Engineering Council of South Africa

Submission to the Department of Higher Education and Training on the Green Paper on Post-School Education and Training

30 April 2012

Executive Summary

The Engineering Council of South Africa welcomes the Green Paper and offers a number of comments that it is hoped will add value to the subsequent process. This contribution begins by sketching the background to education and training for our profession.

We propose improvements to some of the terminology used in the Green Paper. We also encourage a systems thinking approach to the complex system of post-school education and training, namely, divide the system into subsystems; optimize the internal operation of the subsystems; and define the interfaces and interactions between subsystems.

The Green Paper discusses problems in various sectors: FET colleges, higher education and industry. The treatment lacks a pipleline view, that is, the flow from school to higher education to industry higher education and training. The impact of deficiencies in the school system receives only passing reference in the Green Paper. At the same time there is an unrealistic expectation of significant increase in mathematics-capable school leavers to enter higher education.

The Green Paper presents an in-depth analysis of the FET college sector. This would be enhanced by a clearer conceptualization of college education.

The discussion of work-based learning is supported and suggestions are made for alleviating the problems of National Diploma students who cannot graduate because they are unable to get work placements.

We make three main points about the university sector. First, the current aggregation of SET graduate number masks severe shortages in key areas such as engineering. Second, our research has identified a set of reasons for poor success rates in undergraduate programmes. Third, the provision of competent, committed staff is key to functioning universities and programmes.

On the question of national systems, we argue that the present configuration of Quality Councils be further developed and believe that options involving reconfiguration will set the system back severely. We contribute our understanding of the relationship between professional bodies and the Quality Councils to help build a wider understanding.

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1. Introduction

The Engineering Council of South Africa (ECSA), with inputs from its key committees, welcomes the Minister of Higher Education and Training's Green Paper on Post-school Education and Training and makes the following submission that we believe will materially contribute to the fulfillment of key objectives of the Green Paper.

2. Interest of the Engineering Community in the Green Paper

This community also made a submission[1] to the National Planning Commission in response to the National Development Plan (NDP). In that submission, we highlighted the need for a significantly increased number of qualified engineering practitioners, forming a balanced team[2]. While this is a sectoral requirement, achieving this increase relies on the post-school and school systems. Many of the changes proposed in the Green Paper are therefore of vital interest to the engineering profession and industry.

As background to our comments on the Green Paper the remainder of section 2 sketches the engineering sector and its professional education and training requirements to give context to our comments.

2.1 The Engineering Skills Spectrum and Development Pipeline

We provided the following analysis of the lifecycle of an engineering practitioner in our submission on the NDP. This analysis identifies blockages in the pipeline at school, university and post graduation.

The development of engineering professionals is a pipeline[3] process. It has several stages and each stage is dependent on the flow through and quality achieved by the previous stage:

- **Schooling:** Achievement of adequate preparedness in Mathematics, Physical Science and English;
- **Higher Education:** Attainment of a qualification accredited by ECSA for the category of registration shown in Table 1;
- **Candidacy Phase:** Training and gaining experience after graduation to develop the competency required for registration.

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[1] Engineering Council of South Africa and Partners, Submission to the National Planning Commission on The National Development Plan, http://www.ecsa.co.za/documents/010412_ECSA_NDP_Submission.pdf

[2] For background on engineering see:

Amod S. and Wall K., SAICE Infrastructure Report Card for South Africa 2011, The South African Institution of Civil Engineers.

Du Toit R. and Roodt J., Engineers in a Developing Country: The Profession and Professional Education of Engineering Professionals in South Africa, HSRC Research Monograph, HSRC Press, 2009.

Lawless A., Number and Needs: Addressing Imbalances in the Civil Engineering Profession, The South African Institution of Civil Engineering, 2005.

Lawless A., Number and Needs in Local government: Addressing Civil Engineering – the Critical Profession for Service Delivery, The South African Institution of Civil Engineering, 2007.

[3] The term *pipeline* captures the idea of a process with distinct stages where the input to one is the output of the previous. For the pipleline to flow well, all stages must perform. A blockage or shortage of feedstock at one point affects the performance of subsequent sections of the pipeline.

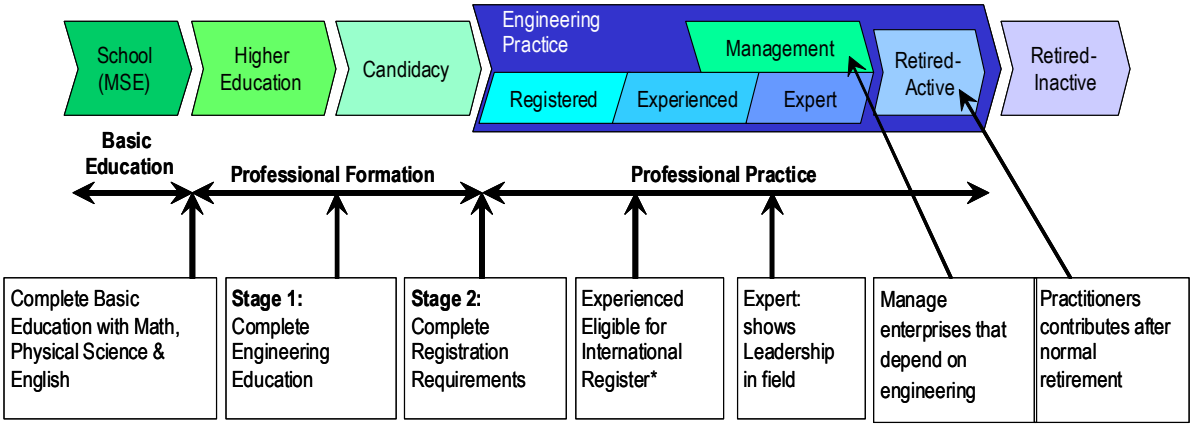

Figure 3: Lifecycle of an engineering professional

Table 1: Educational Requirements for registration in professional categories	
Professional Designation (Category of Registration)	**Type of Accredited Professional Higher EducationQualification**
Professional Engineer	BEng/BSc(Eng) – four-year NQF Level 8
Professional Engineering Technologist	BTech – one-year NQF Level 7, having completed a National Diploma
Professional Engineering Technician	National Diploma Three year (including one year experiential training) NQF level 6
Professional Certificated Engineer	Government Certificate of Competency[4]

