mentor-Manager, Mentor-Mentee and Manager-Mentee relationships. Apart from these three relationships, which will be discussed next, a fourth party is identified, the Co-ordinator. This co-ordinator is an external expert or internal champion who can facilitate the process of structured mentorship and monitor the following three relationships.

Mentor-Manager

This relationship is based on a peer-to-peer connection, and is built on an agreement of technical deliverables and focus areas. Feedback on the progression and productivity of the mentee is imperative in this relationship.

Mentor-Mentee

This relationship is based on trust and a strong personal connection between the mentee and the mentor is vital for the success of the relationship. Key building blocks for these relationships are passion and development potential.

Manager-Mentee

A special relationship is needed between that of the manager and the mentor (of a specific mentee). In this relationship trust and a formal agreement on the confidentiality levels of the process and information used throughout the process, must be agreed upon beforehand. Other important aspects of this relationship are the focus on productivity and processes, and performance management.

The model supplies a list of requirements for both the mentee and the mentor in this structured mentorship process. The mentee requires, amongst others, attitude, willingness and desire to learn and to be mentored. The mentor, on the other hand, is required to:

- Be committed towards the mentee and the mentorship process;
- Be creditable at all times;
- Display confidence towards the process and mentee;
- Have capacity, both in terms of the energy needed for the process and time;
- Be competent for the task expected of him;
- Have the ability to collaborate with the mentee, manager and project champion; and
- Be able to communicate.

The model further proposes that good coordination is needed between an internal program champion, who drives the process from the within the organisation, and an external expert, who plays the role of facilitator for this process.

The model ends off by listing the possible “places” where these learning processes can take place within this structured mentoring process. These opportunities for learning are as follow:

- Approved vendors, or trainers;
- Learning institutions;
- Life coaching;
- “On-the-job” trainers;
- Subject matter experts;
- Tertiary educational training providers; and
- Other external sources.

During the research, no literature could be found to oppose the model proposed by *Mentoring for Success*TM and its findings. A study which supports the model proposed by *Mentoring for Success*TM, is that of the National Institute of Mentorship, USA (How to build a successful mentoring program, 2005). In this study it is mentioned that a formal agreement should be made between the mentor and the manager to ensure trust boundaries are not bridged and professional departmental (technical) aspects does not influence the personal growth and goal setting of the mentee.

Competency levels vs. types

Another concept worth noticing in the application of structured mentorship is the aspects of *competency levels*, and *competency types*. Competency types refer to the development stages of an employee. The process starts off by developing skills. Skills transfer includes low-level interventions such as on the job training. Skills development falls within the technical domain and mentorship does not play a vital role on this stage.

The second competency type falls within the process of knowledge development. During this stage focus is placed on sharing and transferring of the knowledge, rather than training, as in the previous competency type.

The last competency type focuses on the transfer and management of behaviour. If the organisation is able to manage behaviour, mentoring interventions will have a higher possibility to be successful. It is in this last domain that structured mentoring should be applied (Leonetti, 2008). These competency types have a direct relationship with the level of competency held by the employee and the progression thereof. This relationship can be best described by means of a S-curve, and is portrayed in Figure 5.3.

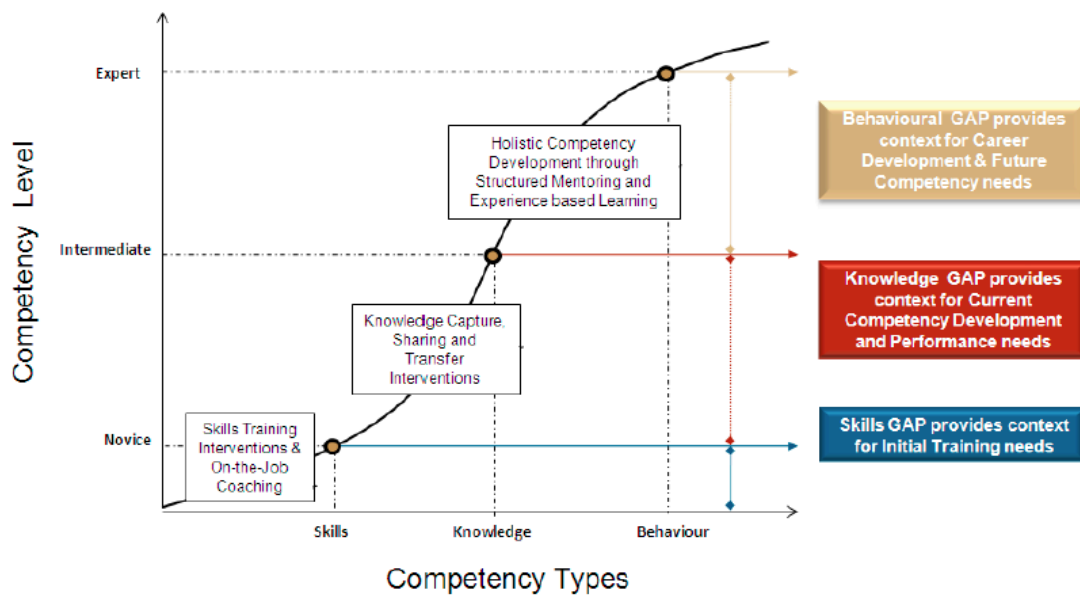
Competency Level vs. Competency Types

Figure 5.3: Mentee competency levels vs. competency types

Source: Understanding structured mentorship, 2011

Marsh (2012) states that each mentee has unique needs and that he/she will go through specific stages in the development of his/her career. These are progressively from developing generic skills, critical skills, scarce skills, specialist/management skills to ultimately developing leadership skills.

The following is taken from the above mentioned information which should be applied and incorporated into the mentorship part of the professional development program which will be developed in Chapter 8:

- The program should be focused on changing behaviour, and not merely to transfer technical skills and knowledge;
- The relationships in the proposed program should be formally defined; and
- The competency of the mentees should be assessed and the program should deliver an offering to fit these competencies.

5.5 COMPONENTS OF A STRUCTURED MENTORSHIP PROGRAM

To identify the structure for a successful mentorship program, the researcher interviewed two organisations, mentioned below, who have successfully completed a mentorship program in the past three years. These organisations are actively

involved in the civil engineering environment. Companies interviewed are BKS Consulting Engineers (now Aecom) and WBHO Civil Engineering Contractors. Both these organisation completed 12 month structured mentorship programs during 2010 and 2012.

The following were findings derived from these interviews:

- Structured mentorship implies a structured process with set deliverables, meeting dates and training for both mentee, mentor and combined training sessions.
- The process of structured mentorship should be managed from a central point, preferably a third party not involved in the organisation.
- A minimum of one year is needed to build relationships and to progressively work on goals.
- A formal agreement is needed between the mentorship program facilitator, the mentee and the mentor.
- Guidelines for both parties should be developed, communicated and followed throughout the mentoring process.
- Regular, structured meetings should take place between mentee and mentor. At least one formal meeting a month is required. Meetings should include progression towards goals, concerns and other related topics. Meetings should always be recorded very accurately.

(Kleynhans, 2012) (Van der Walt, 2012)

All the above-mentioned aspects of the structure of a mentorship program concurred with the mentorship theory dealt with earlier in this chapter. These aspects will be incorporated into the mentorship section of the proposed professional development program in Chapter 8.

5.6 APPLICATION INTO THE PROPOSED PROGRAM

Structured mentorship is thus a process in which junior inexperienced staff are lead through a structured process, by means of an external facilitator, by experienced staff to develop professionally and technically and in line with the organisations goals and

vision for the benefit of the organisation and the individual. The model of structured mentorship involves the following:

- Understand the organisation's goals and direction;
- Identifying mentors;
- Training mentors with the process of mentoring as well as the application of the organisation's goals;
- Lead the mentors and mentees through a structured process to:
 - Understand the organisations vision and goals;
 - Mentee's personal goals;
 - Identify mentee's areas of development to promote the organisation;
 - Facilitate the path of reaching goals identified; and
 - Ensure that new goals are set and that continuous improvement is being practiced.
- Ensure that the organisation facilitate personal growth and development.

On the basis of all the above mentioned information, it is proposed that the following components be incorporated in the mentoring section of the proposed program:

- Identification and appointment of a mentor to each delegate;
- Both mentee and mentor receive training towards the purpose of the mentorship program as well as the process at which it will happen;
- Mentor and mentee meet in a structured and scheduled manner discussing issues dictated by the mentorship process;
- The process of mentorship forms part of the training and experience sections of the program, addressing the same issues and making sure that delegates are exposed to the correct working environments; and
- The mentorship training and feedback towards the program in this regard forms part of the academic block weeks (discussed later).

It is further proposed that, initially, the content of the formal mentorship training for the program be subcontracted to an established organisation dealing with structured mentorship and the process of facilitating that.

5.7 CHAPTER SUMMARY

The aims of this chapter were to quantify the role and importance of structured mentorship, to establish how structured mentorship can be applied, and to identify aspects of a structured mentorship program. In this chapter, it was established that that mentorship could no longer be left to informal processes.

From the study, it became evident that formal mentoring processes and programs should be in place to ensure that successful mentorship does exist. The last section in this chapter provided input from industry regarding aspects which should be included in a structured mentorship program. These aspects will be incorporated into the professional development program, proposed in Chapter 8. The next chapter focuses on *structured work experience* within the environment of professional development.

CHAPTER 6: PROFESSIONAL WORK EXPERIENCE

6.1 INTRODUCTION

To become a registered professional engineer, ECSA requirements state, amongst others, that candidate engineers have to prove experience and competence in the field they practice in (Rules of Conduct for Registered Persons: Engineering Profession Act, 2000). The issue of registering professionally and the process to follow will be covered in Chapter 7. This chapter will however focus on the experience requirements to become a professional engineer working in the public sector.

The aim of this chapter is therefore to identify the components of the “work experience program”, which will form part of the proposed professional development program that will be developed in Chapter 8. This aim will be reached by:

- Analysing the work experience requirements set in place by ECSA and measuring these requirements against the requirements of similar international professional bodies; and
- Consultation with industry role players to analyse generic professional experience requirements, and apply them to the industry in question.

Figure 6.1 presents the graphical presentation of the structure of this study and highlights how the topic of this chapter fits into the rest of the study.

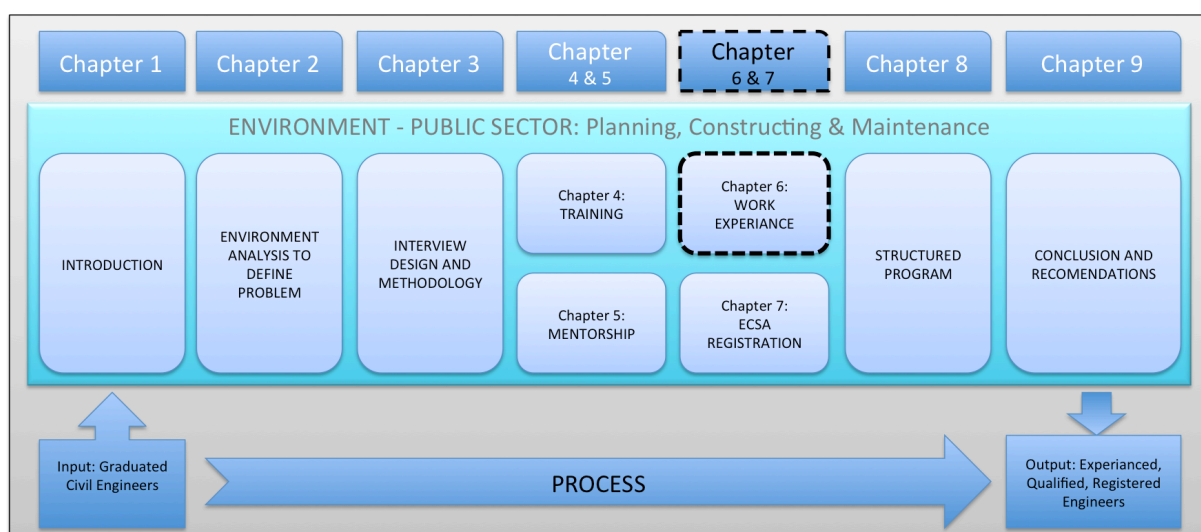


Figure 6.1: Research framework, Chapter 6

6.2 PROFESSIONAL WORK EXPERIENCE REQUIREMENTS

To understand what is required from candidate engineers in terms of work experience for professional registration, a closer look will be taken at the requirements set by professional bodies from South Africa, the United Kingdom and the United States of America.

6.2.1 South Africa – ECSA

To register professionally in South Africa, candidate engineers have to prove the following: qualification, membership to voluntary associations (such as SAICE), registration payment, work experience, mentorship guidance and continuous learning. These requirements are stipulated in the ECSA Policy Statement, R2/1A (2004). According to this document candidate engineers must provide satisfactory *experience* in the application of engineering principles and engineering methods. The document goes further by stating that the practical work experience must include the following elements: problem investigation, problem solution, execution or implementation and responsibility. These elements will now be discussed further.

Problem Investigation: The candidate has to prove that he/she has work experience aimed at the investigation of engineering problems of which engineering judgement is required. The following engineering functions are included in such work:

- Problem identification and formulation;
- Finding and selecting relevant information;
- Evaluating, investigating, testing and research; and
- Analysis of all factors that influence the solution such as relevant engineering and scientific principles.

Problem Solution: The candidate has to prove that he/she has work experience in the full development of the solution towards an identified problem. The document further states that this includes the following:

- A process of synthesis;
- Application of information acquired during problem investigation;
- Using design methods; and
- Through development and communication.

ECSA further states that the list above includes, but is not limited to compiling engineering drawings and plans, executing detailed designs, setting up technical and professional reports, compiling specifications and adjudication of tenders. These tasks should be done by taking into account all practical, economical, social, environmental, quality assurance, safety and regulatory factors.

Execution/Implementation: The candidate has to prove experience in the execution of engineering tasks and projects. According to ECSA, this includes construction, manufacturing, transformation, processing, production, commissioning, testing, certification, quality assurance, operation, maintenance and closure. This should be done by incorporating efficient utilisation of people, materials, machines, equipment, means and funding, and the interaction between these resources.

