REPORT TO JIPSA ON ACADEMIC STAFF SHORTAGES IN HIGHER EDUCATION ENGINEERING FACULTIES

A Lawless
L Kirsten

31 August 2008

SAICE Professional Development and Projects
011-476 4100
Contents

1. EXECUTIVE SUMMARY ........................................................................................................5
  1.1 Attraction and retention of academics in engineering departments ................................6
  1.1.1 Attract and retain experienced academics .................................................................6
  1.1.2 Develop future academics ........................................................................................6
  1.1.3 Develop support staff ...............................................................................................6
  1.1.4 Address HR challenges .............................................................................................6
  1.2 The throughput challenge ...............................................................................................6
  1.3 Review the system ..........................................................................................................7
2. INTRODUCTION ..................................................................................................................8
3. BACKGROUND...................................................................................................................9
4. METHODOLOGY ................................................................................................................10
5. THE EXTENT OF VACANCIES ........................................................................................11
6. IMPACT OF VACANCIES ...............................................................................................13
  6.1 Intake limited (53%) ......................................................................................................13
  6.2 Throughput limited (73%) ............................................................................................14
7. REASONS FOR VACANCIES ..........................................................................................14
  7.1 Non-competitive salaries (66%) ....................................................................................16
  7.1.1 The impact of academic qualification requirements ................................................16
  7.1.2 The impact of consulting ..........................................................................................17
  7.1.3 The impact of subvention ........................................................................................17
  7.1.4 Salaries required to retain and recruit staff ...............................................................18
  7.1.5 Direct access to funding ..........................................................................................23
  7.2 Shortage of suitably qualified and experienced applicants (24%) ..............................23
  7.2.1 Qualifications .........................................................................................................23
  7.2.2 BEE Requirements .................................................................................................27
  7.2.3 Registered professionals .........................................................................................29
  7.2.4 Foreign academic staff ...........................................................................................30
  7.3 Insufficient Funding (21%) ..........................................................................................32
  7.4 Retirement ....................................................................................................................33
  7.5 Ineffective recruitment processes (10%) ....................................................................33
  7.6 Lack of promotion (8%) ...............................................................................................33
8. CHALLENGES ASSOCIATED WITH THE CHANGING ENVIRONMENT ...............33
  8.1 An ever increasing workload (52%) ............................................................................33
  8.1.1 Vacancies ................................................................................................................35
  8.1.2 High staff turnover ..................................................................................................36
  8.1.3 Onerous administrative responsibilities .................................................................36
  8.1.4 Increasing student numbers ...................................................................................37
8.1.5 Intake of poorly prepared students ................................................. 41
8.1.6 Too few support staff ...................................................................... 43
8.1.7 Research .......................................................................................... 44
8.1.8 External and contract staff ................................................................. 45
8.1.9 Too many subjects to lecture per individual ...................................... 46
8.1.10 Work Integrated Learning (WIL) ..................................................... 47
8.1.11 Improved qualifications required .................................................... 48
8.2 Insufficient and under equipped facilities (16%) ................................. 49
8.3 Others ................................................................................................. 49
9. NUMBERS ............................................................................................. 50
9.1 National requirements .......................................................................... 50
9.2 The international perspective ............................................................... 51
10. CONCLUSIONS .................................................................................. 52
11. RECOMMENDATIONS - ATTRACTION AND RETENTION STRATEGIES .... 53
11.1 Increase funding .................................................................................. 53
11.2 Develop an academic career path....................................................... 56
11.2.1 Ensure progression ........................................................................ 56
11.2.2 Practical training and ECSA registration ......................................... 56
11.2.3 Staff retention for mentoring ........................................................... 57
11.2.4 Qualifications .................................................................................. 58
11.3 Develop technical support staff through skills programmes, learnerships and apprenticeships ............................................................ 58
11.4 Develop appropriate organograms ...................................................... 58
11.5 Develop leadership and management .................................................. 59
11.6 Identify postgraduate and research departments .................................. 59
11.7 Further research required on support staff & facilities ...................... 59
11.8 Set and enforce realistic student to staff ratios .................................... 59
12 RECOMMENDATIONS – THROUGHPUT ............................................. 60
12.1 Attract high quality students ............................................................... 60
12.2 Improve teaching ................................................................................ 60
12.3 Improve facilities ................................................................................ 61
12.4 Fund, redesign or remove WIL ............................................................. 61
12.5 Licences ............................................................................................... 61
12.6 Viability of some departments ............................................................. 61
12.7 More autonomy .................................................................................... 62
13 REVIEW HIGHER EDUCATION ............................................................ 62
13.1 Industry perceptions .......................................................................... 62
13.2 Review the HE System ......................................................................... 62
14 SUMMARY .............................................................................................. 64
14.1 Quick fixes ................................................................................................................. 64
14.2 Longer term interventions ........................................................................................... 64
ANNEXURE A: GENERIC LETTER TO DEANS .............................................................. 65
JOINT INITIATIVE ON PRIORITY SKILLS ACQUISITION (JIPSA) .................................. 65
ANNEXURE B: GENERIC QUESTIONNAIRE ...................................................................... 66
ANNEXURE C: STAKEHOLDERS INVITED TO COMMENT .............................................. 72
1. Executive Summary