Blockages exist in the pipeline at all three levels: school, higher education and post-graduation training (the candidacy phase). If the future goals are to be attained, not only will it be necessary to address the blockages but the entire pipeline will have to move to a much larger scale. The first two sectors, schooling and higher education, are discussed in our commentary on Chapter 9 below. Shortcomings in the Candidacy Phase are reviewed next.

School System: While the school system is not the subject of the Green Paper, it is the feeder to the post-school system – and imposes severe limitations.

In our submission on the National Development Plan we made the following points:

> Of particular interest to engineering is the target on page 276 (linked to the higher education entry on page 277) for an increase in the number of students eligible to study mathematics and science at university. The following professions would compete for these students: engineering (degrees and diplomas), accountancy, health sciences, mathematical sciences, natural sciences and future mathematics and science teachers. The assumption is that such students would have adequate grades in Mathematics and Physical Science in the NSC.

We also made the point that official documents often refer to the legal minima for entry to bachelors degree and diploma studies but that level does not reflect reasonable preparedness for such

[4] The educational base for the Certificated Engineer is the Government Certificate of Competency. This is under the control of the Commissioner of Examiners operated jointly by the DMA and DoL. The entry requirements for the GCC examination include a range of qualifications, not accredited by ECSA for this purpose, ranging from the National N Diploma (with passes at 50%). ECSA has proposed a new model for the Certificated Engineer that would bring this professional category in line with other categories.

programmes. We also stressed the importance of language, and English in particular in global professions such as engineering.

In our comments on Chapter 6, we examine proposals for expansion of the number of school leavers eligible for entry into mathematics-based higher education programmes against the current reality.

Higher Education System: Our comments on chapter 6 of this Green Paper discuss blockages in the higher education system.

Candidacy Phase: At the candidacy level, graduates from the higher education system are not receiving adequate training and experience to develop from graduate competency to professional competency. The minimum period of candidacy is three years. Of the persons registered as Candidate Engineers for more than three years about 10% have attained registration as a Professional Engineer in the last two years. About one-quarter of Candidate Engineers have been registered for six or more years.

An important contributory factor is change that has taken place in all sectors: government, state enterprises and the private sector. Two decades ago, two important conditions prevailed. First, there was a culture of training engineering graduates toward registration. Second, these bodies were adequately staffed with qualified professionals who could plan training programmes, supervise work experience and mentor candidates. In all but a limited number of companies these conditions no longer exist. The de-professionalisation of the civil service and short-term responses to competition in the private sector are contributory factors.

It is appropriate to record that a limited number of employers have exemplary training programmes and also contribute the majority of new registrations. Success factors include:

- Adequate funding;
- Training on structured programmes towards professional registration;
- Training in environments with experienced technical staff, giving direction, mentoring and coaching;
- Effective group work;
- Regular reviews and adjustments to trainee's programmes to ensure progress.

However, the experience of the majority of trainees is not conducive to attaining registration in a reasonable period.

ECSA has reviewed its registration guidelines to ensure that there is an awareness of requirements and best practice in training. A candidacy phase strategic initiative is underway that seeks to address the poor throughput of the candidacy process. A key aspect of this is unlocking of Skills Levy funding for firms that commit to training and undertake programmes.

Comment on Chapter 1: Terminology in this Green Paper

The definition of **further education** is couched in terms of the institutions that offer this type of education and training rather than the fundamental purpose of the education it offers. This is

potentially problematic – particularly as regards the possible change in name. A future-proof definition emphasizing the characteristics of further education is recommended.

Several definitions conflate the education and training processes, which are often sequential. In addition, Chapter 9, which is concerned with the Setas and workplace learning, the definitions of **occupational education** and **professional education** are problematic. It is useful to distinguish between trades, non-trade occupations and professions. The first and last are distinctive forms of occupations. The development of competency in a trade, occupation or profession has, in general two components: one that is predominantly educational and one that is predominantly oriented to developing proficiency in the workplace. The following definitions would be helpful.

Provider-based education[5]**:** education where the instruction, assessment and certification are the responsibility of a provider that is subject to a quality assurance mechanism.

Workplace based learning: learning that is primarily conducted through work with possible formal education and training components

Professional education: programmes leading to qualifications that provide the educational foundation toward attaining a professional designation; this is in most cases a higher education qualification.

Professional training: the process of being trained and gaining experience toward attaining a professional designation.

Occupational education: refers to educational programmes, which may lead to vocational qualifications, that are focused on preparation for specific occupations; not normally applied to professions.

Occupational training: ongoing development and training in the workplace toward attaining an occupational qualification; not normally applied to professions.

Apprenticeship: the particular case of occupational training, with associated educational components, leading to qualification in a recognised trade.

The benefit of these expanded definitions is demonstrated in our comments on Chapter 9 of the Green Paper.

Comment on Chapter 2: Main purpose of the Green Paper: A Vision for the Post-school System

Paragraph 1 on page 4 notes that "the establishment of the DHET created the opportunity to being a single, coherent, differentiated and highly articulated post-school education and training system". We agree that this is an opportunity but caution that in planning and operating such a complex system there are pitfalls, particularly in the imposition of common operational and governance models to diverse sectors, as discussed in our comments on chapter 9.