Responsibility: The candidate engineer has to prove that he/she has sufficient work experience to develop engineering and managerial responsibilities to be able to accept professional responsibility for taking engineering decisions. In developing this, the candidate engineer must be exposed to decisions which include economic considerations, social circumstances, environmental factors, quality assurance, safety and legal matters as well as matters relating to the engineering code of professional conduct.

ECSA goes further by stating that the degree of responsibility of candidate engineers should be clearly stated in the reports that are required by the application process. Candidate engineers should also state their specific involvement in terms of all the above-mentioned elements with each project they had exposure to.

ECSA appoints engineering specific institutes (in this case SAICE) to award different weightings to the elements of the *experience* requirements. These weights depend on requirements as stipulated and required by the various engineering disciplines. See Table 6.1 for the engineering elements required for professional registration of civil engineers, as well as the weight assigned to each by SAICE.

Table 6.1: Engineering Elements Require for Civil Engineer

Source: SAICE Industry Specific Guidelines

1	PROFESSIONAL ENVIRONMENT	Requirement
1.1	General appreciation of engineering procedures applicable to civil engineering	1
1.2	Show a working knowledge of the Engineering Profession Act, 2000, (Act 46 of 2000), its Rules, and the SAICE constitution and by-laws	2
1.3	Relationships between Organisations	2
1.4	Structure of organization where CE is employed	2
1.5	ECSA Policy Document R2/1A	2
	TECHNICAL COMPETENCE	
2	DEVELOPING AN ENGINEERING BRIEF (<i>Understanding the assignment</i>)	
2.1	Accurate identification and definition	3
2.2	Systems Approach	3
2.3	National and International standards, Codes of Practice, Environmental Requirements, etc.	3
3	DESIGNING A SOLUTION	
3.1	Resolution of an engineering brief	3
3.2	Present the solution to a problem	4
3.3	Choice of construction material when deciding on a solution	2
4	DOCUMENTATION	
4.1	This involves acquiring an appreciation that technical specifications are an essential part of a solution to the problem.	3
4.2	Costing of solutions to problems by taking off quantities and doing cost estimates	3
4.3	Safety	3
5	IMPLEMENTATION	
5.1	Know how all parties to a contract exercise their duties and responsibilities	2
5.2	Know the procedure for the issuing and/or receipt, registration and filing work instructions and/or drawings and amendments	3
5.3	Keep an accurate daily record of events and instructions	4
5.4	Read and co-ordinate drawings and/or implement work instructions by being involved on a day-to-day basis in the process.	4
5.5	Participate in the dimensional control and accuracy of the work you are implementing or controlling.	4
5.6	Know the use, performance and cost of equipment plant and/or labour resource.	2
5.7	Plan and programme section of work and be involved in progress monitoring and reporting.	4
5.8	Measure and record or independently check work done for payment purposes.	4
5.9	Have a critical approach to safety matters in the implementation process and to the observance of safe working practices.	3

The requirement levels in Table 5.1 is on a scale of 1 to 4 and quantified as follow:

- 1 = APPRECIATION: The candidate engineer must show a general appreciation of the subject.
- 2 = KNOWLEDGE: The candidate engineer must show sufficient knowledge to carry out the processes listed to meet the objectives.
- 3 = EXPERIENCE: The candidate engineer must show experience in independent performance in the processes listed.
- 4 = CAPABILITY: The candidate engineer must have the capability to independently perform the processes listed.

Candidates are expected to prove sufficient experience in these elements through four processes. The first is by means of a Training/Experience report; the second through a training schedule; the third through a project report, and lastly through the professional review (Guidelines for professional registration, 2003). The application process is set in a way that the experience requirements are outcome based and not linked to experience, or exposure time. Although this is true, SAICE indicates that the minimum time that can be utilised to gain the experience requirements, is three years.

6.2.2 UK – ICE

The engineering industry in the United Kingdom is regulated by the Engineering Council of the United Kingdom (ECUK) (Engineering Council, UK [s.a.], 2012). Approximately 235 000 Engineering Technicians, Information and Communications Technology Technicians, incorporated Engineers and Chartered Engineers are registered professionally through the ECUK. The term Chartered Engineer is used in the UK and equates to the term Professional Engineer in South Africa, which is used for engineering professionals in possession of a B.Eng degree (in South Africa) or a M.Eng degree (in the UK). Both these qualifications require at least four years of formal tertiary education.

Apart from being a regulatory body for the engineering industry, the ECUK sets and maintains the standard for competency and ethics within the engineering industry. To be registered, candidate engineers must go through an assessment of competence. This assessment is stipulated in the UK Standard for Professional Engineering Competence (UK-SPEC) and published by the ECUK. Through this assessment

candidate engineers need to demonstrate professional competency in terms of education, training and professional practice (UK-SPEC, UK [s.a.], 2012).

According to the UK-SPEC, chartered engineers are characterised in terms of their capability to develop solutions to various engineering problems. The document goes further by stating that chartered engineers develop solutions using existing technologies, innovation, creativity and change. Chartered engineers are involved with technical and commercial leadership of which effective interpersonal skills play an important role.

The ECUK stipulates in the UK-SPEC that candidate engineers should possess the following experience elements to register professionally:

- Maintain and extend a sound theoretical approach in enabling the introduction and exploration of new and advancing technology and other relevant developments;
- Engage in the creative and innovative development of engineering technology and continuous improvement systems;
- Identify potential projects and opportunities;
- Conduct appropriate research and undertake design and development of engineering solutions;
- Implement design solutions and evaluate their effectiveness.
- Plan for effective technical and commercial leadership;
- Plan, budget, organise, direct and control tasks, people and resources;
- Lead teams and develop staff to meet changing technical and managerial needs;
- Bring about continuous improvement through quality management;
- Communicate effectively with others in all levels;
- Present and discuss proposals;
- Demonstrate personal and social skills;
- Comply with relevant codes of conduct;
- Manage and apply safe systems of work;
- Undertake engineering activities in a way that contributes to sustainable development; and
- Carry out continuing professional development necessary to maintain and enhance competence in own area of practice.

ECUK goes further by stating that candidate engineers must satisfy the ECUK in three areas before they will be considered for professional registration. Firstly they need to be in possession of an accredited academic qualification. This could be a BEng or a MEng degree from an accredited tertiary education institution. Secondly, the candidates should have at least four years of experience in appropriate engineering work exposure, supervised and mentored throughout the four years. And lastly, the candidate engineers need to demonstrate competence in the areas mentioned above.

6.2.3 USA – ASCE

In the United States of America individuals have to register professionally in the geographical state in which they practice. The term used by the Americans is called “licensed engineer”. Professional engineers can only practise professionally in the state where they are registered.

The professional registration process in America consists of four steps: Firstly candidates engineers need to have a four year engineering degree from an university accredited by the Accreditation Board of Engineering and Technology. Secondly the candidates have to write a standard examination called the *Fundamentals of Engineering*. This examination tests the candidate’s understanding of the basic engineering principles. By passing these two steps, the candidate engineer qualifies to be an Engineer-In-Training (EIT) (General Information & Policies USA [s.a.], 2012).

After being registered as an EIT, the candidate engineer has to obtain at least four years of work experience. After obtaining enough relevant work experience in the field of practice, the candidate has to pass a written examination called the Principles and Practice in Engineering. This will test the candidate’s knowledge and skills in the applicable discipline of engineering, in this case civil engineering. After passing this final examination, the candidate engineer can register as a professional engineer and practise accordingly in the registered state.

As a result of the examination system, candidate engineers do not need to prove experience in specific elements, such as in South Africa and the UK. The only indication to show if candidate engineers are eligible for sufficient experience is years of practise. The years of experience vary from state to state, and could be between

four and six years. Although this is the case, it was found in most states the candidate engineer has to include the following with their application to write the Principles and Practice in Engineering written examination (License requirements, professional engineering, USA [s.a.], 2012):

- A demonstration of the application of the engineering principles in the practical solution of engineering problems;
- A demonstration of the knowledge of engineering mathematics, physical and applied science, properties of materials, and the fundamental principles of engineering designs;
- A demonstration of a broad scope of engineering experience;
- A demonstration of a mature engineering knowledge and judgement; and
- A demonstration of experience on engineering projects that required the use of codes and practices used within the United States of America.

6.2.4 Comparison and key aspects

In terms of the registration requirements, all three the above-mentioned organisations have similar requirements. These requirements are based on qualification, experience and training, or continuous learning. ECSA places a strong emphasis on mentorship and the process of proving that the candidate was exposed to relevant and continuous mentorship. Mentorship is not mentioned prominently in the other two organisations. The ICE on the other hand tends to focus on technology and the use thereof to solve engineering problems. None of the other two mention technology in their requirements for registration.

In terms of the experience needed to register professionally, all three organisations have the following in common:

- Problem identification or investigation;
- Problem solving;
- Execution or implementation of a solution; and
- Responsibility, or leadership.

Although the three organisations have similar requirements for registration, the methods to prove experience differ significantly. South Africa and the UK have similar methods in which candidate engineers have to prove competency by means of a

formal application process. This process includes various documents and reports that have to be approved by line managers and proved via affidavits.

The USA, on the other hand, expects of candidates to prove experience by spending a minimum of time in the industry and by means of writing two examinations. According to this method, candidates are assumed to be ready for professional registration, once they have a specific number of years exposure in the industry and pass both the required examinations. The danger of a program where the deliverables are measured by means of an examination is that candidates might have insufficient work experience exposure, but might still have the ability to pass the examinations. This implies that candidate engineers might become registered professionally, but with insufficient work experience and exposure.

6.3 INDUSTRY INPUT ON EXPERIENCE REQUIREMENTS

Chapter 3 provided information on the feedback received from interviews with industry role players regarding various concepts and questions relating to this study. In two of the questions asked during the interviews, the interviewees were asked to supply information regarding work experience requirements within the public sector. From the feedback the following list of experience competencies were identified (Section 3.4.3):

- Engineering design experience;
- Project Management;
- Contract Management;
- Financial Management;
- Experience in people management; and
- Experience in community liaison and public participation.

The interviews further showed that prior private sector experience is just as important for engineers working in the public sector. On this basis, it was agreed by the interviewees that newly graduated engineers need a minimum of one year practical experience in both the engineering contractors' and consultants' environments. This will assist with the establishment of the basic engineering skills needed in any engineering environment.

It is clear from the sections above that the required experience elements for a professional development program could be categorised into two groups. The first being work-experience related, to establish the foundations of traditional engineering activities applicable to any civil engineering working environment. The second being a more focused work-experience applicable to the public sector environment. It was further mentioned, from the interviews, that a minimum of two years is needed in both these experience groups or phases.

6.4 PROPOSED ELEMENTS OF EXPERIENCE REQUIREMENTS FOR PROGRAM

Sections 6.2 identified aspects of work experience applied to the professional development and professional registration for engineers in general. In Section 6.3 industry role player were asked to provide elements for work experience applicable to engineers working in the public sector. These two aspects (see Table 6.2) will now be combined to supply the elements for the work experience program which will form part of the proposed professional development program developed in Chapter 8.

Table 6.2: Identified elements of experience requirements

ELEMENTS IDENTIFIED	
Professional Bodies ECSA, ICE, ASCE	Industry role players
<i>Professional registration environment for engineers in general</i>	<i>Environment for engineers working in the public sector</i>
Problem identification or investigation	Engineering design experience
Problem solving	Project Management
Execution or implementation of a solution	Contract Management
Responsibility, or leadership	Financial Management
	Experience in people management
	Experience in community liaison and public participation
	One year experience in the environment of engineering contractors
	One year experience in the environment of engineering consultants
	Experience in basic traditional civil engineering activities
	Experience in activities used directly in the public sector environment

On the basis of this, it is proposed that candidates taking part in the proposed professional development program be required to take part in an “experience-program” structured as follows:

Foundational experience in the engineering contractor environment – 1 year

During this time it will be expected of the candidate engineers to gain maximum exposure to the basic activities of an engineer working for contractors. This will include site activities, as well as being involved in project procurement other related activities.

Foundational experience in the engineering design environment – 1 year

During this time it will be expected of the candidate engineers to gain maximum exposure to the basic activities of an engineer working for engineering consultants. This will include taking part in activities relating to the traditional technical areas of civil engineering design and procurement in the areas of water, waste-water, transport, structures, etc.

Focussed experience to develop target skills – 2 years

During this time it will be expected of the candidate engineers to gain exposure to the advance skills needed to work in the public sector, i.e. design management, project management, contract management, financial management, people management and public participation skills (identify earlier). Ideally engineers taking part in this phase of the “experience-program” will start off in the design office during the planning and design phase of a project, and move towards the contractor environment during the execution and implementation phase of the project. Taking in consideration durations of engineering projects, the minimum time spent in this phase is two years.

It is important that engineers taking part in this phase of the “experience-program” be placed in an environment which promotes involvement of the areas shown earlier. It is for this reason that regular mentor-mentee meetings will take place as well as coordination with the private sector firms taking part in the professional development program. For further clarity, the structure of the “experience-program” is shown in Figure 6.2.

