CHAPTER 2 - CONSULTING ENGINEERING IN SOUTH AFRICA

2.1 Origins

The object of this chapter is to provide a better understanding of the profession or business of consulting engineering in the South African context. Such an understanding will naturally be a prerequisite for an attempt to develop a meaningful industry-wide management information system of any kind for South African consulting engineers.

The first step in understanding the profession will be to investigate its origins. At the beginning of the 19th century Great Britain was leading the world in industrial development. Britain had a strong national economy and British engineers were responsible for many of the breakthrough industrial inventions, which made the industrial revolution possible. Examples of these inventions are the first steam engine, the first mechanical spinning machine, the first steam driven drilling machine, the first precision lathes for the production of screw threads and the first locomotive [17].

Industrial development in Britain resulted in tremendous structural changes in British society. Parallel to the industrial development, developments in farming and cattle breeding lead to rapid rationalisation in agriculture. This was particularly the case in England where it released large numbers of farm workers so that they could be drawn from the countryside to the cities, where they became industrial workers. The extent of the resultant demographic changes can be illustrated by the example of Manchester, the centre of the textile industry, during the industrial revolution. The

population of Manchester increased from 25 000 people in 1772 to 455 000 people in 1851 [215, 206].

The changes in societal structure and demography gave rise to the need for a national transportation system. Food had to be transported to the cities, raw materials to the factories and manufactured products to the consumers or the export harbours. During the period 1750 to 1850 the length of Britain's inland waterways increased from 1 600 to 5 200 km. The tremendous volume of work involved in the construction of canals, locks, roads and bridges in this period led to the formation of a grouping of British professional civil engineers. Their activities can also be looked upon as the origin of consulting engineering [215].

In 1818 a group of civil engineers in England founded the Institution of Civil Engineers (ICE) with Thomas Telford, the famous civil engineer, as first President. Telford is generally regarded as one of the first consulting engineers in the world, with clients not only in Great Britain, but also in a number of other countries [215].

The term "consulting engineer" came into use during the first half of the 19th century; correspondence from the period shows that the term was used in the 1840's [215]. These first consulting engineers were experts, skilled and experienced through practice. They were differentiated from the other engineers by the fact that their status was a result of their knowledge and know-how and not their rank as a military officer or their position as a government official. They did not own factories or trading companies and they did not work as businessmen and industrialists, but they were highly regarded in society for their knowledge of new technologies, which were of

great importance to society at large. Consulting engineering is therefore relatively young as an independent profession.

The modern history of South Africa was greatly influenced by all of these technological developments in Britain. It therefore stands to reason that the origins of consulting engineering in South Africa can easily be traced back to the development of consulting engineering in the United Kingdom [17].

The first "engineering" works undertaken in South Africa was the construction of a mud and timber fort and the securing of the water supply at the Cape by Jan van Riebeeck from 1652. The first engineering post created in the country was that of "Surveyor and Mapmaker" and Pieter Potter of Amsterdam occupied this position from 1655 to 1691. Other notable engineering works during the Dutch period included the construction of the Castle in 1665 as well as a large hospital, new reservoir and the Grootte Kerk church in Cape Town under the Governors van der Stel (Simon and his son Willem Adriaan) [17].

During the first and second British occupations of the Cape (1795 to 1803 and 1806 to 1814), the British very soon found that the area at the Southern tip of Africa had economic potential, but that the very poorly developed transport infrastructure was a severe constraint to economic development. Infrastructure development was therefore undertaken and the first thrust was to improve transport between the agricultural areas on and adjacent to the Cape peninsula and the market in Cape Town, such as the construction of the first hard surface road across the sandy Cape flats. The next phase was to improve access to the inland areas for trade and

improved communication by constructing mountain passes such as the Tulbach pass in 1807 [170].

The sharp increase in the number of ships to dock in Cape Town (needing fresh meat and other farm produce) and the demand for wool to feed the newly mechanised textile industry in Britain required better infrastructure in order to further stimulate an increase in agricultural productivity [100]. When control of the Cape was transferred from the Netherlands to Great Britain in accordance with the London Convention of 13 August 1814, it became a British colony and large-scale transport infrastructure projects such as the Cape mountain pass roads were undertaken. The Sir Lowry's pass was completed in 1830 and the Montagu, Michell's and Bainskloof mountain passes in the 1840's and 1850's. These projects were generally undertaken under the control of experienced British engineers in the colonial public service [170].