A well-established principle for designing complex systems is to beak the overall system into subsystems and determine the optimum internal workings for each subsystems. The next step is to

[5] Not used in the Green Paper but use of provider-based and workplace based may create useful distinction for future documents.

design the interfaces between the subsystems to allow them to interwork efficiently. This principle should be applied to the higher education, college and industry sectors. Trying to co-ordinate the internals of different sub-systems is well known to be a complicating factor. Good systems engineering dictates: optimize the internal operation of the subsystems and define the interfaces and interactions between subsystems.

Building the capacity of public providers: The Green Paper dwells on the very real problems of parts of the college and higher education system. A large number of interventions by the DHET are envisaged. While recognizing that there are parts of both sectors desperately in need of improvement, the Green Paper does not concentrate sufficiently on the successes and the lessons that can be drawn. For example, successful institutions and programmes are due to the presence of capable and dedicated teaching, research and management staff as well as sound, functioning governance structures. Given these conditions, it is possible to achieve results with limited resources. Conversely, large injections of funding may be dissipated if there are not competent staff to utilize the funding. The emphasis in the Green Paper on resources, without an accompanying logic for how these will leverage the institutions and programmes, is of concern. Similarly, the emphasis on staff training when the individuals may be totally unsuited may also prove to be in vain.

Developing the capacity of statutory bodies: We comment particularly on the Quality Councils in our input on Chapter 9 below

Building a single post-school system: Emphasis falls on ensuring that there are mechanisms for co-ordination and collaboration to build a well articulated and effective system. Our comments above on effective approaches to complex systems are relevant here.

Taking higher education as an example, we stress that the delivery of quality programmes to achieve their respective purposes is the primary function and responsibility of the higher education providers. Programmes must be designed and executed to fulfill their primary purpose Interface considerations must be supported by system-level rules, for example, programmes must lie on pathways with exit points that provide useful qualifications (e.g. as defined in the HEQF). The form of articulation that can be built into the system is at the qualification level. Articulation that involves internal credit transfer or change of pathways is more a provider responsibility than a system responsibility.

Comment on Chapter 3: Challenges in Post-school Education and Training

Section 3.3 analyses the inadequate quantity, quality and diversity of provision in the post-school system. While the entire post-school system falls under the DHET, it is a collection of systems with different characteristics and functions, as tabulated in our comment on Chapter 9 below. Each of these systems contains pockets of excellence as well as problematical areas. Recognition of diverse needs and problems will be essential going forward.

We agree that, in our field of engineering, that the total size and shape of the engineering workforce does not match the needs of the country that we would wish to become, let alone what it is now. In our submission to the National Planning Commission we stated:

We make the obvious comment that skills-planning is not an exact science and should not be used at too fine a grain of detail. Some thought needs to be given to the consequences of acting on projections that turn out to be wrong. Under-providing is always harmful so this should always be avoided. Is over-provision harmful? In engineering education, through our standards and accreditation system, we keep undergraduate degrees broadly based with a solid core of fundamentals and a strong emphasis on problem solving. Graduates are able to make the transition from their original disciplines to many other fields where they make contributions to the economy. Overprovision of engineering graduates is not harmful provided that they are not so narrowly educated and trained that they cannot make career transitions.

Skills planning in engineering must cover the whole team from research scientist to artisan as illustrated Figure 2.

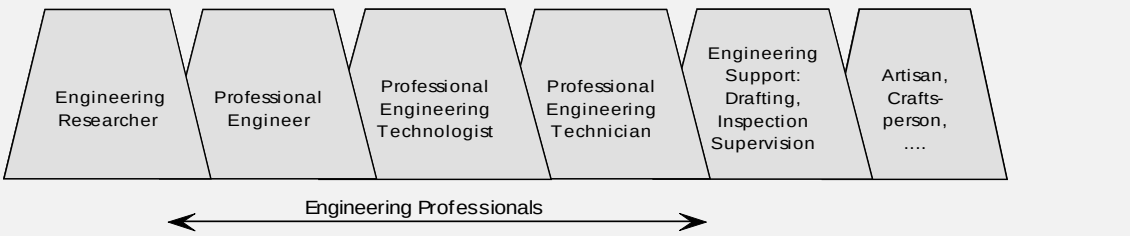

Figure 2: The **Extended Engineering Team** consists of the roles shown

From a skills planning point of view, the post-school sector lies downstream of the school system in the skills development pipleline. The concept of a skills pipeline allows the overall problem to be divided into manageable sub-problems. The Green Paper does not discuss the knock-on effect occasioned in the post-school sector, other than to acknowledge in the first full paragraph on page 10, the "poor quality of most of our schools". The post-school; system is told to face the reality that, for a long time, it will have to deal with inadequately prepared school finishers.

Comment on Chapter 4: A Strengthened and Diversified College Sector

The chapter opens by identifying the need to develop a clear national vision for the types of providers in the post-school system. There is no attempt to articulate objectives of the college sector, but rather to focus on the weakness and small size of this sector. It would be unwise to resolve the latter questions without being clear on the purpose of college education.

The recently published qualifications framework for the Further Education and Training[6] assists partially here. It clarifies the nature and objectives of the National Certificate (Vocational) but does not adequately resolve the question of educational components of apprentice training. The definition of vocational education given in chapter 1 with some rearrangement is also useful here:

> **Vocational education:** provides knowledge, including essential areas such as language and mathematics, and skills to enter the economy in trades and occupations.

[6] The General and Further Education and Training Qualifications Framework, Government Gazette, vol 558, 23 December 2011, No 34883, pages 8-49.