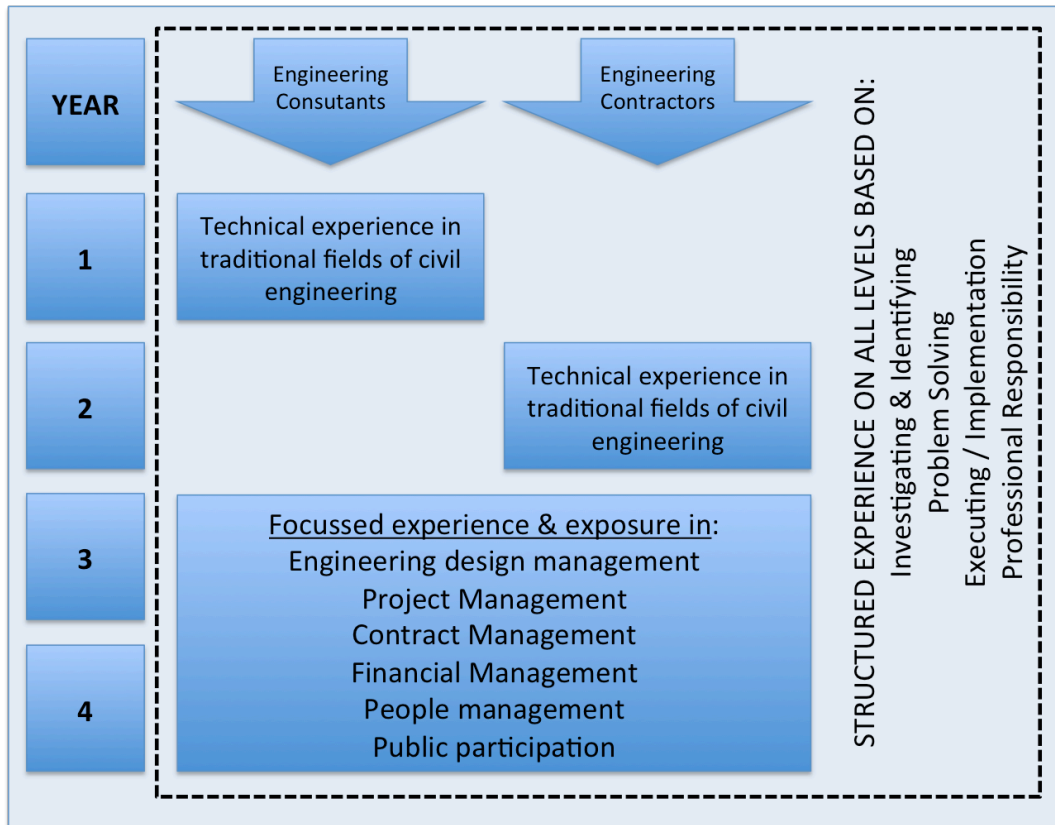


Figure 6.2: Proposed elements for experience program

It was mentioned earlier that one of the goals of the proposed professional development program is to deliver professionally registered engineers. For this reason it is significantly important that the required experience elements (problem identification/investigation, problem solving, implementation and leadership) of professional registration be incorporated throughout the “experience program”. These elements should therefore be formally included in the structure for the professional development program.

It is furthermore important to note that the *training program* of the proposed professional development program, discussed and developed in Chapter 4, be executed inline with the *experience program*, discussed in this chapter. These two programs should thus be executed in a way in which the learning experience and assignments of the training program be applied directly to the work environment, and vice versa.

6.5 CHAPTER SUMMARY

The aim of this chapter is to identify the components of the “experience program” which will ultimately form part of the proposed professional development program. It was established that experience should be gained in two phases.

During the first phase candidate engineers should gain exposure to the fundamental aspects and activities of civil engineering. This includes design and procurement activities. During the second phase of the “experience program”, candidates will gain exposure to gain more focussed experience in the competencies relating to engineers working in the public sector. It was further established that the “experience program” be based on the following four elements of professional registration requirements, namely:

- problem identification or investigation;
- problem solving;
- execution or implementation of a solution; and
- responsibility, or leadership.

The next chapter focuses on the last main component of the proposed professional development program, namely professional registration.

CHAPTER 7: PROFESSIONAL REGISTRATION

It was mentioned earlier in this document that the identified components for the proposed professional development program are *training, mentorship* and *work experience*. It was further mentioned that to be able to address the research problem, the program needs to deliver professional engineers. Consequently it is one of the aims of the proposed professional development program to incorporate the requirements of professional registration and to include the professional registration application in the program.

To achieve this, it is important to understand the full extent of the requirements and procedures of ECSA for professional registration. The aims of this chapter are therefore to capture the requirements and procedures a candidate has to adhere to, to become professionally registered, and to identify the components of the process of professional registration in South Africa. These components will therefore be incorporated into the proposed professional development program developed in Chapter 8.

Figure 7.1 presents the graphical presentation of the structure of this study and highlights how the topic of this chapter fits into the rest of the study.

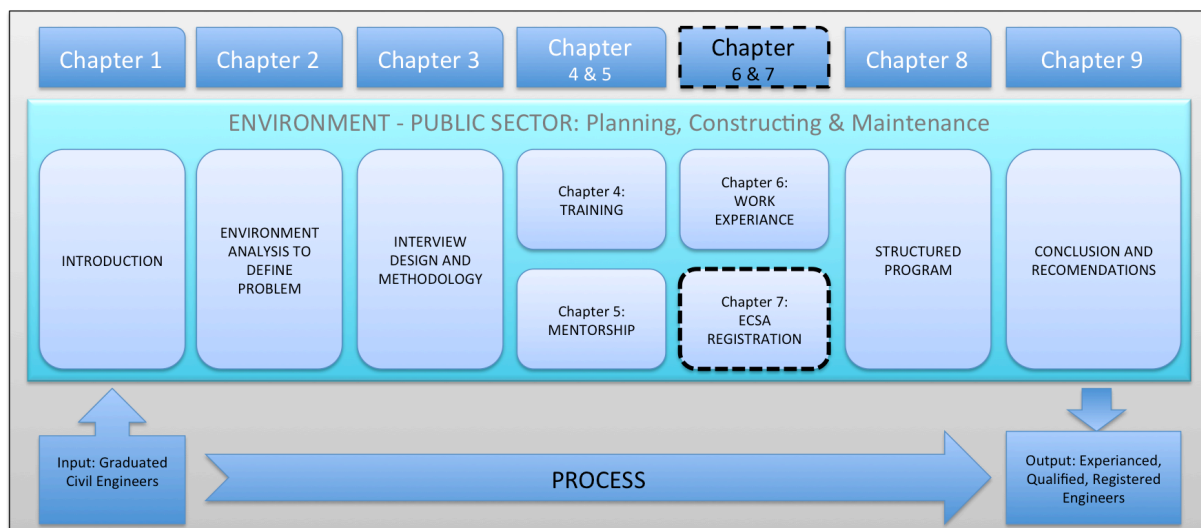


Figure 7.1: Research framework, Chapter 7

7.1 INTRODUCTION TOWARDS PROFESSIONAL REGISTRATION

In South Africa the engineering profession is regulated by the Engineering Profession Act of 2000 (Act No. 46 of 2000). According to the act, the Engineering Council of South Africa (ECSA) is a statutory body established to serve as the custodian of the engineering industry within South Africa. According to ECSA's website (ECSA: Statutory functions [s.a.], 2012), its statutory functions are as follow:

- Setting academic and professional development standards;
- Auditing academic institutions such as universities and technical universities;
- Accrediting tertiary institutions with accreditation towards offering engineering courses;
- Prescribing Continuing Professional Development standards;
- Prescribing and enforcing the engineering Code of Conduct;
- Identifying engineering reserved work that should be carried out by registered professional engineers;
- Advising the Council for the Built Environment (CBE) and the Minister of Public Works on matter relating to the engineering profession;
- Recognition of engineering profession associations; and
- Publication of engineering fee structures for consulting work within the engineering environment.

The Engineering Profession of South Africa Act, Section 18 (1) (Act No. 114 of 1990), empowers ECSA to register engineers professionally through two categories, namely Professionals and Candidates (ECSA: Registration introduction [s.a.], 2012).

According to ECSA, registering individuals bring benefits on four levels, namely benefits for individual, employers benefits, benefits towards the industry and benefits for the country. These benefits are further elaborated on as follows (ECSA: Why register [s.a.], 2012):

Individual benefits from professional registration:

- Peer recognition of qualification and experience;
- Public confidence in professional competence;
- Eligibility to register with various voluntary discipline specific associations;
- International recognition as a professional engineer;

- Individual marketability in the employment market;
- Exclusive use of reserved names; and
- Statutory empowerment through reserved work for engineering professionals.

Employer's benefits:

- Confidence in the professionalism of staff;
- Recourse in improper conduct;
- Marketability of the organisation; and
- Compliance with statutory requirement.

Benefits towards the engineering profession:

- Recognition amongst other professions; and
- Public recognition of competence and adherence to minimum standards.

Benefits towards the country:

- Safety, health and interest of society protected;
- Preservation of professional standards; and
- International recognition.

(ECSA: Why register [s.a.], 2012)

7.2 PROFESSIONAL REGISTRATION PROCESS

ECSA defines a professional engineer as follow:

“Professional Engineers are concerned primarily with the progress of technology through innovation, creativity and change. Their work involves the application of a significant range of fundamental principles, enabling them to develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, and pioneer new engineering services and management methods. They may be involved with the management and direction of high risk and resource intensive projects. They undertake and lead varied work that is essentially intellectual in nature, requiring discretion and judgement. Such work has its base in proficiencies and competencies derived from and extended by experience and research. It is concerned with cost

effective, timely, reliable, safe, aesthetically pleasing and environmentally sustainable outcomes.” (ECSA Policy statement R2/1A: 2004)

According to ECSA (ECSA Registration: Registration Process [s.a.], 2012), any person who satisfies the requirements set out by the *Policy Statement R2/1A* and the *Discipline Specific Guidelines* can register as a professional engineer.

7.2.1 Professional registration requirements

It was mentioned in Chapter 6 that ECSA requirements to register professionally are based on the following four elements:

- Problem identification or investigation;
- Problem solving;
- Execution or implementation of a solution; and
- Responsibility, or leadership.

To quantify these elements and to assure that these elements are being measured specific to each discipline of engineering, ECSA appoints engineering specific institutes. In the case for civil engineers, SAICE publish a document, “*SAICE Industry Specific Guidelines*”, in which the requirements are specified. The document goes further by stating that civil engineers have to show knowledge and competency within the professional and technical environment of civil engineering. Within the technical environment it is expected of candidate engineers to prove competency in developing an engineering brief, designing a solution, documentation and implementation. SAICE goes further by stipulating sub-competencies within these areas, expecting a minimum required level of competency for each (refer to Table 6.1 in Chapter 6).

7.2.2 Application process

Once the above mentioned requirements are met, the candidate can commence the formal application process which consists of firstly submitting a written application, and after initial approval, attending a professional review.

7.2.2.1 Written application

The written application includes the following:

Administrative information: This includes information on the applicant such as personal details, proof of qualification, proof of membership of institutes, affidavits, etc. (Form A2.2).

Summary of training periods: This includes a summary of all training/experience done by the candidate and contains information on the number of weeks within the period, employer with whom the candidate received the training/experience, position held by the candidate during that period and the type of work done during that period.

Training schedule: This includes a detailed form stipulating the required attributes and competencies as required by ECSA and signed off on each by a registered mentor. (From AC7.1 & 7.2)

Interview record: This is a form showing all interviews done with the mentor, as well as topics discussed and dates completed. (AC8)

Training/Experience reports: This is a detailed form, which must be filled in for each period of training/experience the candidate completes. For each period, the candidate must supply information regarding the time period, the employer, the project (or projects) he was involved with, his/her role in the projects completed, responsibilities for each period, special experience obtained through each period and training courses complete during each period.

Project report: This is a 4000 word technical report on a project that was completed by the applicant. The report must supply technical detail on the project, as well as the applicant's roles and responsibilities during the project, the lessons learned and the significance of the project on the applicant towards professional registration.

Record of continuous learning: This includes a proof of all the continuing learning courses the applicant attendant during his/or her career which had a significant input towards the professional application.

Referee reports: Two referee reports from professional engineers who are able to form a judgement on the applicant's status and ability to be registered professionally.

7.2.2.2 Professional review

Once the application has been approved by ECSA (with the assistance of SAICE), the candidate is invited to a professional review. The professional review is in the

form of an interview with senior professional engineers which is performed to assess the quality of the applicant's attributes and level of competence in registering professionally.

According to ECSA, the professional review is compiled to give applicants a chance to demonstrate the following competencies (ECSA Discipline specific guidelines for civil engineers: 6):

- *“they have acquired an understanding of the professional environment in which they work, including moral and ethical issues”;*
- *“they have developed the ability to exercise engineering judgement, to make responsible decisions, to communicate lucidly and accurately, to identify and find solutions to problems and to implement these solutions”;* and that
- *“they have achieved an acceptable level of technical knowledge and understanding in defined training objectives within the discipline of civil engineering.”*

During the professional review it is expected of applicants to complete two essays on topics from a list that is published through the year by SAICE. This poses as a further mechanism to prove to the counsel that the applicant has sufficient knowledge on the engineering industry and can communicate professionally, which further counts towards professional registration.

Once the applicant has completed all these components of the application process successfully, the counsel will communicate a successful application. The applicant will become a professional engineer with immediate effect (ECSA Discipline specific guidelines for civil engineers: 8).

For candidate engineers to pass the professional review, he/she needs to have the following attributes:

- Communicate effectively;
- Has a deeper knowledge of the engineering environment and be able to think quickly and keep a discussion active around this environment;
- Have the capability to write effectively and professionally, and formulate a discussion around a topic given to them; and
- Be presentable and professional.

These attributes will be incorporated throughout all the formal processes of the program. Figure 7.2 graphically shows the process of registering professionally, as administrated by ECSA and SAICE.