As the Cape colony expanded and its economy grew, and especially after the discovery of diamonds in the 1870's, the transport infrastructure required continuous improvement and extension and many more British engineers and artisans emigrated to take up positions in the Cape's colonial public service. In time the infrastructure development expanded to include rail, bulk water supply and later power generation projects. The infrastructure development in the British colony of Natal was similarly linked to economic development. The first railway line in South Africa was built in Durban in 1860 and the railway line from Durban to the Transvaal goldfields was completed in 1895. The completion of the railway line from Durban to Northern Natal in 1889 stimulated the development of the Natal colony's coal mining industry [17].

After the First World War the first known local consulting engineering practices were formed. These practices were small and consisted of a number of eminent engineers whose advice in civil, mechanical and electrical engineering was sought because of their personal standing in the engineering profession. Immigration into South Africa brought younger engineers with overseas experience into both the consulting engineering profession and the contracting industry so that major projects, which had to be undertaken, could be handled in South Africa without reference to overseas associates. The need for local consulting engineering expertise became of growing importance as it became obvious that the best solutions to South African problems were very often not found in experience gained elsewhere. With the advent of formal engineering education in South Africa, the original immigrant engineers were joined by a new brand of locally educated engineers [39, 17].

These first consulting engineering practices generally operated as partnerships and each restricted its activities to a niche market such as roads, railways, bulk water supply, power generation etc., depending on the background and recognised expertise of the partners [17]. By the early 1950's a number of the leading consulting engineering practices were however already employing more than 50 staff members. In 1952 thirty eminent consulting engineers founded the South African Association of Consulting Engineers (SAACE) in Johannesburg [181].

In 1959 the SAACE was admitted as a member association of the International Federation of Consulting Engineers (FIDIC) [215] and during 1998 to 1999 a South African consulting engineer, Steyn Laubscher, served as the first ever president of FIDIC from Africa and the SAACE became the seventh largest member organisation of FIDIC [60].

During the past century the profession of consulting engineering in South Africa grew from humble beginnings to being recognised as an equal member of and meaningful contributor to the international fraternity of consulting engineers.

2.2 Definition of a consulting engineer

In furthering an understanding of the profession or business of consulting engineering, it is necessary to explore the definition of a consulting engineer.

Internationally the term "consulting engineer" is reserved for an independent professional engineer who performs professional engineering services for clients on a fee basis [206]. Consulting engineers are independent contractors in the legal sense because they generally own and manage their firms and serve their clients in terms of a contractual arrangement [190]. As independent contractors or agents consulting engineering firms normally serve a number of clients at the same time.

Consulting engineers must be qualified by academic qualification, professional registration, and experience to practice and offer competent professional engineering services. Consulting engineers sell only service, time, knowledge and judgement and their compensation consists of fees paid by their clients for services rendered.

The clients served by consulting engineering practices can be both domestic and foreign and can be industrial or commercial concerns in the private sector, financial institutions, departments in any tier of government, parastatals, international

agencies, and even individuals [206, 182, 6, 27]. Consulting engineers serve some clients indirectly through services performed for architects and other design professionals or through associations with such professionals [6, 31].

Any organisation or individual in need of engineering services is therefore a potential client of a consulting engineer. Having such a potentially diverse client base and offering such a key service in any modern free economy, the consulting engineering profession can rightfully claim to be an important contributor to the international economy, and more particularly to the developing South African economy. The relevance of this study, which has as its principal aim to develop a better understanding of the consulting engineering industry and its business environment in South Africa, should therefore be obvious. A better level of understanding can contribute meaningfully towards more informed management decisions by the owners and managers of South African consulting engineering practices with resultant improvements in the utilisation, efficiency and effectiveness of consulting engineers as a scarce national economic resource.

2.3 Evolution of the consulting engineering profession

Since the advent of consulting engineering in South Africa nearly a century ago, the world of business has changed in many respects and the consulting engineering industry also had to adapt to changes in its operating environment or become irrelevant and disappear. In order to understand the modern profession or business of consulting engineering an understanding of these evolutionary changes should be developed.

2.3.1 Nature of the professional consulting engineering practice

The work carried out by South African consulting engineers, the services offered and, in fact, the very nature of consulting engineering practices has undergone major changes during the past eighty years.

