

# DEVELOPMENT OF CANDIDATE CIVIL ENGINEERING LEARNERSHIPS

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## BACKGROUND

**'All genuine knowledge originates in direct experience'**  
Mao Tse-Tung

**'Scientists discover the world that exists; Engineers create the world that never was'**  
Theodore Von Karman, Aerospace Engineer

**'It is not wealth which makes good infrastructure possible, but good infrastructure which makes wealth possible'**  
paraphrased from J F Kennedy

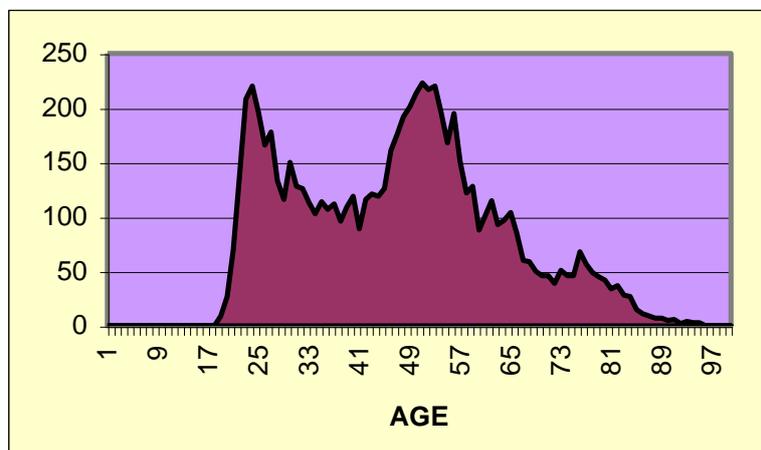
**'Civil Engineers are the Leonardi Da Vinci's of the 21st Century'**  
President Thabo Mbeki at the SAICE Centenary Congress May 2003

In our fast changing world, where changes are often implemented for the sake of change, we have lost sight of many fundamental truths to which the above quotations attest. Engineering professionals are crucial to the development of the infrastructure required for all to live in dignity. Their competence comes from education, training, experience and knowledge transfer by supervisors and mentors. Whilst Tertiary institutions continue to educate, the structured in-house graduate-in-training programs which were registered with the South African Council of Professional Engineers in the seventies and early eighties, and gave graduates exposure to all facets of the delivery process, have largely fallen away.

It is critical that we increase the pool of competent professionals. A sound knowledge of local conditions and requirements to address the needs of the communities at large is imperative in order to ensure sustainable solutions and support in all areas of engineering infrastructure services. The successful registration of professionals after 3 or 4 years of training as candidate engineers is of particular importance.

Statistics of SAICE membership age profile in 2002 show a very worrying situation. In the eighties and nineties, the numbers of students entering civil engineering dropped off dramatically. The low intake of members some 10 to 20 years ago resulted in the current low number of professional civil engineering members of SAICE in the 30 to 45 year age group. Owing to increasing career guidance and campaigning by the Institution, the numbers have increased substantially at student level, but students, particularly in Technikons do not always complete their studies and in addition many graduates do not remain in the industry.

The "valley" as seen in the 2002 graph creates a major problem with the retention of graduate engineers during the training phase. Middle and senior management and engineering professionals are currently so heavily over-committed, that there is often little time to do any training and the young graduate is often expected to manage entirely on his or her own. The result is that a substantial number of graduates are subsequently unable to develop and master their profession and in addition are not offered the opportunity to integrate into the profession. Not being equipped to succeed, young people leave the profession after graduation and before they are fully trained. Valuable resources in terms of national assets are therefore wasted.