JIPSA initiated a study to investigate vacancies in engineering departments when it became clear that although faculties have more than doubled their student intake over the past five years, they are unable to retain existing staff, let alone attract additional staff.

All eighty three engineering departments from eighteen Higher Education Institutions (HE Institutions) were approached to identify reasons for vacancies as well as offer possible solutions to attract and retain engineering staff.

Seventy three engineering departments responded. It was found that 22.8% of permanent lecturing posts in institutions delivering engineering programmes\(^1\) are vacant and 20.8% of permanent posts in institutions delivering technology programmes\(^2\) are vacant. Twenty six departments have a higher vacancy than the average.

Considering the response from the 73 departments, 53% of these engineering departments confirmed that vacancies limit intake, 73% confirmed that vacancies affect throughput and 59% indicated that they required more staff than the full complement dictated by current organograms.

Heads of Departments (HoDs) identified further demands which added pressure to academic staff and contributed to the high level of frustration and staff vacancies in their departments as follows:

- Non competitive salaries (66%)
- An ever increasing workload (52%) resulting from:
  - Increasing student numbers
  - Increasing administrative duties
  - Weak student intake
  - Too few support staff
  - Research and community service demands
  - High levels of part time staff
  - Work Integrated Learning requirements
  - DoE qualification requirements for lecturing staff
- Shortage of suitably qualified and experienced applicants (24%)
- Insufficient Funding (21%)
- Insufficient and underequipped facilities (16%)
- Ineffective recruitment processes (10%)
- Lack of promotion (8%)

The survey found that annual cost to company of academic staff in engineering was on average a third lower than that of their peers in Industry and that approximately 1000 additional academic

---

\(^1\) Engineering programmes refer to the 4 year BEng or BSc (Eng) programmes which meet the requirement for registration as a Candidate Engineer with the Engineering Council of South Africa (ECSA)

\(^2\) Engineering Technology programmes refer to the 3 year NDip (Eng) programmes (these include 1 year Work Integrated Learning) and the BTech (Eng) programmes for which the NDip is a prerequisite. These programmes meet the requirements for registration as a Candidate Technician or Candidate Technologist with ECSA respectively.
staff are required in engineering departments, over and above the 292 vacancies, to lower the student:academic staff ratio from an unacceptable 55:1 to 25:1.

The recommendations below reflect the need for stakeholders to critically engage and agree on a way forward. This will include high level policy decisions as well as more detailed implementation strategies relating to the needs of each engineering faculty and department.

1.1 **Attraction and retention of academics in engineering departments**

The following actions are required to retain, attract and support engineering academics:

1.1.1 **Attract and retain experienced academics**

1. Increase the cost to company of academic staff as recommended.
2. Increase the level of funding as prescribed in the funding formula.
3. Increase the number of permanently funded staff as recommended.
4. Ring fence additional funding raised for engineering departments.
5. Set realistic qualification requirements for academic staff in technology programmes.
6. Pay registration fees and reward professionally registered academic staff.
7. Support registered staff to retain their registration through CPD.
8. Relax over ambitious research requirements in Universities of Technology where inappropriate.
9. Increase retirement age.
10. Canvass experienced lecturers to come to South Africa on 3 or 5 year contracts.

1.1.2 **Develop future academics**

11. Develop an academic career path.
12. Appropriately develop academic staff for research & succession planning.
14. Introduce sabbaticals where research and higher qualifications are critical.
15. Arrange exchange programmes for young academics.