The first South African consulting engineers operated as sole practitioners or as local branch offices of British consulting engineering firms. These small practices were generally formed around the expert knowledge of a resident partner or partners and they offered services that were based on such expertise. The nature of expertise was such that it was generally gained through years of practice and was often more of an empirical, rather than a theoretically founded nature [17, 206].

Internationally the first practitioners were civil engineers experienced in building work and civil engineering construction and they required very little in terms of equipment or support staff. The typical practice consisted of the engineer, a secretary and one or two "technical assistants" who were little more than survey assistants or even glorified labourers. Equipment generally consisted of basic survey equipment, a slide rule and rudimentary draughting equipment. The industrial revolution and subsequent developments resulted in the formation of mechanical and electrical consulting engineering practices. New disciplines such as chemical, industrial, environmental, process and agricultural consulting engineering evolved in time and specialisation within the civil engineering discipline led to new sub-disciplines such as structural, geotechnical, transportation, materials, railway and hydrological engineering [206, 215].

In South Africa the first consulting engineering firms also practiced in one of the original disciplines, i.e. civil, electrical and mechanical engineering, but they generally limited their services to the specific areas of expertise of their partners. Within the group of consulting civil engineers there were for example so-called roads firms, railway firms, water firms etc. In time some firms grew larger and expanded their services by offering related specialist disciplines while still concentrating on their core discipline. For example, a typical "roads" firm would expand into hydrology, geotechnical engineering and structural engineering in order to design large viaducts, soil retaining structures, erosion protection measures, culverts etc., while a typical "water" firm similarly expanded their services to include new specialised disciplines related to their core discipline. The mechanical and electrical disciplines often formed joint practices, because there were so many interfaces between these disciplines. Although these trends led to the formation of some larger South African consulting engineering firms, many firms, both locally and internationally also elected to remain small and chose to focus on a single discipline such as mechanical engineering or even to specialise in a sub-discipline such as the design of cooling systems or the design of materials handling systems [206, 215, 102, 65].

Modern international trends, such as the growing awareness of the impact of engineering projects on the natural environment and the need to increasingly integrate social science principles into engineering projects, are influencing the way that consulting engineering practices operate. The professional consulting engineer can no longer work in isolation, but has to co-operate closely with many other professionals and other industry stakeholders. The successful consulting engineer furthermore had to develop the skills to effectively communicate the benefits of his projects and the reasons for his project proposals or decisions to diverse audiences

that may sometimes include technologically ignorant representatives from beneficiary or affected communities [215, 31, 78].

Today consulting engineers offer a range of services as broad and varied as the needs of their clients. Some firms limit their services to a particular discipline of engineering, while others provide varied multidisciplinary or even multi-professional services. The work of modern consulting engineers can, for example, vary from

- brief specialist consultations to
- the complete planning, design and project or construction management of complex major projects to
- the management of maintenance activities on infrastructure or industrial installations to
- the operation of physical infrastructure and other systems to
- information technology services to
- environmental impact assessments to
- institutional support services to
- management or business consulting services etc. [206, 27, 104, 62, 103].

The rapid growth of practices, the continuous investment requirements with regard to computer software and hardware, the cost of in-house provision of specialist disciplines, the cash flow patterns, the legislative environment (in terms of labour legislation) and economic factors such as high real interest rates have, amongst other factors, led to a steady increase in the capital requirements of consulting engineering practices [48]. Consulting engineers have generally tried to counter this trend by improving the financial management of their practices, by outsourcing certain

services, by multi-skilling in stead of specialising where possible and by improving electronic communication in order to improve utilisation of geographically spread resources [206, 48, 104].

2.3.2 Forms of ownership

Consulting engineering practices are business entities and can therefore be classified in terms of their form of ownership. The form of ownership has many implications for the management of consulting engineering practices and it is therefore essential to gain an understanding of both the preferred forms of ownership, the historic and other reasons for such preferences and the primary implications thereof.

Historically, the legal status of the professional consulting engineering practice in South Africa was that of either a sole practitioner or a partnership [190, 174]. The company as such was for many years reserved for commercial enterprises where the liability of shareholders was limited to the value of their shareholding in the company. The company's liability was thus limited, but its way of operating was closely regulated and reported in compliance with legislation. With the passage of time this form of enterprise became the generally accepted legal basis for business operations around the world [190, 212].