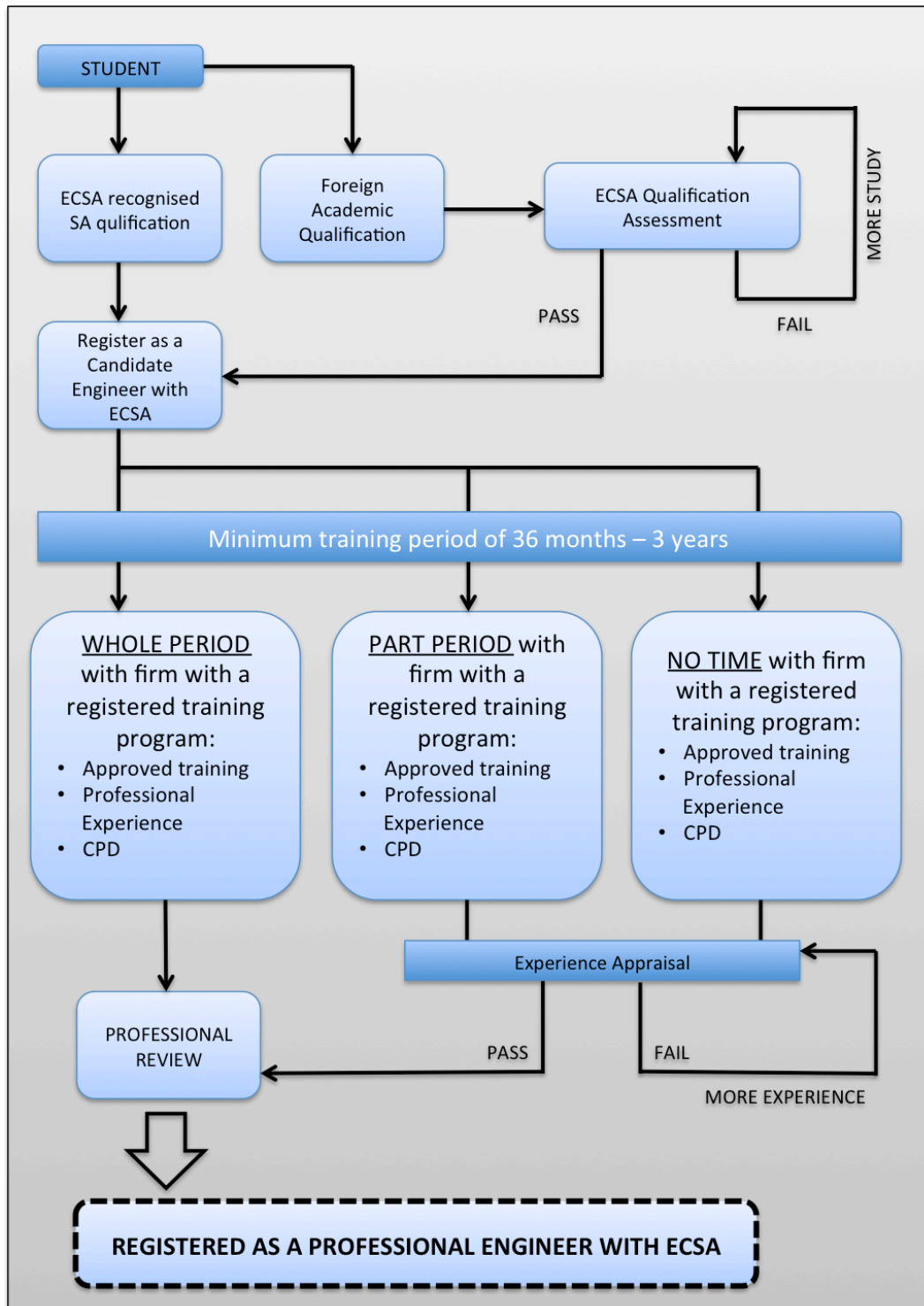


Figure 7.2: ECSA registration process

Source: Guidelines for professional registration SAICE, 2003

7.3 PROPOSED INTEGRATION WITH PROFESSIONAL DEVELOPMENT PROGRAM

As mentioned throughout this document, one of the key success factors of the proposed program is the integration of the various “programs” within the larger program. The integration of the *professional registration program* of the program is therefore no exception. Although the goal of the program is to make sure that the requirements for profession registration are met, the focus is on developing well-rounded profession engineers (or persons). This implies that throughout the program attention is given towards constant and continuous build towards the requirements of ECSA for registration, but also building on the attributes needed to act as a professional person. The following key concepts are therefore identified to be incorporated into the professional registration process within the proposed professional development program:

- Professional registration are treated as one of the formal processes within the proposed program;
- Delegates are to continuously build towards the administrative and technical requirements for professional registration;
- The requirements of professional registration are to be built into the *training-, experience- and mentorship programs* of the larger program;
- Dedicated opportunity should be provided in the proposed program to assist delegates to share progression and challenges in the process of building towards professional development; and
- The professional development process will start the moment delegates enter, or enrol, into the proposed professional development process.

Table 7.1 shows how the registration requirements, mentioned in Section 7.2.1, will be addressed by the professional development program developed in Chapter 8.

Table 7.1: Addressing ECSA requirements

ECSA REQUIREMENTS	PROGRAM EXPOSURE
Problem identification or investigation	The environment of consulting engineers will expose the candidate engineers to the requirements of clients. Candidate engineers will therefore have the chance to do site investigations, procure arrange sub consultants and set up structural status reports.
Problem solving	Problem solving is part of the core elements of engineering. The program will expose candidate engineers to the working environments of consulting engineering (solving clients problems by means of engineering designs) and construction engineering (solving construction related problems).
Execution or implementation of a solution	As resident engineers within the consulting engineering environment, candidate engineers will have exposure the execution, implementation and monitoring processes of engineering. Exposure to the construction environment will expose candidate engineers to the processes end activities the execution and implementation within the environment of constructing basic service infrastructure.
Responsibility, or leadership	Responsibility and leadership will be cultivated throughout the program by exposing candidate engineers to environments and situations whereby leadership and responsibility are required and tested. Although the first part of the program will be utilise to expose candidate engineers to the fundamental and technical aspects of engineering, the latter part of the program would be more focused on developing leadership and responsibility skills.

These concepts will be integrated into the proposed program developed in the next chapter. The *registration program* is developed and discussed further in Section 8.3.3.

7.4 CHAPTER SUMMARY

The aim of this chapter is to capture the requirements and procedures to register as a professional engineer within South Africa. It was found that apart from the experience and academic requirements, various administrative tasks are required from professional engineering candidates. These requirements will be included in the professional development program, which will be presented in the next chapter.

CHAPTER 8: PROPOSED PROGRAM

Chapter 1 clarified that South Africa is currently facing two major challenges, the first relates to a national skills need within the engineering industry, and the second to the state of basic service infrastructure within South Africa. It was further mentioned that a possible solution towards these challenges could include the implementation of a professional development program to prepare engineers for the environment of infrastructure development within the public sector. The various factors discussed throughout this document form the building blocks from which the proposed professional development program will be developed. Figure 8.1 presents the graphical presentation of the structure of this study and highlights how the topic of this chapter fits into the rest of the study.

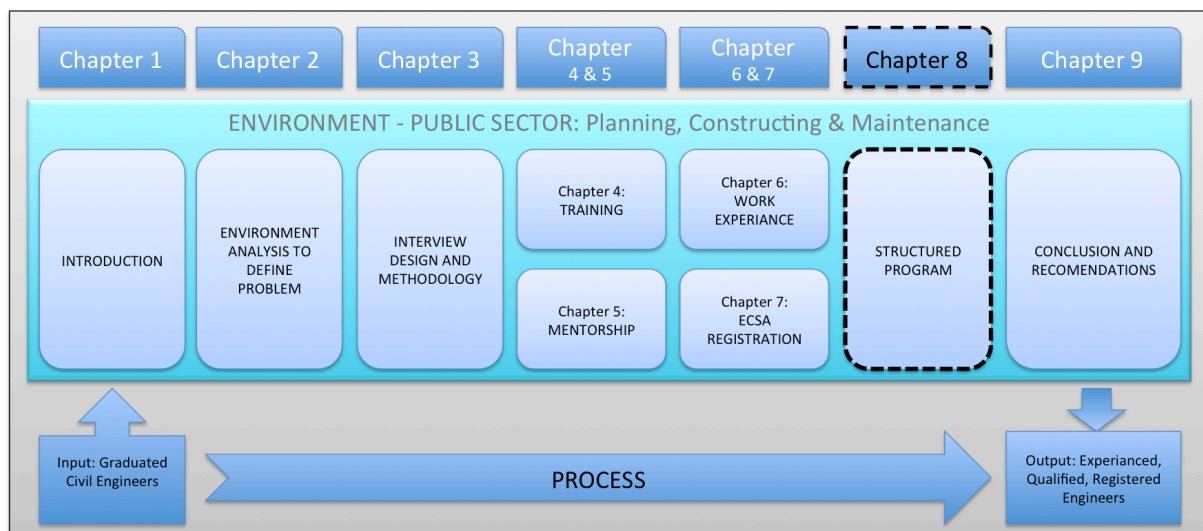


Figure 8.1: Research framework, Chapter 8

The aim of this chapter is to combine the identified factors and concepts mentioned throughout this document into a formal structured program. To assist with this process, the chapter is divided into five sections, namely:

- The purpose of the program;
- The concept of the program;
- The program components;
- The role players involved in the program; and
- The program flow.

8.1 PURPOSE OR ETHOS OF THE PROGRAM

According to Simpson & Weiner (1997), the word *Ethos*, can be defined as follows:

“The characteristic spirit of a culture, era, or community as manifested in its attitudes and aspirations.”

Within an organisation, the ethos refer to the underlying believes and reason for existence, or being in business. The ethos of the proposed program is based on two aspects, namely:

- To ensure basic needs and human rights through national service delivery and basic needs infrastructure; and
- To facilitate positive economic and social development in South Africa.

Based on this ethos, the goal for the proposed professional development program is to deliver professionally registered, experienced engineers, to function in public sector organisations responsible for the development and maintenance of basic service infrastructure. If this goal is reached the strategic outcome will relate to the ethos of the program, which will lead to improved national service delivery through well-constructed and well-managed basic service infrastructure. This will happen by supplying public sector organisations with engineering professionals able to work successfully within this environment.

The program will supply the following fundamental offerings to delegates taking part:

- Relevant and focussed work experience directed towards the public sector environment;
- An environment facilitating preparation for professional registration;
- An academic platform relevant to engineering professionals within the public sector; and
- A postgraduate diploma in public sector engineering (further formal tertiary qualification).

8.2 THE CONCEPT

The concept of the proposed program is based on three aspects, namely:

- The components (discussed in Chapters 4 – 7), being *Experience*, *Training*, *Mentorship* and *Professional registration*;
- The role players; and
- The program schedule.

These aspects are combined to develop the full extent of the program. Each component is discussed further in the following sections. The concept of the proposed program and how it is divided into the above mentioned three aspects, is graphically represented in Figure 8.2. Before the program components are discussed in detail a brief explanation of the concept is provided.

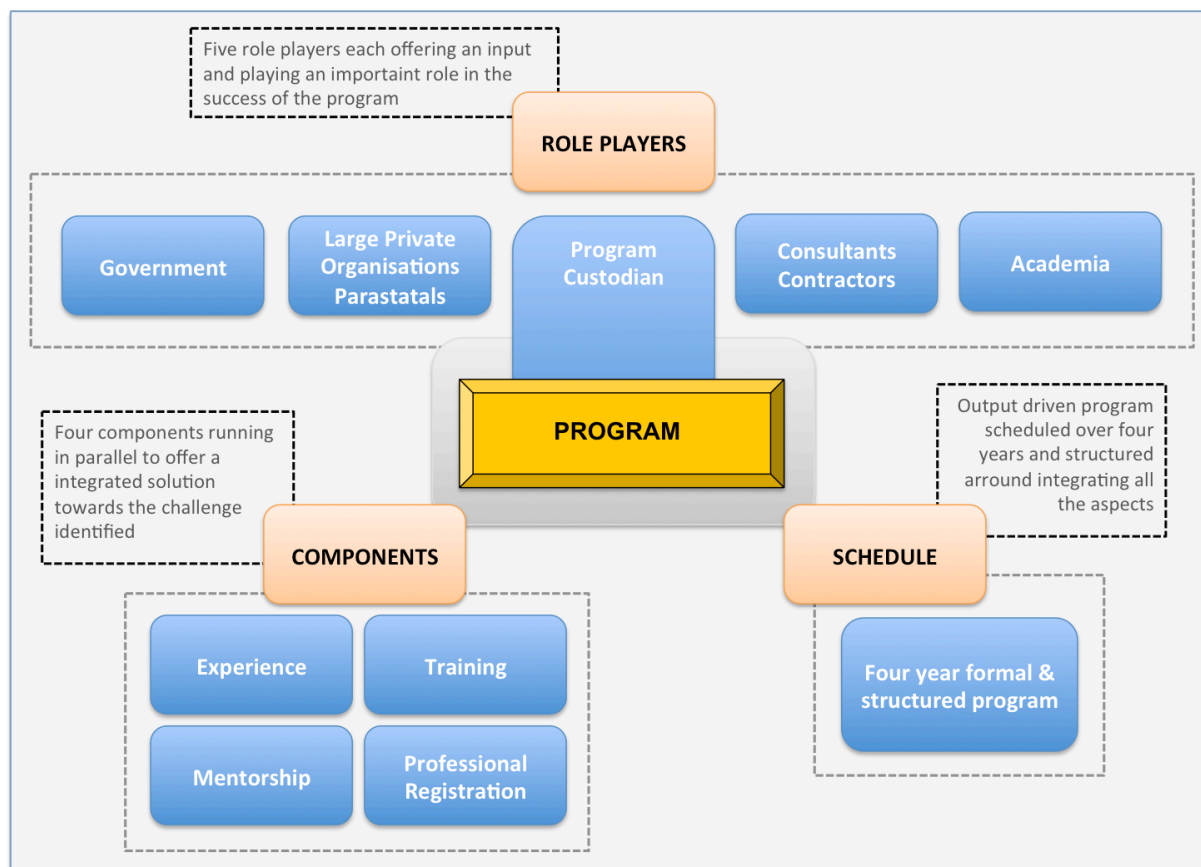


Figure 8.2: Graphical representation of the program components

It was mentioned in Chapter 6 that for delegates to gain sufficient work experience and exposure to all the relevant aspects required for the program, at least four years exposure to the industry is needed (refer to Figure 6.2). Based on this information it

is proposed that the full extent of the program will be offered over a period of four years.

The program will require delegates to be formally entered into the program for a duration of four years. After enrolment, delegates will be placed in full-time employment by either engineering consultants or contractors. The program will automatically include delegates in a formally structured mentoring program as well as a formal academic program. These three processes (*work-experience*, *mentoring* and *academic*) will run in parallel throughout the duration of the program. The three processes will furthermore be managed and integrated, to systematically build towards the deliverables for professional registration. The process of preparing delegates for professional registration therefore forms part of one of the core, and formal, processes of the program.

8.3 PROGRAM COMPONENTS

This section deals with the four components of the program, i.e. *work experience*, *training*, *mentorship* and *professional registration*. Figure 8.3 is an extract from Figure 8.2, which graphically shows the three main aspects of the proposed professional development program.