SAICE membership age profile

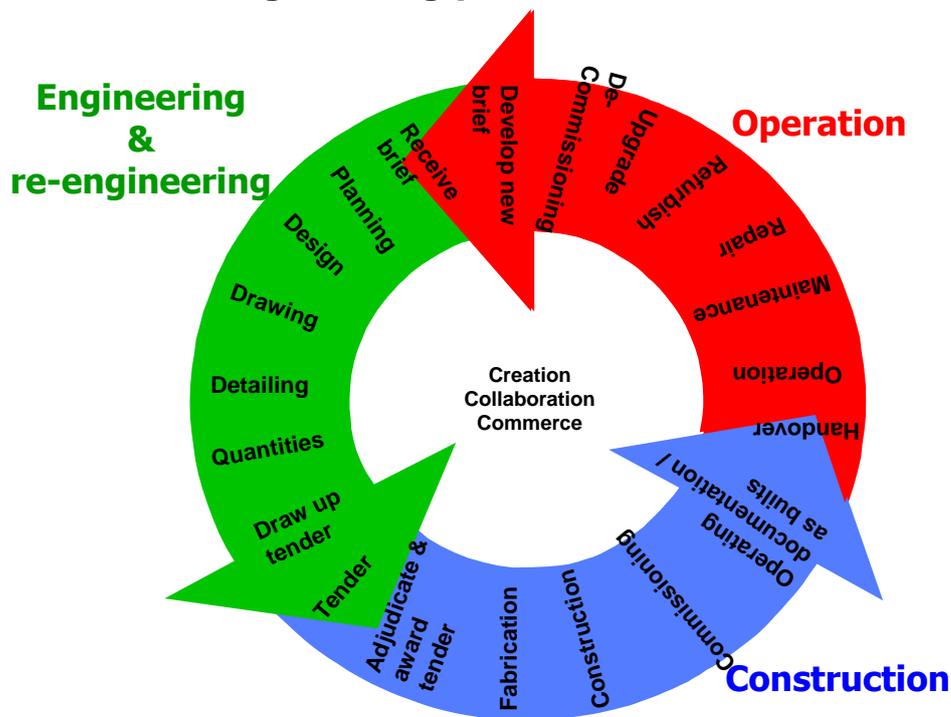
After graduation it is essential that all graduates are placed and offered practical and adequate work place training. Whilst graduates are frustrated with the lack of Skills Development Planning by their employers, companies complain of the inadequacy of the young graduates. The problems that the young graduates encounter are often caused by a lack of so-called life skills and initiative, which is in general a generation related problem.

Our young generation – the so-called X generation, faces many challenges as a result of the current models employed to teach school learners, which result in serious shortcomings in terms of life skills, engineering problem-solving and cost efficiency.

Whilst there are currently guidelines for mentoring and training young personnel to prepare them for professional registration, and many companies sign a Commitment and Undertaking with ECSA, the contents of these undertakings are not necessarily being executed in full. Further, senior staff are not available to offer input and transfer their knowledge.

By developing learnerships based on the new Stage 2 Qualification being registered by the ECSA SGB, comprehensive structured training processes will be put into place for each of the fields of civil engineering and graduates will once again begin to understand the whole project process.

## The engineering process is a Continuum



This will offer better trained engineers and will offer companies an additional income to employ external mentors and supervising engineers to assist with this development phase of the young engineering professional.

The two components of the learnerships are the curriculum and the course material. The curriculum will allow the graduate to chart his or her path over the 3 or 4 years and be sure that they will be exposed to all phases in their chosen field. It is thought that retired engineers should be harnessed to document all practical facets of each discipline for reference by young graduates, to supplement the transfer of knowledge where graduates do not have sufficient access to senior engineers. Further much practical knowledge, rules of thumb etc has been lost due to the early retirement of senior professionals, and it is urgent that this experience be captured to pass onto future generations.

It is now necessary to develop curriculum and program material for this learnership for both the technical competence of graduates based on current Best Practice and their business, and professional development.

Having developed the learnerships and material, a knowledge management system should be developed allowing material to be published on the internet for access by all civil engineering professions. A second proposal will be developed when once the first phase is complete.

# PROJECT PROPOSAL

The business plan covers the development of curricula and program material with input from industry through workshops and interviews, and proposes harnessing various technical committees and professional bodies to develop components relative to their expertise.