The rationale for the college sector is to offer vocational education at mid-levels (a term that is not defined, but would be NQF Levels 2, 3 and 4 with a limited extension to Level 5).

Three options are presented on pages 22 and 23 for the NCV. Options one or two taken alone are restrictive. Option three can be structured to include the short and long curricula envisaged in options one and two.

Currently, there is a mis-perception that college education in engineering subjects is an alternative to university or university of technology programmes engineering programmes. Referring to Figure 2, colleges would be involved in artisan educational components and engineering support occupations. These are complementary to but do not replace Diplomas and Degrees in Engineering.

The previous statement leads naturally to the question of progression from college qualifications to higher education programmes. Considerations vary from field to field, for example what is good for business studies is not necessarily applicable in engineering. The broad principles that would apply in engineering are, firstly, a high level of achievement at NCV4 would be needed and that, irrespective of the technical subjects, good performance in Mathematics, Physical Science and English at NCV4 would be essential.

Comment on Chapter 5: Work-based learning

An important blockage in the engineering skills pipeline for technician and technologist education is the lack of sufficient placements for students in National Diploma programmes. Even if the university of technology makes the best effort to find work placements, this is often insufficient for all students. The consequence is that a significant number of National Diploma students have completed the academic portion of the curriculum but cannot graduate because they have not met the work-based requirement. Consequently, their employment prospects are compromised and they cannot enter candidacy programmes.

This will be a continuing problem when existing National Diplomas are migrated to HEQF-compliant 360 credit diplomas. The HEQF policy requires the provider to ensure that there are adequate opportunities for every student to obtain the work-based placement. While this puts pressure on the providers, it will not solve the problem unless the number of placements increases to match the number of students.

The brief discussion in chapter 5 identifies the roleplayers who must be involved in solving this problem. It does not however identify concrete solutions. While some aspect of the solutions may be generalized these will have to be worked out sector by sector.

As an example of a possible opportunity, ECSA has proposed a 240 credit diploma in the revised HEQF. This would allow a two-stage attack on the problem of students who are unable to graduate because they lack work experience. First, the student would be able to graduate when he or she has completed the Diploma. Even though they have not yet completed the work-based component, they may be more attractive to employers because they have qualified. Second, the work-based component could be structured as a workplace programme and standardized, funded and certified via the QCTO. The Seta skills plans would have to make provision for such programmes.

A second opportunity would be the formulation of a plan to ameliorate the situation of the students who have completed S1-S4 of the National Diploma but not P1 and P2 and are unable to graduate with National Diplomas. A special initiative to award a 240 credit diploma to such students should be a priority. They would then be on a par with graduates of the proposed 240 credit diploma.

Comment on Chapter 6: Universities

We identify the following points for comment.

Size and shape of the university sector: This chapter places more emphasis on size of the university sector, but less on shape. The aggregation of "Science, Engineering and Technology" in Table C is unhelpful in judging how well the universities are meeting the skills requirements of the country. Of the ~41000 SET graduates in 2010[7], some 11 000 were in the health sciences, 15 000 in the natural sciences and mathematics and only some 10 000 in engineering. This includes BEng, BTech, National Diplomas and postgraduate awards. The argument below shows that the number of four year bachelors programmes in engineering is well below the needs to run a country at our state of development, let alone develop it further.

Table 2: Accredited BEng-type programmes per million of population

Country	Population	Programmes	Ratio
South Africa	51.5	51	1.0
Japan[1]	125.0	388	3.1
Turkey	76.9	300	3.9
Singapore[2]	5.1	23	4.5
United States	327.2	1854	5.7
Ireland	4.6	30	6.5
Canada	35.1	261	7.4
Malaysia	28.3	211	7.5
New Zealand	4.4	36	8.1
S. Korea	49.2	463	9.4
Australia	23.8	248	10.4
Taiwan	25.0	331	13.2
Hong Kong	7.1	111	15.6
United Kingdom[3]	64.8	1903	29.4

1: Low estimate, not all programmes accredited
2: Low estimate: number of students per programme is large
3: High estimate: cases where two programmes are required in combination

The relatively small size of our engineering higher education sector may be gauged in terms of the number of engineering programmes per million of population. Table 2 lists the Washington Accord countries with the number of accredited programmes (2011) and their populations (2010). South Africa has the smallest number of BEng-type programmes per million of population.

From Table 2, and by comparison with Malaysia and Turkey in particular, a reasonable inference would be that a five-fold increase in the number of programmes (or a five-fold increase in the number of graduates) is needed over time.

[7] HEMIS Table 2.13: All Graduates for 2010

Differentiation of institutions: On the matter of differentiation of institutions, we would not support a binary divide but rather a pragmatic model as follows. As illustrated in our field, there are professional degree programmes that have strong formative components and are best offered in a research-active environment, while there are vocationally oriented qualifications where a more practice-oriented environment is appropriate. University departments are likely to be configured for one of these modes. The controlling mechanisms are the PQM (for public institutions) and the HEQC Candidacy Phase provisional accreditation. The latter is well geared to determining whether a proposed programme has an appropriate environment. It is not clear how PQM decisions are informed; they clearly lack input from relevant stakeholders. The principles listed on page 40 are supported.