1.1.3 **Develop support staff**

16. Carry out further research on the requirements for support staff and enhanced facilities.
17. Develop technical and support staff through skills programmes, learnerships and apprenticeships.

1.1.4 **Address HR challenges**

18. Enhance HR systems to recruit new staff effectively.
19. Develop new organograms more appropriate to the requirements of each department

1.2 **The throughput challenge**

Whilst an increase in the number of academics, contact and support time will go someway to improve throughput, the view is that this alone will not effect a complete turnaround in engineering departments. The poor schooling system, facilities, bottlenecks associated with Work Integrated Learning (WIL) and many other weaknesses also present challenges. Suggestions extracted from the qualitative responses are listed below:
1. Attract high quality learners.
2. Introduce national entrance test for engineering.
3. Reward throughput & enrolment of high quality students, not only large numbers.
4. Improve facilities.
5. Fund, redesign or remove WIL.
6. Assist academic staff to enhance their teaching methods.
7. Set up mobile learner and license testing units for students to increase their employability.

1.3 **Review the system**

Although the survey focused on reducing vacancies in engineering departments a much broader review of the HE system is required to understand the root causes of the apparent system breakdown. Furthermore, an Industry perception survey should be carried out to determine the frustrations and needs of employers.
2. Introduction

The Joint Initiative for Priority Skills Acquisition (JIPSA) has identified engineering as one of the priority skills in South Africa that urgently needs attention. The JIPSA report (March 2007) includes the following interventions required in engineering education:

- Increase the annual number of engineering graduates over the next four years.
- Improve throughput and efficiency of the current engineering education and training system.

Against this backdrop it has been gratifying to see the increasing number of students registering for engineering studies as shown in Figure 1. This has however placed a severe strain on the academic environment.

![Graph showing enrolment data for engineering and technology programmes](image)

**Figure 1: Enrolment data for engineering and technology programmes**

As a result of earlier research, the Department of Education (DoE) increased funding to many engineering departments to upgrade and improve facilities, equipment etc. Outputs are therefore expected to increase. However, JIPSA has become aware that faculties of engineering are further challenged as a result of their inability to attract or retain staff. Staff are leaving the academic sector for the private sector for a number of reasons and due to the apparent unattractiveness of the environment, vacancies cannot be filled.

This JIPSA study was initiated to identify the extent of the vacancies in the engineering departments of both Universities and Universities of Technology and to identify and propose solutions for retaining current academic staff and attracting new staff.

---

3 The DoE’s Higher Education Management and Information System (HEMIS), www.education.gov.za
3. Background

Explanatory letters (Annexure A) as well as questionnaires for each engineering department (Annexure B) were sent to the Deans of the 18 Higher Education (HE) faculties of engineering during the first week of April 2008. These included the following 83 engineering programmes, shown in Table 1.