## METHODOLOGY

### The audience

The large Civil Engineering bodies in South Africa, being SAICE (South African Institution of Civil Engineering), SAACE (South African Association of Consulting Engineers) and SAFCEC (South African Federation of Civil Engineering Contractors) possibly represent some 85% of the Civil Engineering professional workforce. Their technical committees lead technology in each of their fields and are keen to contribute to the development of the learnership on behalf of their membership, but few have capacity to devote their energies to the project full time, which is now what is required to fast track an outcome.

IMESA (the Institution of Municipal Engineers of South Africa) also plays an important role in local government in South Africa, and they work closely with the above organisations.

### The model

There are many content components to this learnership as well as many facets to implementation.

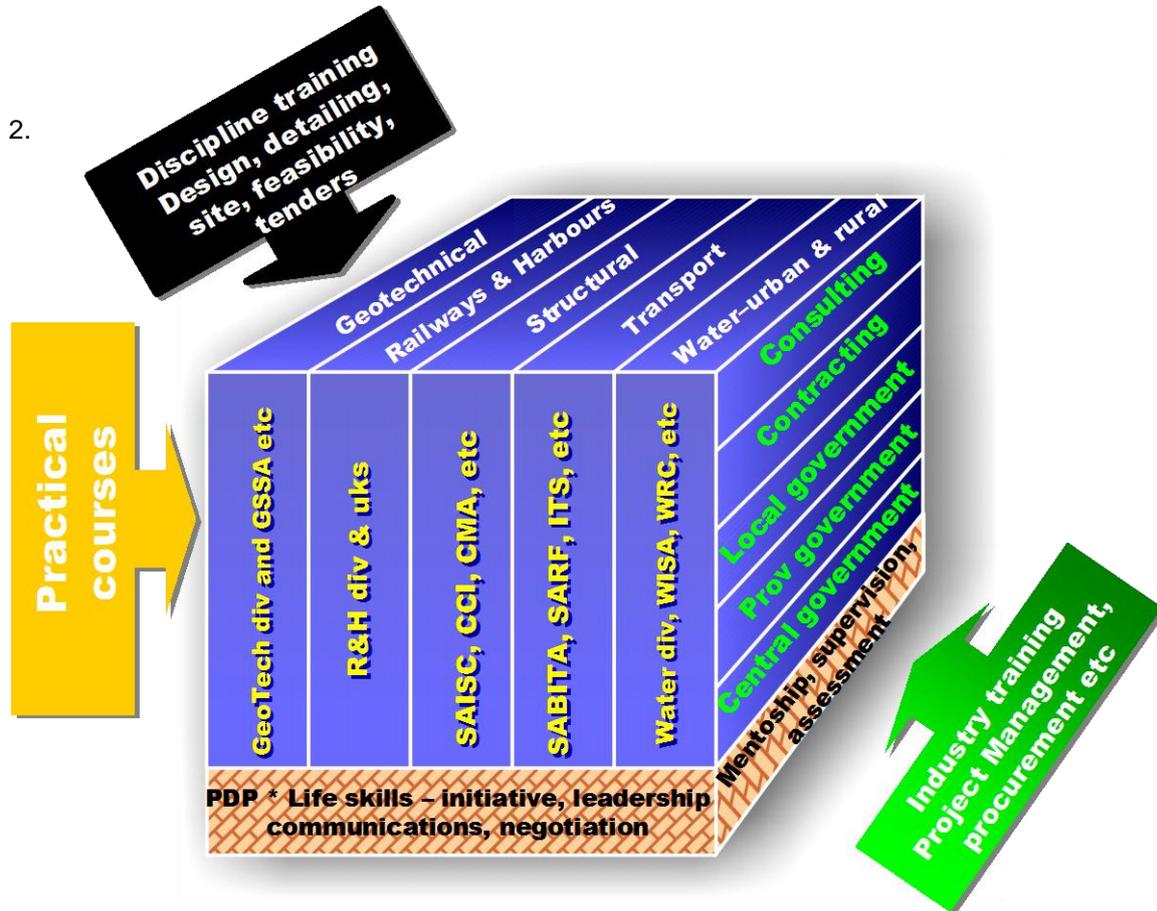
#### 1. Content

The components are as follows:

- **Fundamentals**  
Life skills, including literacy, communication, report writing, computer usage, etc are an essential foundation for working effectively as an engineer. In terms of general and statutory issues many items are already covered in the ECSA requirements such as knowledge of SHE, the Skills Act, Labour Law etc need to form part of the basic knowledge.
- **Technical content**  
It is necessary for graduates to be involved in one or more technical fields during their experiential phase. These include Geotechnical, Structural, Water and Transport. The entire project phase needs to be understood and the young graduate must be exposed to all components, including design, detailing, tendering, site work, environmental aspects, maintenance and costs efficiencies. Some 20 – 30 curricula need to be developed to cover the various disciplines
- **Industry content**  
Content varies per industry. In the consulting world, project management, ethics, indemnity etc are of key importance, whilst in the contracting world contract management, materials, labour intensive construction, environmental requirements, labour and contract law etc are of key importance. In local and other government positions, issues such as procurement, government budgeting and finance, working with politicians, local communities, legislation etc is of major importance. Content needs to be developed for each of these facets.
- **Practical courses**  
Universities cannot be expected to offer practical design and detailing training for every facet of civil engineering. The undergraduate degree essentially offers a foundation on which to build civil engineering experience. In order to fast track the development practical skills, young graduates should attend many of industry's practical courses. Suitable courses need to be identified and further courses need to be developed. Typical organisations offering practical short courses include SAISC (South African Institute of Steel Construction), C&CI (Concrete and Cement Institute), SARF (South African Road Federation), SABITA (South African Bitumen Association), and WISA (Water Institute of South Africa)

The 4 facets and scope are outlined in the diagram below.

2.



## 2. Implementation

The curriculum in each field will dictate the level of exposure the graduate has in each facet of his or her chosen field. The learnership document will therefore serve as a sound document for career path planning, and will offer the employer excellent guidelines, and give the employee a reference document against which to measure employer commitment to training.

For graduates to receive sufficient input and develop a feel for what they are doing, it will be necessary for mentors and supervisors to offer input and for this to be supplemented by learning material and courses. Further it will be necessary to develop reporting methods, so that graduates can keep meaningful records of what they have done and learnt.

## Material development

### 1. Finalization of the Stage 2 qualification

Theoretically, the process of developing learnerships should not commence until the qualification, being developed by ECSA, has been registered. However this process is well underway. Our industry has offered significant input and additional unit standards are being developed to cover our needs. The approach was tested at the International Mobility Forum in London in May 2004, and was acceptable. It is expected that the qualification will be ready for registration late this year or early next year. Attached please find an email from the ECSA team leader, Professor Hu Hanrahan, stating that there is no reason why we should not proceed with the learnership material development.

The unit standards suggested at this stage are as follows:

#### Mandatory

- ◆ **Engineering Management**  
Personal development, teamwork, management skills
- ◆ **Engineering Design and planning**  
Covering all aspects of planning and design
- ◆ **Engineering investigation**  
Covering all aspects of troubleshooting

#### Electives

- ◆ **Management of engineering operations or processes**  
Covering the operation of a plant
- ◆ **Management of construction**  
Covering the actual construction phase
- ◆ **Management of a consulting practice (being added)**
- ◆ **Management in local government (being added)**

- ◆ **Operation and maintenance of plant**
- ◆ **Occupational Health and Safety**
- ◆ **Occupational Health and Safety under the MH&S Act.**
- ◆ **Research, development and commercialization of engineering products**  
Covers commercial and post graduate research / studies
- ◆ **Education, training and development of engineering personnel**  
Addressing the training of academic staff
- ◆ **Environmental**
- ◆ **Value Engineering**
- ◆ **Large dams**

It is expected that this qualification will attract some 360 credits. From the structure above it is expected that 30 - 50 credits will apply to fundamental training, 180 to technical, 70 to industry and the balance of 60 -80 will be made up on short courses, but this area is still to be finalized.