The company was, as late as the middle 1970's, not regarded as an applicable form of business for professional consulting engineering practices in South Africa [190]. The liability of shareholders and, in most circumstances, the liability of directors of a company was limited and this was considered to be in conflict with the unlimited liability of the professional person.

In terms of South African law a **partnership** is regarded as an association of individuals who share the contribution of money, goods, labour and skill in lawful commerce or business and who divide the profit and bear the loss in certain proportions [174]. Profits are furthermore taxable in the hands of the individual partners and not in the partnership itself. Each and every partner in a partnership is jointly and severally liable for each other's negligent actions notwithstanding the fact that one or more of the partners may not even have been involved in the rendering of the specific professional services. In practicing in a partnership, each partner faces the possibility of not only losing his capital invested in the partnership, but also the loss of any other personal assets or wealth not forming part of the partnership assets.

Over time legislation was amended to provide for several forms of modified companies, but none of these proved to be suitable for the purpose of the consulting engineering practice [24], at least not until the advent of the **Incorporated company**. The Companies Act, No 61 of 1973, makes specific provision for the formation of incorporated companies or "incorporated partnerships". This company form retains the original spirit of the professional partnership in that directors and past directors are jointly and severally liable, together with the company, for such debts and liability of the company as are or were incurred during their period of office by way of contracts only. This legislation did therefore improve the situation of the professional person by excluding any delictual liability from the concept of joint and several liability as in the conventional partnership. The act furthermore allowed consulting engineering firms practicing as incorporated companies to operate within the formalised framework of company law [24].

The tax liability of an incorporated company is different from that of a partnership. Taxation is on the taxable income of the company, which means that the company pays tax, i.e. as an entity apart from the owners, directors or employees [30].

From 1985 the SAACE allowed its members to practice in incorporated companies and a number of firms, especially the larger firms, subsequently converted from partnerships to incorporated companies [174, 178].

The Close Corporation Act 69 of 1984 made provision for the formation of **close corporations** by between one and ten persons who are referred to as members [30]. This form of ownership have certain similarities with the partnership in that members each have a proportional interest in the business and owners are not distinguished from management. Unlike a partnership, however, the interest of a member may be sold without terminating the existence of the business. It also differs from the partnership in its tax liability. Taxation is on the taxable income of the close corporation, that is tax is paid by the close corporation as determined by the Income Tax Act, i.e. as an entity apart from the members, in much the same way as companies pay tax [30].

A major advantage of the close corporation is the absence of the "jointly and severally liable" provision of both the partnership and the incorporated partnership. Members of a close corporation are not jointly and severally liable together with the close corporation for each other's negligent acts and omissions. Each member can only be held liable in his capacity as a professional for his or her own personal negligent acts, errors or omissions. Members of a close corporation furthermore enjoy

limited commercial liability unless they conduct themselves in a way that can be proved to be reckless or fraudulent [174].

From 1986 the SAACE allowed its members to practice in close corporations and a number of the smaller consulting engineering firms have since converted from partnerships to this style of practice [174, 178].

The effort to limit joint and several liability was taken a step further when South African consulting engineers started practicing under the style of **private Proprietary Limited [(Pty) Ltd] companies**. This common form of ownership has been in existence in South Africa since 1973 (Companies Act, 52 of 1973) and provides shareholders the benefit of limited liability insofar that their exposure to loss is limited to the value of their investment in the company. Each owner, director or employee can furthermore only be held liable in his capacity as a professional for his or her own personal negligent acts, errors or omissions and directors enjoy limited commercial liability unless they conduct themselves in a way that can be proved to be reckless or fraudulent. A private company is a legal and taxable person in its own right [174, 30].

This gradual acceptance (over a period of approximately twenty years) by stakeholders of more "liberal" business structures for South African consulting engineering practices can primarily be ascribed to the following:

- Client risk, with regard to the consulting engineering input in their projects, is currently mostly covered by professional indemnity insurance taken out by either the professional practice (for all its operations) or the client (for a specific project). Internationally the

modern contracting trend is furthermore to identify, quantify and allocate risk in terms of all aspects of a project and not to have an unfair and unreasonable situation where it is expected of any of the contracting parties to accept unknown and unquantified risks without compensation.