Student success rate and the lower success rate for African students in particular: This problem has been studied in the case of four-year bachelors degrees in engineering[8]. Seven groups of factors, some of which interact, are identified as being material to any attack on the problem of student success rate:

i. **Schooling**: improving the 'talent pipeline' from schools into university by, *inter alia*
    a. Engaging government re gaps in the mathematics curriculum
    b. Engaging government about school exit standards and the reliability of school-leaving results
    c. Promoting school outreach and career advice initiatives
ii. **Student selection**: selecting the right students, by
    a. Critically reviewing current selection approaches, in both mainstream engineering and foundational programmes
    b. Investigating how selection processes could better identify student interest, aptitude, insight and problem-solving and analytic abilities
    c. Providing better career advice and student placement mechanisms
    d. Engaging bursary providers to improve student selection and reduce inappropriate 'steering' of student degree choices
iii. **Student support services**: closing the gaps in student support services, both at the institutional level, and from the side of bursary funders and student financial aid agencies, in order to ensure that
    a. Students receive support from the first year of their studies, which is when they need it most
    b. Financial support is available from the commencement of the academic year, so that students do not have to spend the first term or semester worrying about accommodation, books, transport costs etc.
    c. Ensuring that all of the 'hygiene issues' affecting students, such as food, accommodation, transport etc. are comprehensively packaged for each student, and explained to them at commencement of the academic year
    d. Bursaries and student financial aid are available to students on extended as well as flexible mainstream programmes, and that there is flexibility to continue financial support where promising students fail or repeat a course

[8] Fisher G., Improving Throughput in the Engineering Bachelors Degree Programme, Report to the Engineering Council of South Africa, October 2011.

e. Ensuring that all institutions, at university, faculty and department level, put in place coherent and comprehensive student support mechanisms which effectively address the social and educational backgrounds of their student intakes

iv. **Curriculum**: ensuring that the engineering curriculum remains relevant and responsive to the demands of professional practice and the needs of business in a changing world, and flexible enough to cater successfully for a diverse student intake by, for example

a. Undertaking a comprehensive, system-wide review of foundational and extended programmes, aimed at strengthening foundational support to students while informing the development of a more flexible and responsive mainstream curriculum
b. Monitoring and a critical review of key 'experiments' in curriculum reform, such as those that are under way at the Universities of Pretoria, KwaZulu Natal and Cape Town
c. Engaging government in order to ensure that the HEQF, HEMIS and funding framework provide funding and recognition for a flexible mainstream curriculum as well as foundational and extended degree programmes
d. Convening a 'blue ribbon' review of the mainstream Bachelors degree, possibly in cooperation with international as well as national bodies; this should consider *inter alia* the policy choices and practical implications pertaining to foundational and extended programmes and a flexible mainstream curriculum

v. **Teaching and Learning**: strengthening the core mission of teaching and learning, *inter alia* by

a. Holding institutions accountable for teaching and learning outcomes, at key stages in the degree
b. Encouraging each institution to put in place an effective institutional Teaching and Learning Strategy, as called for by the HEQC
c. Encouraging the development and recognition of teaching expertise in engineering
d. Giving national recognition to teaching expertise and research into engineering education, by establishing a system of prestigious grants and awards

vi. **Staffing**: ensuring that mainstream engineering as well as foundational programmes are appropriately staffed, with a sufficient foundation of teaching expertise and professional development support available to lecturers, by

a. Facilitating the development of a coherent package of measures, including improved funding and salary subventions, to address the staffing crisis in engineering [8]
b. Reviewing the staffing implications of a flexible mainstream engineering curriculum, alongside options for foundational provision
c. Supporting postgraduate training and the development of engineering 'centres of excellence' aimed at broadening and expanding the academic staff pipeline

vii. **Funding**: ensuring that engineering education is sufficiently well-funded to meet the current and future demand for engineers, maintain quality and standards, and meet the needs of a diverse student intake, by

a. Engaging government on funding levels for engineering
b. Engaging government on the higher education funding framework, HEMIS and the HEQF, in order to ensure that foundational, extended and flexible mainstream curricula are recognised and funded through the funding framework
c. Engaging government with a view to ensuring that the teaching and learning mission of universities is sufficiently recognised and supported
d. Ensuring that institutional funding of engineering is adequate

e. Engaging with DHET, NSFAS and bursary funders, to help ensure that students' financial needs are met in a timeous and effective manner, that students' career choices are not unduly influenced by the availability of funding, and that bursaries and student financial aid are linked more effectively to student outcomes.

Staffing of Engineering Faculties: A 2008 report[9] identified that engineering faculties at South African Universities were operating at staff student ratios that potentially affect the various departments' ability to offer programmes. This research is currently being brought up-to-date but is unlikely to signal any improvement. It is to the great credit of our academics that, while graduation rates leave much to be desired, the quality of graduates is generally recognised. However, the situation is fragile. This situation also affects the ability of our engineering academics to contribute to another priorities identified in this chapter, namely, increasing access, enhanced research and innovation and the production of increased numbers of masters and doctoral graduates.

Finally, we can do no better than to reiterate the comment that the key to solving most problems in higher education is the recruitment and retention of staff. The development of high quality academic staff is a long process requiring substantial input from established academics. Single interventions such as "subject matter training" have little potential impact.

Academics must be supported appropriately by management and systems. The paragraph at the middle of page 46 refers to "management problems". In the troubled universities referred to this problem in all probability extends from cleaner to council. We re-iterate or earlier comment about the importance of getting capable, committed people in at all levels of the institutions and good systems operating. The DHET alone cannot do this alone and all stakeholders have to play their parts. The first priority is to get competent, committed people of integrity in the key positions.

Comment on Chapter 9: Building State Institutions and Streamlining the Regulatory System

Comment on Section 9.3: The National Qualifications Framework

Here we need to follow the "systems engineering approach" expounded earlier. The sub-frameworks must each be effective and efficient internally and have agreed, defined external interfaces. We comment on the following aspects.

Higher Education Qualifications Framework: In our submission on the NDP we stated:

> Higher education and further education qualification frameworks have been in an uncertain state and revision proposals have been gazetted recently. The long delay in revising the Higher Education Qualification Framework (HEQF) has been counterproductive. The revised HEQF will meet the needs of engineering if implemented according to the proposal. The FET framework also needs stability and quality implementation of programmes.