When once the curricula have been developed, it should be possible to register the learnerships, since experience is theoretically work based. However the course material will enhance the learning process when once ready.

Due to the range of disciplines covered under civil engineering, many learnerships will be developed, totalling several thousand credits, or it may be more practical to group the various disciplines into Skills plans. Steps 1 to 4 in Activities and Time frames below will have to be carried out, before a comprehensive understanding of the scope and complexity of the whole project is gained. Deliverables may need to be re-defined at that stage.

When once the knowledge system has been developed, its value will not be limited to civil engineers, but will also apply to technologists and technicians. It will be a relatively simple process to develop curricula for the technologist and technician candidate learnerships.

## **2. Technical material and processes**

The technical panels from most Institutions have indicated a willingness to be involved, but require funding for full time commitment to the project. Funding is also required for a small co-ordination and development team. Each set of discipline material will be developed in parallel, in order to try and fast track completion.

## **3. Industry courses**

Organisation representing employer bodies such as SAFCEC and SAACE have also developed training material specific to their areas of operation, which must be incorporated into the overall learnership. Material mainly for local, provincial and central government employees still needs to be developed

## **4. Practical courses**

Excellent short courses are available from many specialist organisations, but they are poorly attended as at present claiming back for short courses is not in place, and many of the courses are poorly advertised. Full time capacity is needed to locate and research all the relevant short courses, make recommendations regarding upgrading to line up with the learnerships, and publicise.

## **5. Mentorship, general and statutory issues**

Mentorship courses exist. However, they are pitched at different levels and different professional needs. For professional registration in Engineering, it is necessary to follow the guidelines defined by the Engineering Council of South Africa (ECSA). For young people to succeed in the industry, their professional aspirations and training needs must be addressed.

Assistance from experienced professionals is required, but the generation gap between the majority of experienced professionals and those entering after graduation must to be addressed for interaction of these groups to be successful. Hence research is required to develop comprehensive mentor and supervisor training material would be as follows:

- Investigate commercial content, field and success rate of various existing commercial courses
- Investigate the requirements of ECSA for mentors and supervisors
- Locate appropriate training material including paying attention to generation issues
- Interview individuals and research approaches developed and used by small, medium and large enterprises in the field.

## **The activities and time frames**

1. Develop draft curricula for all civil disciplines for discussion and acceptance by all – call upon SAICE Technical Divisions and retired engineers - 2 weeks per topic
  - a. Geotechnical
  - b. Structural

- i. General structural principals
    - ii. Concrete
    - iii. Steel
    - iv. Timber
    - v. Masonry
    - vi. Bridges
  - c. Transport
    - i. Practical pavement design and construction techniques
    - ii. Haul roads
    - iii. Farm to market roads
    - iv. Tertiary
    - v. Secondary
    - vi. Primary
    - vii. Transport planning
    - viii. Airports
  - d. Railways and harbours
    - i. Railways
    - ii. Harbours and coastal structures
  - e. Water and sanitation
    - i. Water resources
    - ii. Water supply
    - iii. Water services management
    - iv. Return flow and treatment
  - f. Local government
  - g. Consulting
  - h. Contracting
  - i. Research
  - j. Life skills
  - k. Management
  - l. Environmental
  - m. Materials
2. Stakeholder workshop to debate process and solicit input and assistance – attendance by professional bodies such as SAACE, SAFCEC, IMESA, SABBACO, ECSA, SALGA, SAICE and related SETAs – 2 weeks. Present:
    - a. ECSA approach and progress
    - b. Outline programme for the development of the qualification, learnerships and mentorship
    - c. Outline draft civil documents as models for other Built Environment professionals to use
    - d. Set up working committee to start detailed learnership development per discipline
  3. Fine tune curricula based on input, circulate for approval and finalize – 3 days per topic
  4. Identify and research all existing unit standards and qualifications registered with other SETAs which may be relevant and feed into working teams – 3 weeks
  5. Involve SAICE divisions, experts in the various disciplines and employer bodies who are interested in contributing in the fields above, as well as SAFCEC / NABCAT etc for contracting, SAACE / SABBACO etc for consulting, IMESA / SALGA etc for local government and others for possibly financial, management etc. Allow 3 months per topic, many in parallel, with roads and water requiring 6 to 9 months due to the dependencies of one section on another. Total man months Allow 84 man months
  6. Identify practical short courses to compliment on-job training – 4 weeks
    - a. Research and document all existing courses
    - b. Establish which are accredited
    - c. Advise those not accredited but suitable of process
    - d. Identify gaps in terms of short courses required
    - e. Recommend development work to the training specialists in each field
    - f. List recommended course on the CETA WSP matrix
  7. Through on-going consultation, test content and approach with industry – interviews and on-site workshops – 4 weeks
    - a. Workshops (4) with Tertiary Institutions to ensure congruency and push for changes in curricula
    - b. Consulting
    - c. Contracting
    - d. Parastatals
    - e. Local government
    - f. Government