- Geographical spread of the larger partnerships have, with the passage of time, resulted in a situation where a partner could be held jointly and severally liable for issues over which he had no control or of which he may not even be aware.
- The advent of multi-disciplinary practices resulted in unacceptable situations where professionals in partnerships were being held jointly and severally liable for issues, which were totally outside their field of knowledge or expertise.
- The ever-increasing size and complexity of large projects resulted in a situation where the "protection" being gained by holding partners personally liable could often be insignificant when compared with the amount of potential claims.

Today South African consulting engineers practice as sole proprietors, partnerships, closed corporations, incorporated companies and proprietary companies as reflected by the data for members of the South African Association of Consulting Engineers contained in Table 2.1.

TABLE 2.1

Forms of ownership of SAACE member firms as in January 2000 [178]

Form of ownership	Number of firms
Sole proprietors	61
Partnerships	52
Incorporated companies	52
Close corporations	109
Proprietary Limited companies	107
TOTAL	381

2.3.3 Size of firms

The nature and appropriateness of the management practices required in a successful professional consulting engineering practice will often be largely dictated by the firm's size. In order to improve understanding of the nature of the business of consulting engineering in South Africa as well as of the management of consulting engineering enterprises, the current distribution and trends in terms of firm size should be acknowledged.

South Africa, as a developing country, had the bulk of its existing stock of physical infrastructure built during the past century. In order to create this infrastructure for a growing South African population and to sustain the economic development of the country, increasingly larger and more complex projects were undertaken. These, in turn, required increasingly greater integration of engineering disciplines. The need also arose for a continuously expanding range of new engineering sub-disciplines. In the period following the Second World War, the South African educational institutions

were producing increasing numbers of locally trained engineers and, with a growing economy, government spending on capital projects rose dramatically [17]. The planning, design and construction of large water supply projects, new national road networks, modern airports, modern power stations, new industrial complexes and other major projects, resulted in the rapid organic growth of larger consulting engineering firms. Some of those firms were the then partnerships of Van Wyk and Louw; Van Niekerk, Kleyn and Edwards; Bruinette, Kruger and Stoffberg; Ninham Shand; Watermeyer, Legge, Piesold and Uhlman, Scott and de Waal and others [181]. With the passage of time the larger firms ventured out of their traditional core disciplines and started to offer increasingly multi-disciplinary engineering services. This was primarily driven by three factors, i.e.

- the need to improve their utilisation of in-house specialists such as specialist geotechnical engineers, hydrologists, geophysicists etc., and
- the need to diversify in order to minimise the economic effects of an increasingly cyclical industry on their practices and
- the requirements of large client bodies.

The 1960's and 1970's were periods of dramatic growth for a relatively small number of South African consulting engineering firms, but simultaneously the number of very small practices increased rapidly [177]. The resultant skewed size distribution of South African consulting engineering firms, as shown in Table 2.2 for the membership of the SAACE, is still prevalent today and it often introduces structural problems into the local industry [48]. Examples of such problems are the resultant professional indemnity insurance cross-subsidization of the (many) small firms by the (few) large firms [180] and the fact that the small capital base (as a result of the large number of

small firms) of the South African consulting engineering industry limits its capacity to participate as equity partners in infrastructure projects of the public-private partnership type or to compete internationally [48].

The staff in a typical present-day South African consulting engineering practice can vary from a single engineer in a small firm to more than a thousand staff members including many non-engineering professionals such as architects, geologists, quantity surveyors, natural and social scientists, urban and regional planners, accountants and information technology specialists. Although several of the trends discussed in the previous sections resulted in the formation of larger firms, many firms also elected to remain small and chose to focus on a single discipline or even to specialise in a sub-discipline. The current size distribution of SAACE member firms is shown in Table 2.2.

TABLE 2.2

SAACE member firms: number of staff employed per firm as in January 2000 [177]

Firm size (no. of employees)	Number of firms	% of total number of firms	% of total no. of employees
1 to 20	291	76%	18%
20 to 40	38	10%	9%
40 to 80	22	6%	11%
80 to 150	16	4%	17%
150 to 300	6	2%	10%
300 to 500	3	1%	10%
>500	5	1%	25%
TOTAL	381	100%	100%

2.4 The current significance and role of consulting engineers in the South African economy

Consulting engineering is a technology-based service profession and, according to the FIDIC 1999 annual country survey, consulting engineering globally represented a US $270 billion ($270 x 10^9) per year industry [52]. During 1999 South African consulting engineers who were members of the SAACE planned, designed and managed the implementation of various types of capital works projects to the value of approximately R35 000 million [51]. Approximately 90% of these projects are located in South Africa. This represents a significant amount in a developing country economy with a gross domestic product (GDP) of R945 863 million and gross domestic fixed investment (GDFI) of R145 540 million [203].