The DHET is urged to complete the HEQF Revision without delay.

1. [9] Lawless A. and Kirsten L., Report to JIPSA on Academic Shortages in Higher Education Engineering Faculties, Unpublished Report, Joint Initiative on Priority Skills Acquisition, 2008.

Levels of the NQF and Level Descriptors:

Section 9.3.3 presents options for simplifying the NQF. The following background comments are helpful. The HEQF defines a number of **qualification types** having distinctive purpose and characteristics and their possible progression routes. It also assigns an exit level to each type. The assigned levels provide a background grid which is helpful if it is there but would not compromise the HEQF if it is not. The General and Further Education Sector is organized using grades, the uppermost of which correspond to NQF levels 1, 2, 3 and 4. The same comment applies: if the purpose and characteristics of, say Grades 10, 11 and 12 as NCV 3, 4 and 5 are well defined, the levels form a background grid that provides a background structure but is not a critical factor. In the occupational space, particularly where the various modules of learning are small, the levels serve a purpose.

The arguments for and against NQF levels are evenly balanced. They may be more compelling at the lower levels of the NQF. However, we have had levels since the inception of the NQF and living with them into the future is probably less disruptive than scrapping them. To remove levels merely to resolve ownership of quality assurance of Level 5 qualifications would be irresponsible.

We made the following comment about Level Descriptors in our submission to the DHET on the HEQF Revision.

> The concept of the level descriptors being the outermost layer of the qualifications specification is accepted as a broad principle. We understand that SAQA is the custodian of the level descriptors and has published the document "Level Descriptors for the South African National Qualifications Framework", which appears still to be a public comment document. We also understand that the level descriptors are "broad qualitative statements against which more specific learning outcomes can be compared and located". The level descriptors are not useful until contextualized in a field.
>
> ECSA has the experience of developing standards for qualifications at NQF Levels 5, 6, 7 and 8 and has used outcomes and level descriptors that are internationally benchmarked for engineering professional qualifications. Our observations when comparing our standards with NQF level descriptors are the following:
>
> a) The level of demand in the knowledge categories A-C[10] of the NQF level descriptors at levels 6 to 7 is greater than we have found to be warranted in practice. Without detailed comparison, the level 5 descriptors may also be pitched at too demanding a level. For example it is unlikely that the graduate of a level 5 exit qualifications is able to "demonstrate knowledge of the main areas of one or more fields, disciplines or practices, including an understanding of the key terms, concepts, facts, principles, rules and theories of that field, discipline or practice"
> b) There are notions that may be valid in some fields but are inappropriate in others. With reference to category B, level 7, knowledge is not regarded as contested in our

[10] The NQF Level Descriptors for Levels 5-10 use ten categories: A: Scope of knowledge; B: Knowledge literacy; C: Method and procedure; D; Problem Solving; E: Ethics and professional practice; F: Accessing, processing and managing information; G: producing and communicating information; H: Context and systems; I: Management of Learning; and J: Accountability.

field. There is, for example, a substantial body of fundamentals on which engineers rely on absolutely.

c) The level of problem solving indicated in category D is in excess of that in our standards at levels 6 and 7.

d) The level descriptors cover ten categories A to J. Some of these are particularly applicable in educational programmes while other are more suited to occupations and professions. For example, the level of responsibility and accountability and the expectation of a student to take responsibility for the learning of others are excessive for educational qualifications. For example, does one expect a level 7 graduate to take accountability for the decision and actions of others (category J)? An education qualification cannot have all the attributes A to J, nor could an occupational qualification.

We conclude that the NQF Level Descriptors in their present form may be problematic when locating the standards for actual programmes that, by all other measures, are fit for purpose. Contextualisation is necessary in developing standards at the designator level.

Comment on Section 9.4.1: Quality Assurance Structures.

Section 9.4.1.1 deals with several issues relating to professional bodies and Quality Councils. We comment on proposals to possibly alter the configuration of the Quality Councils and relationships between the professions and the Quality Councils, the HEQC in particular, perhaps by documenting ECSA's relationship which is seen by some as a model to emulate.

Comment on Section 9.4.1.2: Configuration of the Quality Councils

Section 9.4.1.2 raises the questions of whether the Quality Councils should be reconfigured - and this before the QCTO has become operational and before new standards setting arrangements have been settled in the other councils. The principal motivation seems to be to settle territorial disputes about which QC is in charge of NQF Level 5 qualifications.

The following is an extract from our submission on the National Development Pan:

> We are distressed to see the suggestion that the three Quality Councils arising out of the NQF Act of 2008 are seen to be in need of reconfiguration. The analysis in the Plan is superficial. We strongly urge that energies be directed at making the present configuration work. Rather solve the right problems. For example, the third paragraph refers to the battle for ownership of Level 5 on the NQF. The simple solution recognises that there will be different types of qualifications at Level 5: occupational qualifications, national vocational certificates and higher certificates designed to give access to higher education, to name a few possibilities. Thereafter, qualifications are quality assured by the appropriate Quality Council.

The information about the various education and training sectors, their typical qualifications and the QCs presented in this section provides the rational for a strong recommendation in favour of Option 2 and strong arguments against the other options.

The starting point of our argument is to summarise the information (including the school sector for completeness, since Umalusi is a candidate for reconfiguration) in Table 3.

The sectors used in Table 3 are consistent with the revised definitions proposed in our comment on chapter 1. The roles and responsibilities are identified for a number of functions: who is the provider, who sets the standards, who designs the curriculum, who assesses, who certifies qualifying learners and which body quality assures?