8. Liaise with ECSA – 3 weeks
    - a. Sit on qualification reference group on behalf of CETA
    - b. Research existing registration requirements
    - c. Update ECSA guidelines to tie up with new learnership
  9. Develop learner documentation - 5 weeks
    - a. Develop reporting system for candidate professionals to plan and log their training
  10. Convene a large workshop to fine tune and ratify learnerships and proposed mentorship programme 2 weeks - invite
    - a. all professional bodies
    - b. SAICE technical divisions and Education and Training Panel
    - c. Tertiary institutions
    - d. Large organisations committed to HR development – e.g. large consultants, local authorities, parastatals, etc with the resources and need to develop learnerships and training programmes
    - e. Related SETAs (TETA, LGWSETA, Services, MERSETA, MQA etc)
  11. Polish and finalize documents – 4 weeks
  12. Register learnerships with CETA – 2 weeks
  13. Work with ETQA division at CETA and ECSA to develop processes for accrediting all companies in the industry to register as training providers and supervisors and mentors to be recognised as assessors. SAICE to act as ETQA agent? - 3 weeks
  14. Develop mentorship documents - 4 weeks
    - a. Research mentor training courses and additional material required for civil engineering mentor training
    - b. Research successful industry models
    - c. Develop mentorship guidelines
    - d. Develop / locate assessment tool to select mentors
    - e. Develop measurement and reporting system for mentors
- Possibly replicate all these steps in the other Built Environment professions

Thereafter commence mentorship and supervisor training. This will mean that companies will be able to claim for the expense of employing mentors and supervisors to train their young graduates.

## OUTCOMES

At our meeting with President Mbeki and Minister Trevor Manuel, it was indicated that they may slow down expenditure on infrastructure as they had been advised that there was a capacity problem in the industry. With such a learnership in place the numbers remaining in the profession should increase. The outcomes in more detail would therefore be:

- An increased pool of registered professionals, particularly from disadvantaged backgrounds and with an improved gender balance than is the case at present.
- More companies being prepared to train young graduates
- Older professionals returning to the field to assist with mentorship and so increase the speed of project delivery
- Reduced emigrations, as young people feel that they can benefit by remaining in the industry
- Young professionals will be trained in state-of-the-art and sustainable techniques as currently offered by the specialist bodies operating in the field, and will be in a better position to offer appropriate solutions
- A complete civil engineering knowledge system
- A framework for developing technologist and technician candidate learnerships

## BENEFITS

CETA will benefit from:

- Having raised its profile and having displayed willingness to address industry issues.
- Having many more courses accredited
- Improving its claim and training rate
- Having many more trainees registered on learnerships – it is estimated that some 600 graduates would enter the program within 6 months of its introduction

- A framework will have been developed which could easily be modified for graduate technologists and technicians and other professions in the built environment
- Improving the balance of disadvantaged, including women, in the civil engineering industry