<table>
<thead>
<tr>
<th>HE Institution</th>
<th>Engineering Programmes a</th>
<th>Dean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HE Institutions</strong></td>
<td><strong>Engineering Programmes b</strong></td>
<td><strong>Dean</strong></td>
</tr>
<tr>
<td><strong>Universities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Nelson Mandela Metropolitan University (NMMU)</td>
<td>Mechatronics</td>
<td>Prof H de Jager</td>
</tr>
<tr>
<td>2. North West University (NWU)</td>
<td>Chemical, Chemical with Minerals Processing, Electrical and Electronic, Computer and Electronic, Mechanical</td>
<td>Prof J Fick</td>
</tr>
<tr>
<td>3. University of Cape Town (UCT)</td>
<td>Civil, Chemical, Electrical, Electrical and Computer, Electromechanical, Mechanical, Mechatronics</td>
<td>Prof F Petersen</td>
</tr>
<tr>
<td>4. University of Johannesburg (UJ)</td>
<td>Civil, Electrical, Mechanical</td>
<td>Prof H Kirsten</td>
</tr>
<tr>
<td>5. University of KwaZulu-Natal (UKZN)</td>
<td>Agricultural, Civil, Chemical, Electrical, Electronic, Computer, Mechanical</td>
<td>Prof Ijumba</td>
</tr>
<tr>
<td>7. University of Stellenbosch (SUN)</td>
<td>Chemical, Chemical Engineering-Mineral Processing, Civil, Mechanical, Mechatronics, Industrial, Electrical&amp; Electronics, Electrical and Electronic with Computer Science</td>
<td>Prof A Schoonwinkel</td>
</tr>
<tr>
<td>8. University of Witwatersrand (WITS)</td>
<td>Chemical, Civil, Electrical, Information, Aeronautical, Industrial, Mechanical, Metallurgy and Materials, Mining</td>
<td>Prof B Lacquet</td>
</tr>
<tr>
<td><strong>HE Institutions</strong></td>
<td><strong>Engineering Technology Programmes c</strong></td>
<td><strong>Dean</strong></td>
</tr>
<tr>
<td><strong>Universities of Technology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Vaal University of Technology (VUT)</td>
<td>Chemical, Civil, Electronics, Industrial, Mechanical, Metallurgical, Power, Process Control &amp; Computer Systems</td>
<td>Prof L Masu</td>
</tr>
<tr>
<td>10. Tshwane University of Technology (TUT)</td>
<td>Civil, Chemical &amp; Metallurgical, Electrical, Industrial, Mechanical</td>
<td>Prof F Otieno</td>
</tr>
<tr>
<td>11. Central University of Technology (CUT)</td>
<td>Civil, Electrical &amp; Computer Systems, Mechanical</td>
<td>Prof G Jordaan</td>
</tr>
<tr>
<td>12. Mangosuthu University of Technology (MUT)</td>
<td>Civil, Chemical, Electrical, Mechanical</td>
<td>Mr S Malinga</td>
</tr>
<tr>
<td>13. Durban University of Technology (DUT)</td>
<td>Civil, Chemical, Electrical, Electronics, Industrial &amp; Mechanical</td>
<td>Prof T Andrew</td>
</tr>
<tr>
<td>14. Cape Peninsula University of Technology (CPUT)</td>
<td>Civil, Chemical, Electrical, Industrial, Mechanical</td>
<td>Dr O Franks</td>
</tr>
</tbody>
</table>

4 Engineering programmes – see note 1
5 Engineering Technology programmes – see note 2
15. University of Johannesburg (UJ)  | Civil, Chemical, Electrical, Electronics, Industrial, Mechanical, Metallurgical, Mining, Power & Control, Electronics and Computer | Prof H Kirsten

16. Walter Sisulu University (WSU)  | Civil, Electrical, Electronics & Computer, Mechanical | Prof SP Songca

17. UNISA  | Chemical, Civil, Electrical, Industrial, Mechanical, Mining | Prof M Setati

18. Nelson Mandela Metropolitan University (NMMU)  | Civil, Electrical, Industrial, Mechanical | Prof H de Jager

Total number of programmes: 83

Table 1: Faculties and Departments offering Engineering and Engineering Technology programmes

4. Methodology

The questionnaires consisted of a quantitative (Section A) and a qualitative (Section B) section. Section A requested data such as student and academic staff numbers as well as the profile of the academic staff. In Section B the following 8 questions were asked to provide Heads of Departments (HoDs) an opportunity to comment on or make recommendations on vacancies, retention strategies, number of staff required, throughputs, intake and demands on staff:

- Please describe what in your view contributes to the high level of staff vacancies in your department (if any)?
- Please provide your suggestions on a possible retention (including incentives) strategy.
- If all the positions in your department were filled, would you consider your staff structure adequate or do you believe your department requires additional positions?
- Share your ideas on how the University/University of Technology can rebuild and retain young people who would like to pursue an academic career.
- What demands add pressure to academic staff?
- Do the vacancies in your department affect throughput?
- What is required to ensure that throughputs are increased?
- Do the vacancies in your department limit your intake?

The data from the completed Section A questionnaires was processed and summarised into engineering and technology programmes per discipline specific tables. Data was then extracted to demonstrate further findings such as:

- Vacancies
- Student:lecturer ratio
- % of external lecturers
- The number of academics with PhDs, Masters and first qualifications
- Number of subjects lectured per academic
- % Lecturing staff registered with the Engineering Council of South Africa (ECSA)
- % suggested cost to company increases
- etc

Unless otherwise stated, Tables and Figures presented are applicable to data collected in 2008.
The comments received from HoDs in Section B were clustered and were compared with the findings from Section A to develop the report.

The report was then circulated to experts in the field and thereafter to a broad stakeholder working group for comments. *(Annexure C)*

5. The extent of vacancies

Responses from 73 engineering departments (an 86% return) were received. The first question was whether engineering departments do in fact have a significant number of vacant posts.