As direct employers, the member firms of the SAACE in 1999 employed about 12 000 people of which approximately 3 300 were professional engineers [182] . When seen in isolation, and in the light of the millions of unemployed people in South Africa, these figures may not seem significant. It should however be taken into account that these numbers represent a significant proportion of the South African skilled labour pool and, even more so, of the small professional, technological and technical engineering skills pool. For example, in 1999 SAACE member firms employed more than 20% of the 15 000 registered professional engineers in South Africa [182, 47].

During 1999 approximately 9,5 % of the total fee income of the consulting engineering profession was derived from sources outside South Africa (mostly projects elsewhere in Africa) [182]. At the same time the private sector contributed approximately 40% to the total industry revenue, with the balance split between

central government (15%), provincial government (16%), local government (22%) and parastatals (7%) [182]. These statistics illustrate the extent to which the national economy was still being controlled by government and the vulnerability of consulting engineering firms to shifts in government policy.

2.5 Composition of the profession

During 2000, an average of 382 consulting engineering firms were registered as members of the South African Association of Consulting Engineers [171, 179]. These consisted of less than 10 larger multi-disciplinary firms (employing 400 or more people), a large number (76%) of small firms employing less than 20 people, with the balance being medium sized firms (Table 2.2). South African consulting engineering firms have traditionally been privately owned by the same professionals who managed the firms on a full-time basis. The adoption by the SAACE of more liberal ownership requirements for its professional member firms led to the separation of ownership and management in these firms, which meant that non-engineering businesses could have substantial shareholding in consulting engineering firms. In recent years, since the normalization of South African politics, international participants have furthermore entered the local market by purchasing shares in some of the larger South African firms.

The engineering disciplines, practice areas or areas of competence that made the largest percentage contribution to the total fee income of the South African consulting engineering industry (SAACE member firms) during 2000 are shown in Table 2.3.

TABLE 2.3

SAACE members: Percentage of total fee income earned from main engineering disciplines or areas of competence as at December 2000 [185]

Date	Civil engineering	Transportation engineering	Structural engineering	Project management	Electrical engineering	Development Engineering
June 2000	27.37%	11.42%	11.8%	8.08%	4.90%	3.80%
December 2000	45.33%	10.27%	13.86%	7.65%	2.74%	2.34%

2.6 Conclusion and recommendations

South African consulting engineers, whose main business it is to supply technology-based consulting intellectual services for the built and natural environment, play a pivotal role in capital formation projects to the value of approximately R35 000 million per annum [51]. This represents a significant amount in a developing country economy with a Gross Domestic Product of R945 863 million and Gross Domestic Fixed Investment of R145 540 million [203].

The pool of professional engineers, technologists and technicians constitute a valuable resource in the economy of any country and even more so in a developing country. The South African consulting engineering profession employs a significant proportion of this resource pool.

It is widely acknowledged that services are the crucial force for change towards a global economy [64] and that the next wave of world economic growth will mostly originate in the services sectors, especially in the area of intellectual services [209, 138, 111]. In the era of globalisation it is therefore imperative for any country to look after its services sector and especially its intellectual professional services sector. In the local environment, South African consulting engineers furthermore have a key role to play in improving the quality of life of all South Africans and of the people of the greater region. This role will primarily be to manage the creation of new infrastructure and to optimise the utilisation and management of existing infrastructure.

In the light of the key role that consulting engineers can play in regional development as well as their potential for contributing to the economic success of South Africa, it is important to improve our knowledge and understanding of the health, external business environment and dynamics of the local consulting engineering industry and thereby to optimise the management and utilisation of these professional service firms. This chapter has provided some background information on the nature of the South African consulting engineering industry. The next chapter (Chapter 3) therefore discusses the impact of changes in the macro external business environment on the strategic and operational management of South African consulting engineering firms against this background.