Table 3: Summary of roles and responsibilities in various education and training sectors

Sector	Typical Provider	Standards	Curriculum	Assessment	Certification	Quality Assurance
Basic Education	School	National				Umalusi
Vocational Education & Training	FET College	National				Umalusi
Higher Education	University/ Private HEI	CHE, link to HEQF Type	Provider			HEQC
Professional (Higher) Education	University/ UoT	CHE/ Profession, HEQF Type	Provider			HEQC/ Profession
Professional Candidacy	Industry	Profession	Industry	Profession – award of Professional designation		Profession
Occupational Education and Training	Industry + E/T Providers	QCTO and DQP Linked to Occupational Profile (OFO)		AQP/ Assessment Specification	QCTO	QCTO
Trades	Industry/ FET Colleges	NAMB	NAMB	NAMB-accredited test centres	NAMB recommend to QCTO	NAMB (Test Centres)

Option two on page 76, namely to continue to build the three bodies in their current forms, is strongly supported for a number of reasons evident from Table 3:

1. The three sectors assigned to CHE, Umalusi and QCTO respectively are sufficiently distinctive in character and function to operate at maximum efficiency if they are independent. If they are merged, internal divisions will still be needed that must operate according to the requirements of the sector. In option one, the single overarching council will have a substantial span of control over diverse chapters. Only rare and exceptional people will have sufficient insight into the different worlds of education and training. Such a council will inevitably lack the detailed domain knowledge of all the sectors. To be effective, it would have to grant a high degree of autonomy to the chapters, virtually recreating the present situation and rendering itself redundant. There is a danger that the overarching council, which will, in all probability, be unable to deal with the complexities of all sectors without imposing a one-size-fits-all model, much as SAQA did.
2. Option 3 is not detailed in the Green Paper. However, as the proposal seems to imply, moving professionally oriented [educational] qualifications out of the Higher Education Sector to the QCTO and vocational qualifications from Umalusi to the QCTO creates the same problem of complexity for the QCTO as option one would create for the entire system.
3. Option 4 creates a situation where Umalusi would be concerned with two worlds: the school/college world and the world of a myriad occupational qualifications. The complexity is shifted to Umalusi in this model.

A further argument in favour of retaining the existing configuration of Quality Councils is that it minimizes the range of external stakeholders that each council must deal with. For example, option 1

means that the single council must interact with the entire diverse education and training world. Option two restricts interactions to matching external sectors.

The HEQF and Umalusi are well established and have appropriate policies, criteria and practices, as well as staff and peer evaluators, in place appropriate to their roles and responsibilities. While opportunities for improvement no doubt exit, the investment into these bodies to date is immense and their achievements are significant. The QCTO is still to bed-down but it is of necessity on a distinctive trajectory that has been judged best for the trades and occupational sector.

The disputes about who quality assures what at level 5 does not need a sledge-hammer solution. A qualification with a distinctive characteristic must be quality assured by the QC that it best fits. The refinement of definitions for occupation qualifications that distinguish between a educational, provider-based focus and a more practical workplace focus allow a definition of qualification types that ease the identification of the most appropriate Quality Council.

Finally, we must make a plea not to perpetuate the delays, uncertainty and false starts of the past. Adoption of options one, three or four will throw the system off its present trajectory, particularly the well-established and functioning CHE and Umalusi. Options one, three and four are all disruptive to the QCTO as it tries to find its feet. Adoption of any option other than two would be grossly irresponsible.

Comment on Relationship between Professions and Quality Councils

The comments start, of necessity with a few caveats:

- Not all professions are at the same state of maturity in their approach to standards, assessment and best practice; the model assumes a degree of maturity of the profession.
- Professions are distinguished from other occupations by requiring a substantial body of knowledge, based on fundamentals that are most efficiently acquired through a higher education programme.
- Practice of such professions, while providing services and bringing benefit to the public, also occasions risks involving variously health, safety, property, environmental degradation, personal rights and financial loss. Hence, such professions are normally regulated either by statute or by a body that enjoys widespread recognition.
- Models for education and professional development differ from profession to profession. The main differences are in the balance between the educational phase and the practical training and experience phase leading to professional registration (or equivalent).

These comments are organized according to the education and training and experience phases.

Higher Education Phase

Various functions common to professional bodies and Quality Councils relating to higher education are as follows.

- **Standards:** In the higher education phase, the standards for the qualifications must embody the purpose of the qualification and the outcomes that demonstrate that the purpose has been

attained. While the responsibility for setting[11] standards for higher education qualifications is assigned to the CHE by the NQF Act, the reality is that the community of practice that has the peer knowledge and judgement to define standards rests in the profession and in the engineering faculties in the universities, two bodies that operate in partnership.

- **Delivery – Curriculum, Instruction, Assessment, Certification:** the programmes and the resulting qualifications are provider-based. The universities are responsible for the curriculum, teaching and learning processes, assessment and certification of graduates.

- **Quality Assurance:** In the case of statutory professions, quality assurance usually has two legal empowerments. The Higher Education Act requires the CHE, through the HEQC, to quality assure programmes. In practice this is restricted to the evaluation of new programmes and this is done with input of evaluators that understand the professional requirements. The profession's legislation typically empowers the professional body to conduct accreditation visits[12], This is to determine whether a programme provides the educational base for a particular professional designation. The professional body conducts accreditation visits to programmes that are producing graduates on a defined cycle. The accreditation criteria are not restricted to the purpose and outcomes defined in the standard but also cover the programme design, assessment, quality of teaching and learning and resourcing of the programme. These additional criteria are substantially equivalent to those specified by the HEQC. The profession's ongoing quality assurance of programmes producing graduates therefore informs the HEQC of the continued quality of the programme.