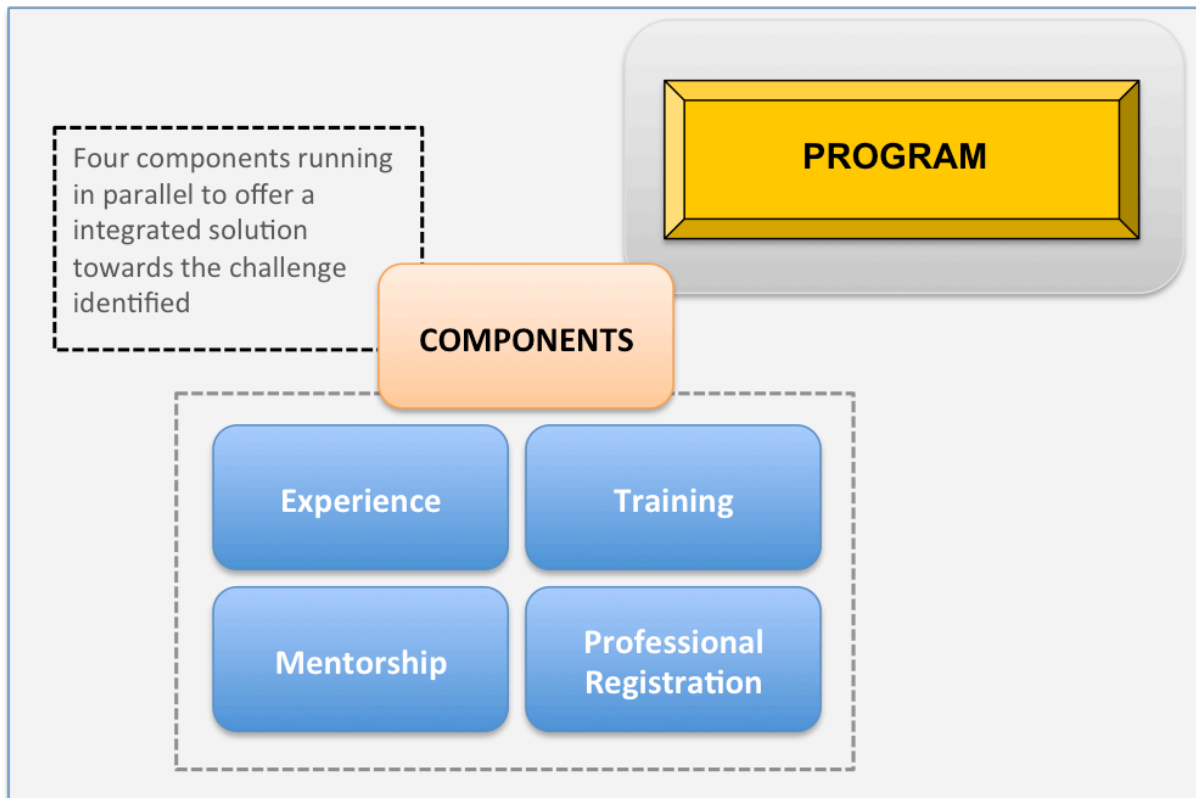


Figure 8.3: Program Components

8.3.1 Structured work experience

It was mentioned throughout this document that work experience forms a key aspect of professional development and should therefore be included in a professional development program. In Chapter 6 the concept of *work experience* within a professional development program was explored and discussed. From existing literature, and feedback received from industry role players, Chapter 3 and 6, following mechanisms were identified to offer structured work experience within the proposed program:

- Engineers must be professionally exposed to private sector industry environments of engineering contractors and consultants;
- Engineers preparing to work in the public sector should have at least two years of structured work experience in the traditional technical fields of engineering; and
- After gaining sufficient fundamental experience in the traditional technical engineering environments, experience is needed in the management of

engineering processes as well as the environment of general management. At least two years of exposure in this environment is required.

The work experience component will therefore be structured around two phases, namely:

- Phase 1: Technical fundamentals of engineering; and
- Phase 2: Management focussed experience.

These two factors will now be discussed in further detail.

Phase 1: During the first stage of this phase delegates will be placed in full time employment of an engineering consultant's firm. During this period the delegate will be exposed to engineering challenges from the perspective of design engineers (Phase 1.1). Delegates will have to spend one year full time in the employment of engineering consultants for this purpose.

During the second stage of this phase (Phase 1.2) the delegate will be placed in the employment of engineering contractors working on infrastructure development projects. The duration of this stage will be one year. The focus in this stage will be on the expectation that the delegates gain maximum exposure to the fundamentals of the execution of engineering projects. This is in line with ECSA's expectations towards professional development, as discussed in Chapter 7.

Throughout this phase, focus will be placed on gaining maximum structured exposure to the technical fundamentals of engineering. The full extent of the first phase of the program will therefore be two years.

Phase 2: The duration of the second phase will be two years. The focus of this stage will be placed on gaining maximum experience in two fields of management. The first is the management of engineering processes such as engineering design management, project management and engineering contract management. The second is to gain exposure to general business management challenges within the engineering environment. During this phase, delegates will again be expected to rotate between at least a year on site and a year in the design office. This time the focus will be placed on experience in the two aspects of management mentioned earlier and not purely on the fundamentals of engineering, as in the previous phase.

It is important to note that the process of gaining work experience will be managed through a central program management system. This experience will be outcome driven and integrated with the other two systems, namely: *mentorship* and *training*. Throughout the *work experience* section of the program, delegates will be expected to have regular meetings and discussions with formally assigned mentors. It will furthermore be expected of delegates to formally log all experience and mentorship sessions in their master file (or portfolio of evidence). This will be discussed further in Section 8.3.3.

In the process of gaining work experience, delegates will be guided to focus on the four aspects of professional work experience as stipulated by ECSA (and captured in Chapters 6 and 7), namely:

- Problem identification and investigation;
- Problem solving;
- Project execution; and
- Professional attitude.

The work experience will be formally captured; this will lead towards the requirements towards professional registration at the end of the final year of the program (Author's analysis. 2013).

The structure of the *work experience* section within the program is graphically shown in Figure 8.4.

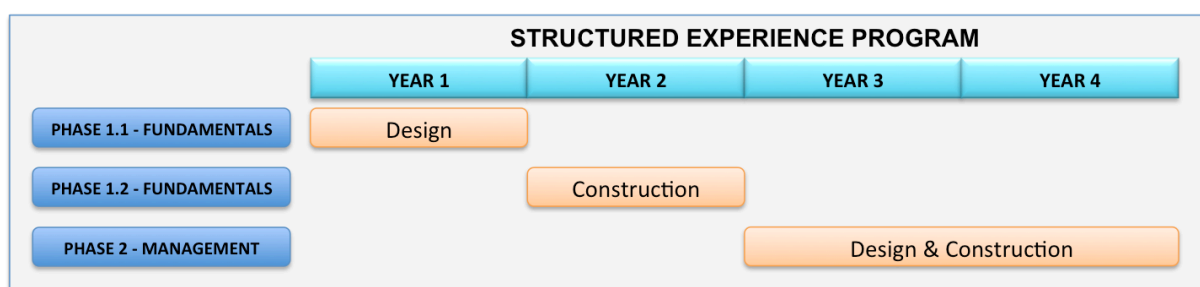


Figure 8.4: Graphical representation of the work experience program

8.3.2 Structured training

The second vital part of the proposed profession development program is *training*. The aspect of training, and the role it plays within professional development

programs, were discussed in Chapter 4. From the input of existing suppliers of CPD programmes, both nationally and internationally, existing literature and further input from various industry role players it was identified that professional training for public sector engineering professionals should be offered within three categories (Chapter 4) namely:

- Training in technical skills;
- Training in management knowledge areas; and
- Training in public sector specific knowledge areas.

Chapter 4 of this document went further by proposing 20 course subjects which should be offered to prepare public sector engineering professionals. These course subjects are listed again in Table 8.1.

Table 8.1: Proposed course subjects

	TECHNICAL	MANAGEMENT	MUNICIPAL
1	Technical writing and Professional Communication	Project Management	Government Procurement Systems Management
2	Urban engineering	Engineering Contracts Management	Municipal Institutional Management and Bylaws
3	Introduction to city planning	Design Management	Municipal Finance Management
4	Courses in civil, water, waste-water, transport and structures engineering	Infrastructure Management and Maintenance	Community Liaison and Public Communication
5		General Financial Management	
6		Capital Spending Management	
7		Resource and Supply Management	
8		Human Resource Management	
9		Occupational health and safety	
10		Conflict management	
11		Professional ethics	
12		Leadership & Leadership development	

It is proposed that these course subjects be offered to delegates over the full extent of the program, i.e. four years. It is further proposed that the academic offering be structured by incorporating an academic block-week system. This requires that delegates spend two weeks per year (one week every six months) in a formal classroom environment.

During the block-week sessions delegates are exposed to lectures as well as getting the opportunity to work in groups, work on group presentations, writing tests and writing examinations. Between academic block-weeks it is expected of delegates to work through study material, complete assignments and study for tests.

Academic content will be outcome based and integrated with the *mentoring* and *work experience* components of the program. This implies that the *training* program runs in parallel with the *experience* component of the program. This opens up the opportunity for assignments to be applied to real life working environments projects on which delegates are involved in.

As noted in Table 8.1, the course subjects offered by the program are listed under three categories, namely technical-, managerial- and public sector specific course subjects. The academic offering represented in the first column (Table 8.1) represents existing knowledge areas from courses already available in the CPD environment. It is proposed that existing training providers are utilised to offer these courses as part of the *training* program. It is furthermore proposed that the courses from the second and third column (Table 8.1) be specifically developed for the proposed program. The reason for this is to ensure that the courses offered, not only cover the technical information of the knowledge area, but to ensure that delegates know how to apply this knowledge to the environment of infrastructure development within the public sector. All course subjects completed by the delegates will be ECSA certified CPD courses which will form part of the professional registration requirements.

It is furthermore proposed that the academic offering of the program be formally accredited to offer, in partnership with a tertiary academic institution, a post graduation diploma in public sector engineering. Delegates successfully completing this program will therefore acquire a formal academic qualification.

8.3.2.1 Post graduation diploma proposal

It is a national requirement that a post graduation diploma consist of 120 SAQA credits (SAQA Advance diploma [s.a.], 2013). It is therefore proposed that the list of course topics, identified in Chapter 4, be formalised into 20 academic courses offerings, 6 SAQA credits each. These 20 academic courses will be distributed over the course of the four years, seven academic semesters, in which the proposed

professional development program will be delivered. The proposed structure for the *training* section within the program is graphically showed in Figure 8.5.

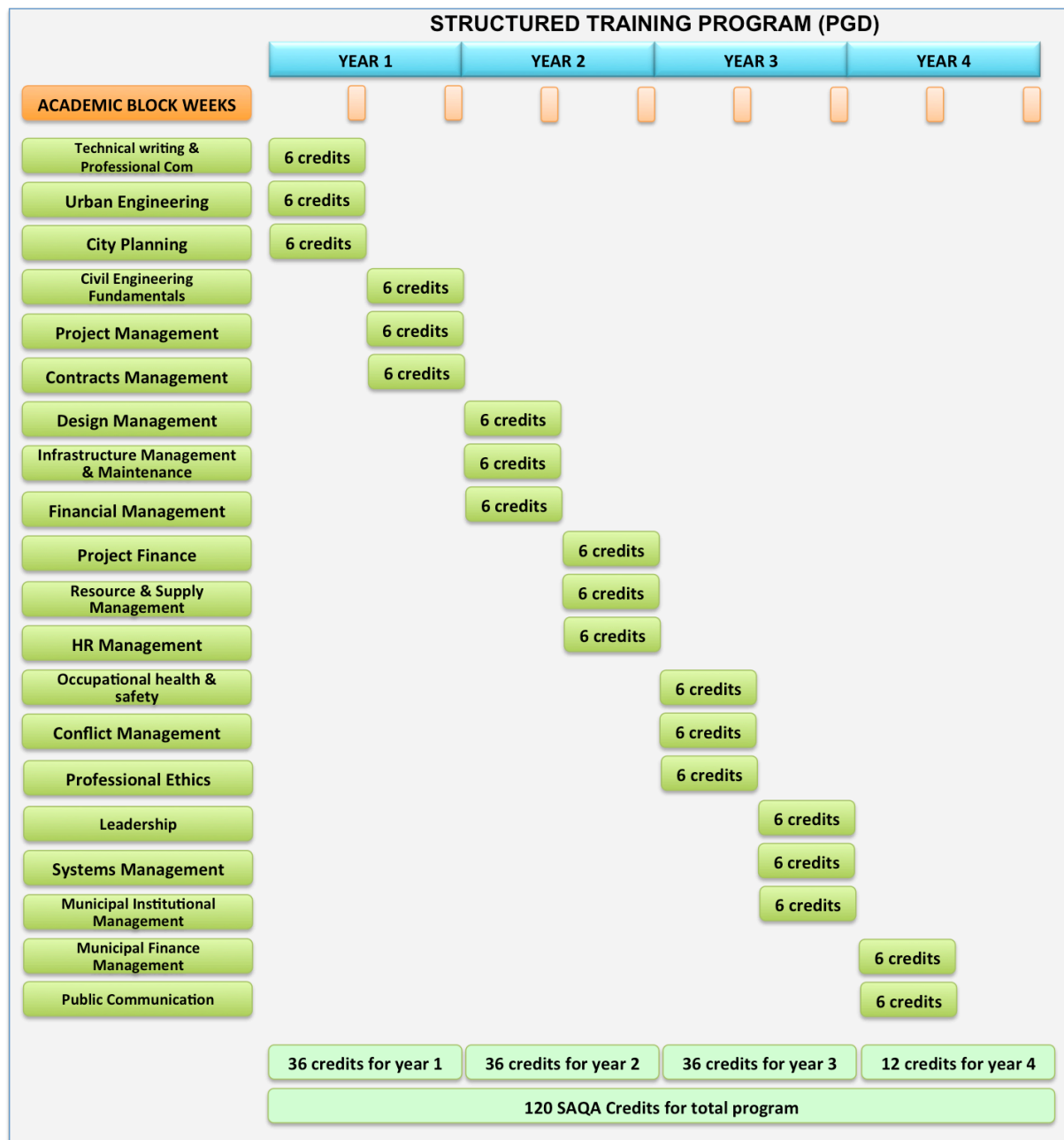


Figure 8.5: Graphical representation of the training program

8.3.3 Structured mentorship

The third component of the proposed professional development program entails professional and structured *mentorship*. Chapter 5 highlighted the importance of structured mentorship as well as proposed possible components of a successful structured mentorship process. Chapter 5 went further by proposing that the following mentorship aspects form part of the *mentorship* program:

- The mentee-mentor relationship should be formally introduced to both parties, and both parties should enter into a formal agreement;
- The mentorship program should be structured and managed from a central point;
- Guidelines towards the process and deliverables of the program must be supplied to the partnership;
- Regular formal meetings should be held between the mentee and mentor to discuss progression, concerns and other related topics; and
- The mentor should preferably not be the mentee's direct line manager, but rather someone with influence and technical experience in the field of work.