Candidacy Phase and Professional Registration

After graduation the aspiring profession must undergo practical training, gain experience and be assessed prior to obtaining the professional designation.

- **Standards:** The profession's legislation typically assigns the responsibility for determining the standards of competency for registration to the professional body. The peer expertise for defining and approving these standards lies in the body of registered professionals.

- **Curriculum and Instruction:** While some professions have highly structured programmes that graduates must follow to attain professional registration, other professions do not find this practically possible. This aspect of professional development is, for good reason, is most variable from profession to profession and within some professions.

- **Assessment, Certification:** The professional body is responsible for assessing the competence of applicants for registration. Such assessment is performed against the standards of competency set by the professional body. Successful assessment leads to the award of the professional designation by the professional body. The designation is not a qualification: it

[11] The NQF Act uses the "standards setting" terminology. The CHE prefers the notion of "standards development". These terms are used interchangeably in these comments.

[12] In the case of a non-statutory professional body, the functions must be empowered in its founding document but must also enjoy the respect of the profession, government and the public.

can be rescinded, for example due to proven professional misconduct, or relinquished by the holder.

Appendix: Excerpt from Submission on the National Development Plan: School Leavers with Mathematics and Science

Of particular interest to engineering is the target on page 276 [of the NDP] (linked to the higher education enty on page 277) for an increase in the number of students eligible to study mathematics and science at university. The following professions would compete for these students: engineering (degrees and diplomas), accountancy, health sciences, mathematical sciences, natural sciences and future mathematics and science teachers. The assumption is that such students would have adequate grades in Mathematics and Physical Science in the NSC. The uncertainty is whether this target is restricted to bachelors programmes or includes diplomas (at universities of technology). The following comment includes consideration of diplomas. It is also uncertain as to whether the Plan refers to the legal minimum for entry to degree studies or to a higher level that reflects reasonable preparedness, for example, well above 50% for bachelors programmes.

The Plan sets a target of 450 000 school leavers with mathematics and science at a level where they would qualify for entry to university. (The DHET has target of ~300 000 for 2024, somewhat more demanding than the NDP.) Both of these targets are ambitious. For degree and diploma studies, all 450 000 would have to take Mathematics (not Mathematics Literacy) and Physical Science and attain grades that are not only above the legal minimum but that indicate preparedness for the chosen programmes. This should be compared in Table 5 with the base of totals of 290 000 and 220 000 that wrote maths respectively in 2008 and 2011 respectively. In 2011, only 67 514 scored 40% or more in Mathematics and 41 586 were above the legal minimum of 50% required for bachelors degree entry.

Table 5. NSC Mathematics performance: 2008-2011

(blanks indicate data not published).

Mark	Year			
Range	2008	2009	2010	2011
0-29	162168	156902	138285	120620
>=30%	136504	133505	124749	104033
>=40%	89788	85356	81374	67154
>=50%	63035			41586
>=60%	42320			
>=70%	25539			
>=80%	12637			
Total	298672	290407	263034	224653

The target of 450 000 university-ready matriculants should be seen in the light of only 41 586 obtaining 50% (degree legal entry) in 2011. More noteworthy is the decline since 2008 in the number taking Mathematics and the proportionate decrease in those achieving at the higher mark levels. Also, unless the shape of the mark distribution (and the corresponding distribution of achievement) changes to the more common bell curve, it will be necessary to enroll some 1.6 million in Mathematics to get

this output! Thus, while the Plan seeks a large increase at the higher education entry level, the current trend is firmly in the opposite direction.

Given the five-fold increase in engineering graduates inferred in our comment on Chapter 6, it seems reasonable to set the target at about five times the 2011 value, that is, some 200 000. This is still a stretch target requiring in excess of 9% compound annual growth rate over 18 years.

There is also the question of the adequacy of the legal minimum mark as a preparation for engineering (or other) degree study. A CDE report[13] highlights the grade inflation that has taken place with the introduction of the NSC and the leveling of Physical Science down to the former Standard Grade. This is borne out by the experience of academics who find that high NSC symbols, even straight As in some cases, are not necessarily indicative of preparedness for degree study.

While setting targets is an important part of any planning process, other key factors must be taken into account. We identify two important considerations

- Expansion of numbers in SET programmes without improvement in performance will be counterproductive. It is therefore insufficient to simply set numerical targets. Quality targets are also needed. For example, the school curriculum, teaching, learning and assessment should be such that levels of achievement are meaningfully graded. For example, 60% achievement in Mathematics, Science and English once was a reasonable prognosis for an engineering degree programme (and the examination system should return to this situation). A common understanding of the outcomes of school education for success in SET careers must clearly be developed.
- The production of engineering professionals is a pipeline process. The performance of the pipeline, by analogy, will depend on the feed stock, the flow conditions and blockages. A perfectly functioning pipeline cannot exceed its inherent capacity, nor can it produce an output that is not already in the pipeline. Output cannot simply be turned on as the 2014/15 targets seem to assume.

If there is progress toward the 200 000 university-entry qualified matriculants, (let alone 450 000), soon the universities will be faced with further increase in demand for places in engineering programmes. It is common cause that the engineering departments in universities are under capacity, particularly in teaching staff, with the present numbers of students [8]. University departments are not in a position to grow at the required rate without major intervention, both externally in the form of increased PQM allocation (backed by real funding increases) and industry sponsorship and, internally, by the universities allocating increased resources over a sustained period. More important, making up the backlog and any increase of student will need more academic staff in engineering department. This is a very difficult task to fulfill with the conditions of service and competition from industry for top engineers.

[13] CDE. The maths and science performance of South Africa's public schools: Some lessons from the past decade, The Centre for Development and Enterprise, Number 1, September 2010.