It is on the basis of these aspects, compiled in Chapter 5, that the researcher proposes the following structure for the mentoring program within the proposed professional development program:

Mentors: Mentors are sourced from organisations offering employment to delegates. These mentors will be receiving formal training in the form of a one-day mentor's master class, equipping them with information on the program. The mentor's master class will furthermore be a vehicle to identify and train new mentors to the program. Guidelines will be developed to guide mentors in the process of structured mentoring. In some instances, external mentors could potentially also be appointed, i.e. from retired engineers with in depth and specific experience needed in the field in which the delegates are gaining experience.

Mentees: Delegates enrolled in the professional development program will automatically be included in the structured mentorship program. During the first academic block of each year, delegates will receive formal training which will prepare them for what is expected of them in terms of the mentorship process. These sessions will furthermore include combined training sessions for mentors and mentees.

During each year it will be expected of delegates to have regular, structured meetings with assigned mentors. These meetings will promote an environment in which delegates are free to discuss work challenges, aspects of their professional work environment and personal challenges. Delegates will be expected to formally document these meetings as well as to supply a six-monthly reports on their experience and mentorship progression.

Finally delegates will be expected to give formal feedback in the form of a class presentation and a final project report. This will be due and facilitated during the last academic block-week of each year. These feedback sessions will further add value towards facilitating networking between peers and the sharing of knowledge.

A mentoring master file will furthermore be supplied to all delegates to facilitate the program expectations and to structure the mentoring process. Mentors will also be supplied with material and training to guide them towards successful mentorship. The ultimate goal of the mentoring program is the following:

- Facilitate and maximise structured work experience;
- Integrate academic program and content with work experience;
- Facilitate the process of setting long-, medium- and short term goals for delegates; and
- Facilitate the formal mentoring process as expected by ECSA and mentioned in Chapter 7.

The proposed structure of the mentoring program is graphically showed in Figure 8.6.

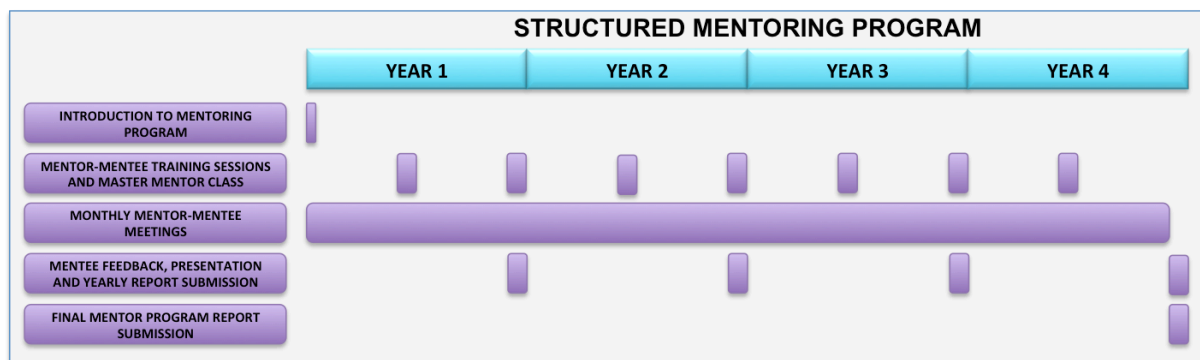


Figure 8.6: Graphical representation of the mentoring program

8.3.4 Professional registration

It was identified in the problem statement, Chapter 1, that South Africa is in need of professionally registered engineers to manage and maintain basic service infrastructure. It was furthermore mentioned as part of the industry feedback in Chapter 3 that professional registered engineers should be one of the deliverables of any professional development program (Chapter 7).

Chapter 7, in this document, focused on the registration process for the Engineering Council of South Africa (ECSA) and stated that the following are key deliverables in submitting the final application for professional registration:

- Proving experience;
- Proving training record;
- Proving involvement in a mentorship program;
- Compiling a project report; and
- Administrative documentation and procedures.

For the proposed professional development program, the *experience*, *training* and *mentorship* sections are composed according to ECSA's requirements for registration. The professional registration process therefore starts the moment delegates enter into the program. The deliverables for professional registration are therefore interlinked with the other aspects of the program on a continuous basis throughout the duration of the program. By the end of the program, all requirements for professional registration are met, and the delegates can submit their applications for professional registration.

After commencement of the program, each candidate will be supplied with a file for professional registration. In the file all the information and requirements for professional registration will be stipulated as well as blank forms and guidelines on what is expected of the delegate. The file therefore forms part of a portfolio of evidence which will continuously be developed until completion of the program. At this point the candidate will be ready for registration, backed up with completed documentation as required by ECSA.

The five aspects of professional registration, as well as how they are integrated into the program, will now be discussed in further detail.

Experience: The professional application includes the submission of a detailed report of each experience phase with information mentioned in Chapter 7. Through direct communication with delegates; information supplied through files and contact sessions; and through the mentorship program, delegates will know exactly what is expected in terms of acquiring relevant and focussed work experience, all according to the requirements of ECSA.

Training: Training needs will be provided through the training-program of the professional development program.

Project report: It was mentioned in Chapter 7 that one of the requirements for professional registration is a 4000 word project report indicating detailed involvement and lessons learned by delegates on a specific project. To assist with this process, it will be expected of delegates to prepare project reports at the end of each year. Delegates will furthermore be required to present these project reports on the last academic block-week of each year. This will also form part of the academic requirements for the program.

Mentorship: As in the case of the work *experience* and *training* sections of the program, so will the mentorship requirements be met by following a structured mentorship program and capturing all components and deliverables in the correct format, as expected by ECSA. Mentorship training and information sessions will furthermore form part of the academic block-weeks, to ensure that candidates are informed of the principles of mentorship and what is expected in this regard.

Administration: All administration- and documentation requirements for the registration application will be integrated throughout the program and will form part of the formal deliverables of the program. This implies that by the completion of the program, delegates will be ready to submit the professional registration application.

From the above mentioned information, it is clear that the goal of the professional registration process is not merely to deliver registered engineers as part of the program, but to add structure to the proposed professional development program in-line with ECSA's requirements. The focus is to facilitate an environment of continuously building towards professional registration, which is directly in line with ECSA's policies and procedures. A dedicated timeslot will furthermore be supplied on each academic block-week for further guidance towards the registration process and to get feedback and lessons learned by delegates. The structure of the *professional registration* program is graphically showed in Figure 8.7.

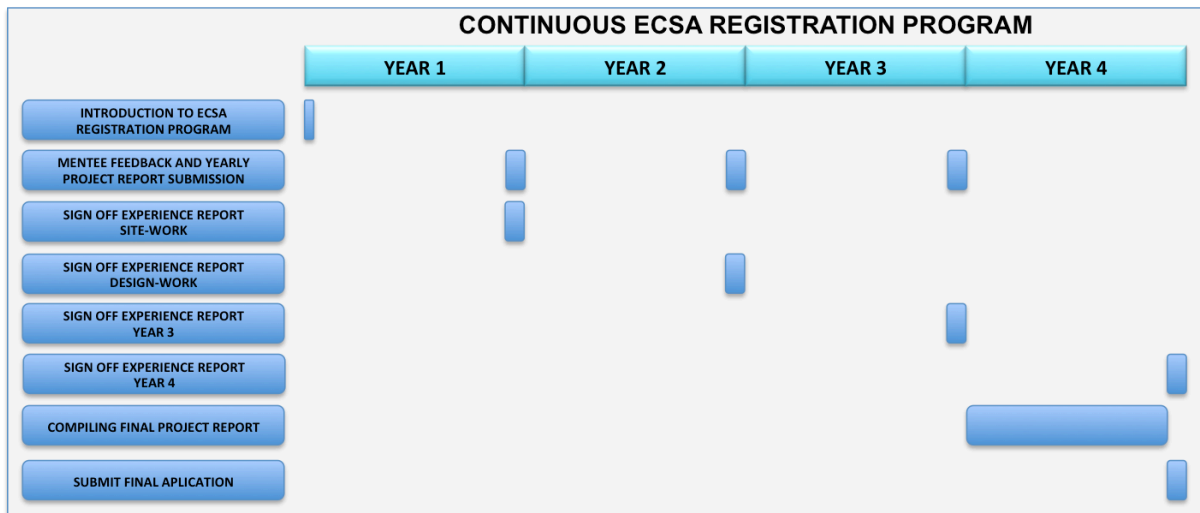


Figure 8.7: Graphical representation of the professional registration program

8.4 ROLE PLAYERS

This section deals with the role players involved in the proposed professional development program and focuses on their roles and responsibilities towards the success of the program. The role players, identified by the researcher, are *government, large private organisations, engineering consultants, engineering contractors, academia* and the *program custodian*. Figure 8.8 is an extract of Figure 8.2, which graphically shows the four main aspects of the proposed professional development program.

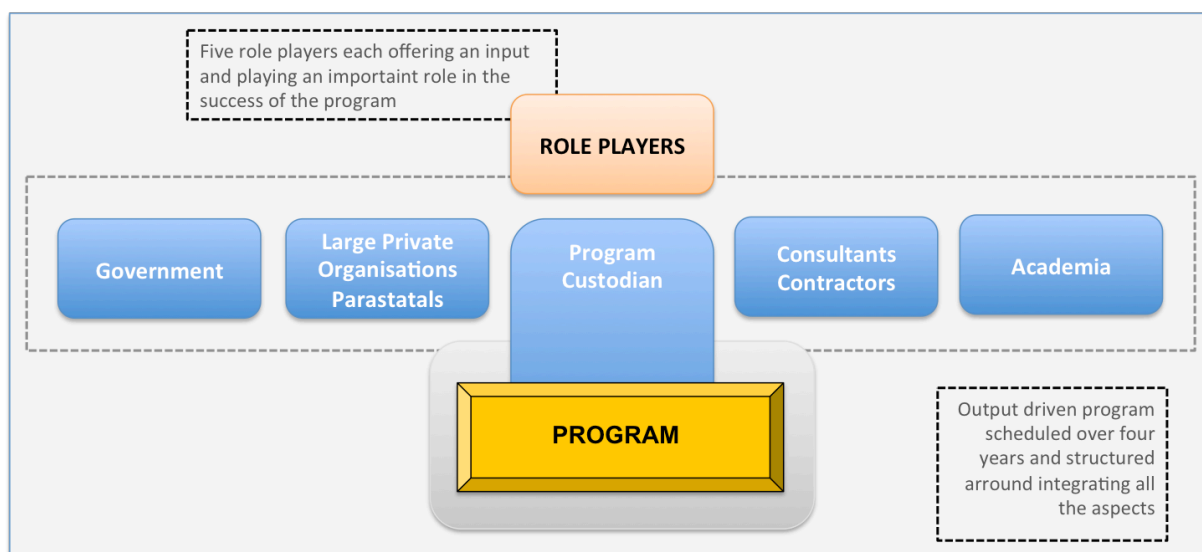


Figure 8.8: Program Components

8.4.1 Government

Government plays three major roles in the success of the proposed professional development program, namely:

1. Primary stakeholder and driving force behind the program;
2. Source of funding; and
3. Supplying infrastructure development projects.

Driving force: Chapter 1 indicated clearly that the issue of engineering skills shortage and lack of infrastructure are experienced on national level. This problem should thus be addressed on national level. Consequently, the South African national government should be a major driving force behind the success of the program.

Funding: It is proposed, in the long run, that the program becomes self-sustainable and that funding generated by program tuition fees, paid for by employers and individuals, pay for all the operational expenses of the program. Operational expenses includes cost such as course material, administrative assistance, academic block week costs (catering and venue), and faculty for the delivery of the academic content.

In the short run, however, “seed-funding” will be required to launch and carry the program during the initial years. It is further proposed that a full financial feasibility study be done to capture the exact initial financial needs as well as to set up a future financial projection model to assess the long-term sustainability of the program. Government funding could be released as special grants or paid out to individuals by means of program bursaries.

Infrastructure development projects: To train engineers and to ensure relevant and focussed experience, delegates will be required to be exposed to national and local infrastructure development projects. It is proposed that government, either on national or municipal level, identify such projects and that delegates be granted access (through identified employers) to gain relevant experience on these projects.

8.4.2 Large private organisations or parastatals

It is proposed that delegates not only get exposure to infrastructure development projects executed by government, but that delegates gain access to projects

executed by private organisations (and parastatals) such as ESCOM, SASOL, TRANSNET, ACSA etc. This will ensure that delegates are not only exposed to public sector procurement, construction and execution policies and processes, but that they gain experience on large infrastructure projects executed by the private sector as well.

8.4.3 Engineering consultants and contractors

The proposed professional development program is based on the integration of focussed, structured work experience and training. For this to happen it is important for delegates to be exposed to quality employment for the full duration of the program. To facilitate this, engineering contractors and consultants will be required to show full support for the program and to supply employment towards delegates taking part in the program.

Although some financial grants for this process could be sourced from government, it is proposed that these organisations recover their employment costs by income generated from delegates working (and gaining experience) on infrastructure development projects.

8.4.4 Academia

Academia refers to an academic institution offering the academic content of the proposed professional development program. The academic institution involved will be responsible for the full extent of the academic offering and the courses offered throughout the program. The academic institution will furthermore be responsible for the delivery of the proposed formal qualification, in the form of a postgraduate diploma.

8.4.5 Program custodian

A key differentiator for the proposed program is the fact that the whole program will be run and administrated from a central point. It is for this reason that a program custodian, in the form of an organisation or body, be appointed to run the entirety of the program. The program custodian is therefore the body responsible for the administrative, management and strategic direction of the proposed professional

development program. It is proposed that for the start-up phases of the program a partnership with an existing organisation, having access to the required knowledge and resources, be set up. As the program grows, and more resources and delegates are added to the program, an independent organisation could be formed to, independently, take on this role. It is furthermore proposed that a strategic board is compiled from representatives from all the role players mentioned above to supply strategic direction to the program.

8.5 THE PROGRAM

To gain a better understanding of the flow of the proposed professional development program, the program is shown chronologically in Figure 8.9.

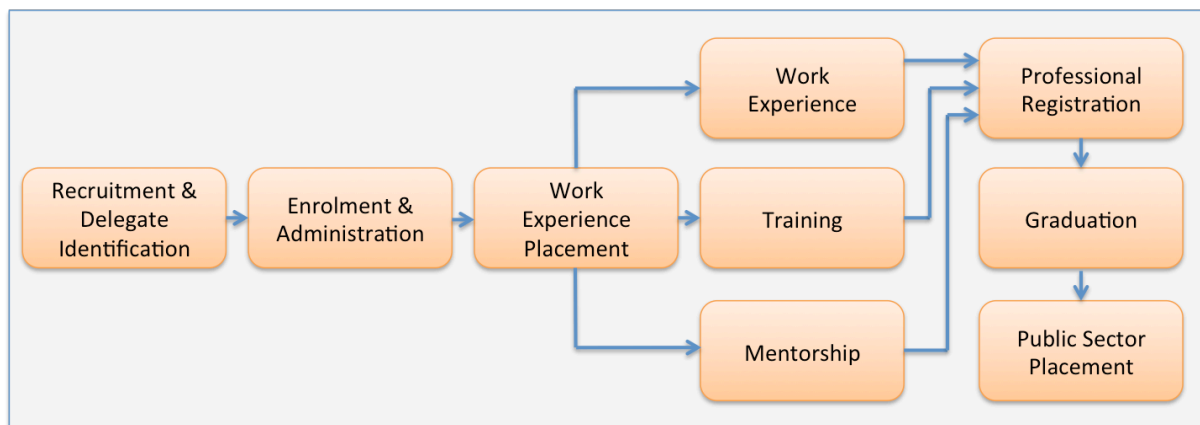


Figure 8.9: Chronological flow of proposed program

One key aspect to the success of the proposed program is the integration of all the components of the program, mentioned throughout this study. A graphical presentation of the integration of these components is supplied in Figure 8.10.

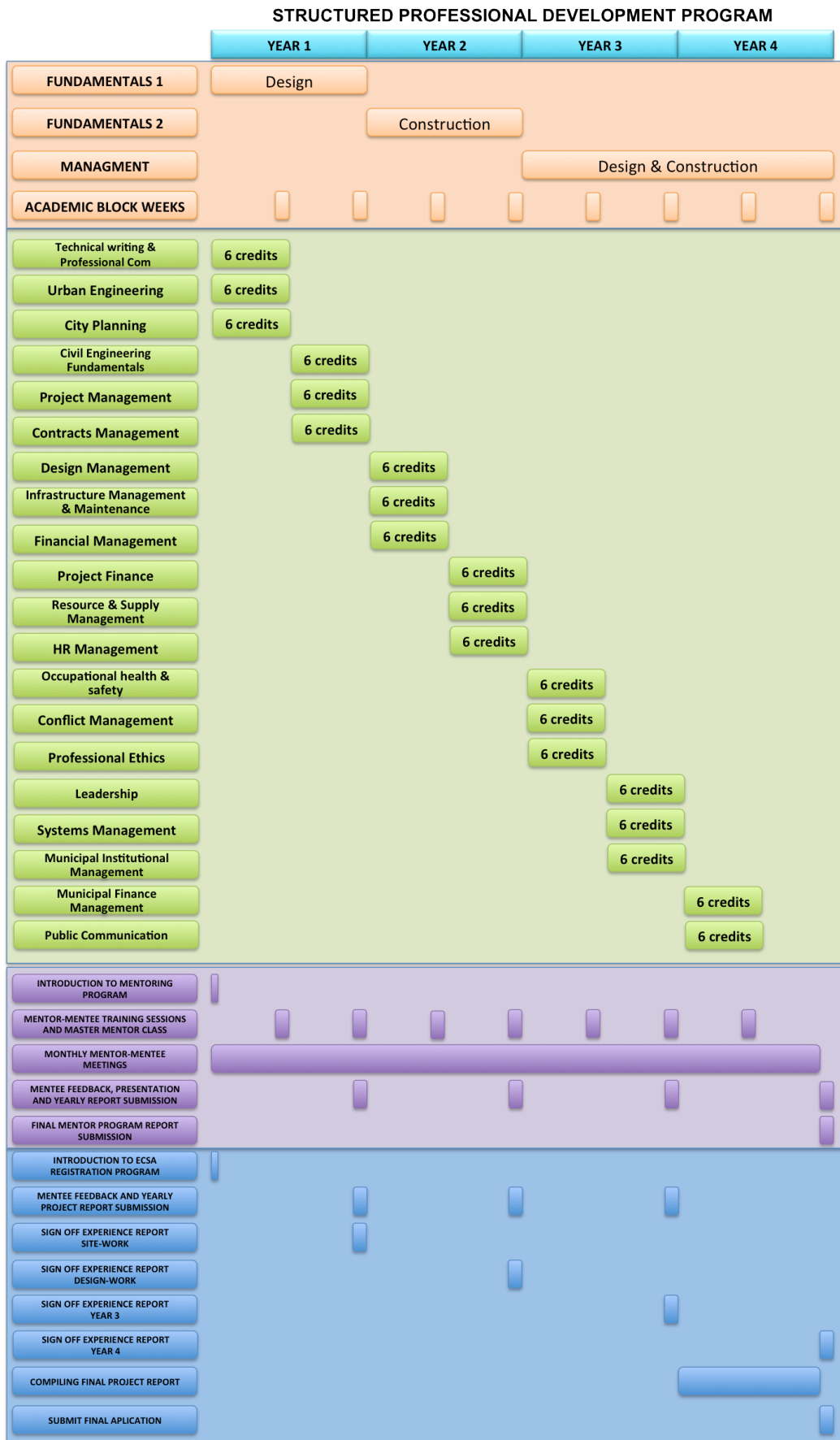


Figure 8.10: Program components integration

8.6 CRITICAL SUCCESS FACTORS

The success of the professional development program, as proposed by this study, is a function of various factors and role players. These factors and role players were named and discussed earlier in this chapter. Three factors are identified further as critical to the success of executing the proposed program. These factors are *funding*, *industry involvement*, non-financial *government involvement* and *professional bodies*. These factors will now be discussed further.

8.6.1 Funding

Initial funding is required to initiate the program and to create public awareness and industry buy-in to the program. It is proposed that government funding, from sources such as the National Planning Commission (Trevor Manual) and the National Skills Fund (NSF), amongst others, provide funding for the program. International funding and grants could also be sourced. The following aspects require initial funding:

- Initial selection and recruitment of suitable candidates by a selection panel using predetermined selection criteria.
- Management of the integrated process and setting up systems for the program, these include the following:
 - Administration systems;
 - Communication systems, i.e. managing relationships amongst delegates, employees, mentors and clients;
 - Recruitment systems, i.e. the recruitment of suitable employers in private, public and parastatal organisations;
 - Placement systems, i.e. placement of trainees with employers throughout the duration of the program;
 - Employment placement systems, i.e. assisting trainees to find employment after completion of the program; and
 - Support systems, i.e. accounting, delegate management and industry relations management systems.

- Initial selection of mentors and managing the mentor-mentee process.
- Developing program processes specifying the workplace assignments to be completed and mentor guides to ensure that delegates are exposed to appropriate work experience and to assist mentors to give the required guidance/assistance.

8.6.2 Government sponsor

A need exists for a high level driving force in the form of a government institution or department who can act as the sponsor for the program. This will ensure trust and credibility when gathering funds for initiation and assist with getting agreement and buy-in from industry. National departments such as the national planning commission or the department of public works could be two ideal candidates to play such a role.

8.6.3 Industry involvement

The involvement and buy-in from private sector industry participants are vital to the initiation and sustainability of the program. Commitment for involvement from these parties is thus cardinal to the success of the program. Before the program can be initiated, the following commitments are required from private sector industry participants:

- Employment to delegates for the duration of the program; and
- Exposure for delegates to applicable projects and responsibilities within these projects.

To accomplish this, extensive consultation is needed with potential employers prior to the initiation of the program. Further input could also be required from these role players in terms of the development of the academic curriculum of the program.

8.6.4 National industry professional bodies

To assure further success buy-in from industry professional bodies are required. These bodies should include organisations such as ECSA, SAFSEC and CESA, amongst others. Furthermore, these organisations could supply valuable input towards developing and finalising academic content and training requirements.

8.6.5 Major initiation risks

From the success factors, mentioned in the previous section, the following major initiation risks for the program are identified:

- Not getting sufficient public support to raise initial funding for the program;
- Various professional development programs already exist. A major risk in this regard is to integrate the various existing programs into this program and get all parties to work together to focus on solving the larger problem of infrastructure development and skills shortage; and
- The political environment in South Africa is very unstable. It is important for the political environment to set aside personal agenda, and focus on solving the national problems mentioned in the previous point.

8.7 POST PROGRAM

After successful completion of the program, it is important that the candidates taking part in the program get integrated into the environment of public sector engineering. As an extension to this study, a full integration and follow up strategy for the program could be developed to assure sustainability for the program and the candidates taking part in the program.

8.8 CHAPTER CONCLUSION AND SUMMARY

The output of this research is a proposal towards a structured professional development program which could serve as a solution towards the research question. The aim of this chapter is to supply the reader with information regarding the various components of the proposed program and to identify some critical success factors for starting the program. This aim was achieved by firstly supplying information regarding the purpose of the program and what the concept of the program is. Subsequently a better description of the subsections of the program was given, namely: the four program foundations, the major role players in the program, and lastly the program schedule process. The chapter is concluded by the identification of four critical success factors and risks for initiating the program.

The aim of this chapter was to combine all factors and concepts dealt with during this research to develop a potential professional development program for engineers working in the public sector. This aim was reached by answering the following questions:

- What is the purpose of the proposed program?
- What is the concept of the program?
- What are the components that make up the program?
- What role players are involved in the program, and what are their roles in the success of the program?
- What is the structure and flow of the program?

After answering these questions further success factors and risks in initiating the program were identified. These factors included funding, private sector industry involvement and the involvement of industry professional bodies. The next chapter includes the findings, conclusions and recommendations for this study.

CHAPTER 9: FINDINGS, CONCLUSION AND RECOMMENDATIONS

The previous chapter includes details of the proposed professional development program, developed in this study. Chapters 4 to 7 include information and aspects regarding this proposed professional development program. This chapter includes conclusions drawn, by integrating the findings of this study and bringing it in context with the research objectives. This chapter will also make recommendations based on the above mentioned conclusions and high lights the research shortcomings of this study. The chapter concludes by presenting areas for potential future research in this study area.

9.1 PROBLEM STATEMENT AND RESEARCH OBJECTIVES

It was stated in Chapter 1 that South Africa is experiencing a phase in which existing infrastructure is reaching it's design life end. Another challenge identified in Chapter 1 is that South Africa is currently experiencing high levels of engineering skills shortages. Through data from existing literature and feedback from industry role players, it was established that a professional development program could serve as a solution towards these challenges. The development of such a program therefore became the primary objective of this study. Secondary objectives were further listed as follow:

- Investigate ECSA's requirements to register as a professional engineer and identify the impact this has on engineering professionals working in the public sector;
- Assess capability needs for engineers working in the public sector, identify potential training areas and develop a work-experience program for these engineering professionals; and
- Identify the role of structured mentorship within a professional development program.

The above mentioned were systematically assessed and solved throughout this document. This process in which this was done, is presented in Figure 9.1 below.

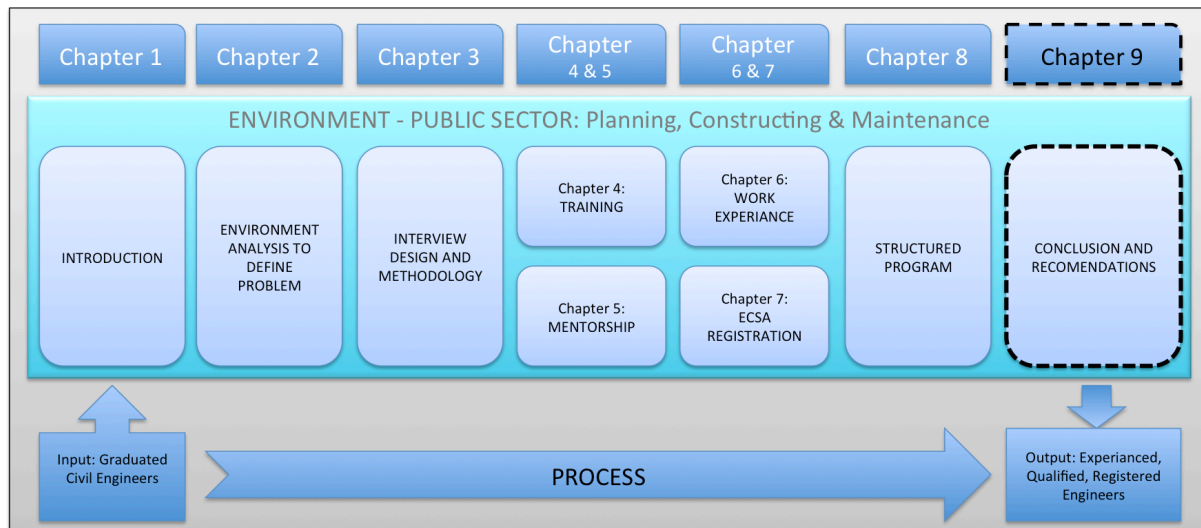


Figure 9.1: Research framework, Chapter 9

In the next section, the findings of the research are discussed briefly.

9.2 FINDINGS

Literature assessed in Chapter 1 confirmed the initial hypotheses regarding the two major challenges South Africa is currently facing, namely:

- Deteriorating infrastructure and need for new infrastructure; and
- Engineering skills shortages.

The first challenge is that South Africa is indeed facing a phase in which the condition of public sector infrastructure is deteriorating rapidly and the need for infrastructure is increasing drastically. During the discussion of the second challenge, addressed in Chapter 1, it became evident that South Africa is indeed facing a challenge in terms of engineering skills shortages within the public sector. The literature further indicated that skills shortages within this sector not only exist in terms of insufficient numbers of engineers, but challenges in terms of the quality of existing engineers are being experienced as well. All interviews completed, and noted in Chapter 3, confirmed this.

Chapter 3 presented information from interviews executed with industry professionals. Engineers interviewed are either working in public sector organisations, or consist of engineers having a significant influence on public sector organisations. The interviews were executed and the data captured from the

interviews were processed and utilised throughout the document. The interviews were specifically designed to answer questions regarding the development of a professional development program, as a possible solution towards the challenges discussed in the previous paragraph. Data from the interviews further confirmed information from literature, stating that the challenges, named above, is a reality.

The analysed data from the interviews were further applied to compile the building blocks for the *training* component of the proposed professional development program. The interviews, likewise, supplied valuable information regarding the skills requirements for engineers working in public sector organisations. Data extracted suggested that these engineers should acquire skills regarding government and public sector regulations and policies; traditional technical engineering skills; and general and management skills. The data extracted in this regard were later in the document applied to develop the *work experience* component of the proposed professional development program.

The data received and analysed during Chapter 3 in combination with information from various literature sources, were applied in Chapter 4 to 7 to develop the components of a proposed professional development program. In Chapter 8 this information is combined to develop the structure and layout of the proposed program. From these chapters and sections, the research proposes a professional development program, for engineering professionals working within public sector organisations, to include the following:

- A structured training program structured in the form of academic block-weeks and working towards a Post-Graduation Degree in Public Sector Engineering;
- A structured work experience program to gain relevant engineering and management skills to work within the public sector;
- A structured mentoring program to lead engineers towards successful and relevant work experience and training;
- A system in which professional registration is facilitated throughout the duration of the program to ensure the delivery of professionally registered engineers by completion of the program;
- Participation of role players from the various spheres in the industry (i.e. government, private and public infrastructure developers, engineering

consultants and contractors, and academia) working together and contributing various resources and time; and

- A structured and centrally managed administrative process for strategic direction of the program, quality control and administrative excellence.

Critical success factors for initiating the proposed program were further identified and include aspects such as funding, industry involvement and buy-in in the program, government commitment towards the program, and the involvement of national industry professional bodies in the program. Major risk identified for the initiation of the program includes aspects such as insufficient public support, integration with existing professional development programs and political instability.

9.3 RECOMMENDATIONS

The following recommendations are made regarding this study:

Phasing in and further development: It is recommended that this study forms the basis of the development of a professional development program to solve the research problem discussed in Chapter 1 and 2. The program structure supplied in Chapter 8 could serve as a basis to execute a project to develop the proposed program. It is further proposed that a project manager be assigned and a task team be compiled to initiate the project.

High-level industry buy-in: It is recommended that a strategic board be compiled to start the process of consultation with role players mentioned above. It is further recommended that industry buy-in be formalised and communicated through workshops and high-level strategic meetings with key role players.

Establishment of a Chair: It is recommended that a chair in public sector engineer is established within an existing academic institution. The aim of such a chair would be to facilitate the process of further development of the program, as well as to develop academic content for the program.

9.4 AREAS OF FUTURE AND FURTHER RESEARCH

Further research on this study includes the following:

- Initial cost proposal and feasibility study for the proposed professional development program;
- Final design and implementation plan for the proposed program;
- In depth cost-benefit analysis for the proposed program;
- Further development and research in the course subjects, and academic content, for the proposed academic program to be implemented in the professional development program;
- Development of a structured mentoring program designed for the proposed program, addressing the industry specific needs;
- Identify ways to attract and recruit high potential candidates for the program and developing a system to attract talent to the program; and
- Development of a follow up strategy and integration process to assure that candidates taking part in the program get successfully integrated into the environment of public sector infrastructure management and development.

Further research in the area of public sector engineering, in general could include the following:

- A study could be executed to compare remuneration and payment packages between public sector and private sector organisations. This could shed more light on the reason why fewer engineers are deciding to stay in public sector organisations and prefer working in private companies.
- A study capturing the activities engineers are involved in, from junior design level to senior engineering management level. This data could be compared between public and private sector organisations.

9.5 SHORTCOMINGS IDENTIFIED

The following shortcomings were identified:

- Sample size and demographic distribution of interviews are limited. This raised the question as to the viability of the feedback received from the interviewees. It is recommended that as part of further development of the proposed program, an in depth quantitative study be undertaken to capture more accurate data for the items discussed in Chapter 3.

- Throughout this study various references are made to course subjects. These subjects were identified by identifying skills needs within the public sector and by assessing various course offerings from existing CPD course service providers. No analysis was done to develop, or assess the course content of the various courses proposed throughout this study. It is proposed that as part of further development of this program, an in depth study is carried out on the content offering of the various proposed CPD subjects and the development thereof.
- A shortcoming in this study is that no attention is being given to the follow up strategy of the program. If the initiation and execution of such a program, proposed in this study, is successful, the numbers of engineering professionals working in the public sector will increase and the shortage will be satisfied. The question then arises: what is the purpose of the program after that? It is on this basis that it is proposed that an in depth follow up strategy be investigated and put in place before the program is implemented.
- Another shortcoming of this study, is that the delegates taking part in the process get no work exposure to the public sector, before completing the program and integration into the public sector takes place. This is a shortcoming and should be addressed before the proposed program can be implemented.

9.6 CHAPTER CONCLUSION

This chapter is the last chapter of this study. The chapter includes information on the research findings developed, a list of recommendations, areas of future research and the shortcomings for the study.

REFERENCES

About ASEC. [S.a.] [Online]. Available: <http://www.asce.org/About-ASCE/> [24 August 2012].

About CESA. [S.a.] [Online]. Available: <http://www.cesa.co.za/about> [15 September 2012].

About DaVinci Academy. [S.a.] [Online]. Available: <http://www.davinciacademy.org/AboutUs.php> [12 August 2012].

About the ICE. [S.a.] [Online]. Available: <http://www.ice.org.uk/About-ICE> [18 August 2012].

About the School of Consulting Engineering. [S.a.] [Online]. Available: <http://www.cesa.co.za/node/160> [10 September 2012].

Allix, M. 2012. South Africa Lacks Skills for the State's Build Spend. *Business Day*, 29 August 2012.

ASCE Continuing Education Catalogue – Fall/Winter 2012/2013. American Society of Civil Engineers, 2012.

Candidate Academy to be Launched. 2010. *Magazine of the South African Institute of Civil Engineers 18.1*, January: 57 – 60.

CESA Courses offered. [S.a.] [Online]. Available: <http://www.cesa.co.za/node/160> [10 September 2012].

CESA Mission Statement. [S.a.] [Online]. Available: <http://www.cesa.co.za/node/9> [15 September 2012].

CESA's Objectives. [S.a.] [Online]. Available: <http://www.cesa.co.za/node/9> [15 September 2012].

CESA Structure. [S.a.] [Online]. Available: <http://www.cesa.co.za/node/9> [15 September 2012].

Cooper, M.W. 2011. *Future skill sets for the municipal engineer*. Institute of Civil Engineers Proceedings, Volume 164, No ME4, February 2011. London: Institute of Civil Engineers Publishing.

DaVinci Course Catalog 2012/2012. [S.a.] [Online]. Available: http://www.davinciacademy.org/DASA_Files/DaVinci%20Academy%20Course%20Catalog%202012-2013.pdf [12 August 2012].

De Koker, V. 2011. *SAICE launches its second Infrastructure Report Card*. Civil Engineering Magazine, Volume 19, No 4, May 2011. Midrand: South African Institute of Civil Engineers (SAICE).

ECSCA: Statutory functions. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=functions> [26 November 2012].

ECSCA: Registration introduction. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=registration> [26 November 2012].

ECSCA: Why register. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=why> [26 November 2012].

ECSCA Policy statement R2/1A, September 2004. Engineering Council of South. 2004.

ECSCA: Registration process. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=procedure> [26 November 2012].

ECSCA Discipline specific guidelines for civil engineers, Engineering Council of South.

ECSCA new registration system. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=NewReg> [8 August 2012].

ECSCA registration process. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=procedure> [8 December 2012].

Erasmus, J. & Breier, M. (ed.). 2009. *Skills Shortages in South Africa, Case Studies of Key Professions*. Cape Town: HSRC Press.

Engineering Profession Act, 2000 (Act No 46 of 2000). *Government Gazette*. No 21821, 1 December 2000.

ECSA Policy on Continuing Professional Development. Engineering Council of South Africa, 30 November 2012.

ECSA, *About ECSA: Transformation*. [S.a.] [Online]. Available: <http://www.ecsa.co.za/index.asp?x=transformation> [3 July 2013].

Engineering Council UK. [S.a.] [Online]. Available: <http://www.engc.org.uk/> [6 November 2012].

General Information & Policies. [S.a.] [Online]. Available: <http://www.op.nysed.gov/prof/geninfo.htm>. [13 November 2012].

Guidelines for professional registration, 3rd Edition, March 2003. South African Institute of Civil Engineers. 2003.

Herold, M. 2009. The water crisis in South Africa, in 14th SANCIAHS Symposium. 21 – 23 September 2009, Johannesburg.

Holland, C. 2009. *Workplace mentoring: a literature review*. Work and education research and development services, supported by the industry of training federation, August 2009. New Zealand.

How to build a successful mentoring program – Using the elements of effective practice. National Institute Mentorship, USA, 2005.

Hutchins, D.B. 1996. *Resource Library, Mentoring*. SHRM Library, March 1996. Unpublished.

IACET Who are we. [S.a.] [Online]. Available: <http://www.iacet.org/about/who-we-are> [24 August 2012].

ICE Training Courses. [S.a.] [Online]. Available: <http://www.ice.org.uk/Training-courses> [18 August 2012].

Infrastructure Report Card for South Africa 2006. South African Institute of Civil Engineers, 2006.

Infrastructure Report Card for South Africa 2011. South African Institute of Civil Engineers, 2011.

Kleynhans, C. 2012. Personal interview. 10 September, Bellville.

Lawless, A. 2007. *Numbers and Needs in Local Government*. Unpublished article. 2007.

Leonetti, A. 2008. *The coaching and mentoring revolution – is it working?* ACCA Education and professional development, March 2008. London.

License requirements, professional engineering. [S.a.] [Online]. Available: <http://www.op.nysed.gov/prof/pels/pelic.htm>. [13 November 2012].

Marsh, P. 2012. *Foundations in structured mentorship*. Mentoring 4 Success™. Johannesburg.

MFMA. [S.a.] [Online]. Available: <http://mfma.treasury.gov.za/Pages/Default.aspx> [1 July 2013].

Motlanthe, K. 2011. *Address by Deputy President of the Republic of South Africa Kgalema Motlanthe during the 90th Anniversary of the South Africa Reserve Bank* [Online]. Available: <http://www.thepresidency.gov.za/pebble.asp?reid=4400> [30 June 2011].

Naidoo, B. 2011. *Lack of workforce, a constraint to business growth*. Johannesburg: Engineering News.

National Treasury. June 2012. *Accounting Guideline, GRAP 17, Property, Plant and Equipment*.

National Treasury. June 2012. *Generally Recognised Accounting Practice, Disclosure/compliance checklist*.

Odendaal, N. 2012. Engineers Confident of their Future but Skills a Concern. *Engineering News*, 18 June 2012.

PDNA Da Vinci Academy develops local talent. 2012. *Engineering News Online*, 20 February 2012.

Ragins, B., & Verbos, A. K. 2006. *Positive Relationships in Action: Relational Mentoring and Mentoring Schemas in the Workplace In Exploring Positive Relationships at Work*. Jane E Dutton & Belle Rose Ragins (Eds.), Building a Theoretical and Research Foundation (pp 91-115).

Rules of Conduct for Registered Persons: Engineering Profession Act, 2000 (Act No. 46 of 2000). *Government Gazette*. No 28605, 17 March 2006.

SAICE Course Calendar. [S.a.] [Online]. Available: <http://www.saice.org.za/training-courses> [7 August 2012].

SAICE Mission Statement. [S.a.] [Online]. Available: <http://www.saice.org.za/about/mission-statement> [5 August 2012].

SAICE Structure. [S.a.] [Online]. Available: <http://www.saice.org.za/about/organo> [5 August 2012].

SAICE Services. [S.a.] [Online]. Available: <http://www.saice.org.za/services> [5 August 2012].

SAQA Advance diploma. [S.a.] [Online]. Available: <http://pcqs.saqa.org.za/viewQualification.php?id=90559> [19 September 2013].

Simpson, J. & Weiner, E. 1997. *The Oxford English Dictionary*. Oxford: Oxford University Press.

The State of Municipal Infrastructure in South Africa and its Operation and Maintenance; An Overview. *Council for Scientific and Industrial Research & Construction Industry Development Board*, July 2007.

TTT All Courses. [S.a.] [Online]. Available: <http://www.ice.org.uk/Training-courses> [18 August 2012].

Understanding structured mentorship. *Mentoring 4 Success™*, 2011

UK-SPEC. [S.a.] [Online]. Available: <http://www.engc.org.uk/professional-qualifications/standards/uk-spec>. [6 November 2012].

Van der Walt, S. 2012. Personal interview. 19 June, Stellenbosch.

Welcome to CBE. [S.a.] [Online]. Available: <http://www.cbe.org.za/> [8 December 2012].

Wium, D.J.W. 2012. Personal interview. Personal interview – telephonic, Stellenbosch.