Figure 2 presents the number of filled posts per discipline.

![Graph showing filled posts per discipline]

**Figure 2: The % of filled posts per engineering discipline**

The graph indicates that vacancies exist in most engineering disciplines with agricultural, civil and industrial experiencing the highest vacancy levels.

The data in Figure 2 further indicates that 23% of permanent lecturing posts are vacant at institutions providing engineering programmes and 21% of permanent posts are vacant at institutions providing technology programmes.

This translates into an additional 245 academics required (preferably with Masters or PhD degrees in engineering) to fill the vacant posts in those departments which responded. Recruiting staff is a key challenge due to the major infrastructure delivery programme in the country at present.

Comparing data from each institution in Figures 3 & 4 with the average % vacancy the following 27 departments (70% technology programmes) have higher vacancies than the average:

- 100% vacancy, Industrial Engineering, UNISA
- 75% vacancy, Civil Engineering, UNISA
- 62% vacancy, Civil Engineering, CPUT
- 58% vacancy, Mechanical Engineering, UKZN
- 50% vacancy, Chemical Engineering, UKZN
- 50% vacancy, Agricultural Engineering, UKZN
- 50% vacancy, Industrial Engineering, TUT
- 38% vacancy, Civil Engineering, UKZN
- 38% vacancy, Civil Engineering, NMMU
- 37% vacancy, Civil Engineering, CUT
- 32% vacancy, Electrical Engineering, UCT
- 31% vacancy, Mechanical Engineering, UJ
- 30% vacancy, Civil Engineering, TUT
- 30% vacancy, Civil Engineering, WSU
- 29% vacancy, Chemical Engineering, UJ
- 28% vacancy, Chemical Engineering, VUT
- 28% vacancy, Chemical Engineering, NWU
- 28% vacancy, Mechanical Engineering, CUT
- 28% vacancy, Mechanical Engineering, VUT
- 27% vacancy, Chemical Engineering, TUT
- 27% vacancy, Electrical Engineering, UKZN
- 27% vacancy, Civil Engineering, UCT
- 25% vacancy, Chemical Engineering, UNISA
- 25% vacancy, Industrial Engineering, SUN
- 24% vacancy, Mechanical Engineering, TUT
- 23% vacancy, Mechanical Engineering, TUT
- 22% vacancy, Mechanical Engineering, UNISA

![Figure 3: % Posts filled per HE Institution (per technology programme)](image-url)
6. Impact of vacancies

6.1 Intake limited (53%)

One of the questions posed to the Heads of Departments was whether vacancies limit intake. Considering the response from the 73 departments, 53% of engineering departments confirmed that vacancies limit intake. Here are a few comments.

“Yes (vacancies limit intake). Our intake has increased but we cannot increase any further (in fact, we have controlled the number down to match teaching and lab resourcing – which has not increased in the past 20 years)”\(^6\)

“At current staffing levels and facilities, we are unable to cope with the sudden surge in student numbers. We are only able to take in 100 students. In the last couple of years, about 300 students a year meet our minimum requirements”\(^7\).

“Going forward in the current situation we will have no other option but to start reducing current intake (120 per year) to a more acceptable level of 50-60 per year starting 2009”\(^8\).

“We are also not able to grow the postgraduate student numbers, because each lecturer has reached his/her saturation level of supervising capacity”\(^9\).

“There is a huge demand for Computer Systems students, but we don’t even advertise the qualification because we don’t have the staff to teach the subjects. We turn away large numbers of prospective National Diploma students. This year we turned away half the B Tech students”\(^10\).

Departments who said that vacancies did not limit intake stated that it was a pity.

\(^6\) HoD, Electrical Engineering  
\(^7\) HoD, Civil Engineering  
\(^8\) Acting HoD, Industrial Engineering  
\(^9\) HoD, Chemical Engineering  
\(^10\) Executive Head, Electrical Engineering
“They do not appear to limit our intake which is a great pity. There seems to be no realistic limits on the numbers of students we allow to register at the beginning of each year”.11

6.2 Throughput limited (73%)

Considering the response from the departments, 73% of engineering departments confirmed that vacancies affect throughput. (However, in the quantitative analysis they also cited the challenge of poor schooling as a barrier to high throughput.)

“Most definitely it affects throughput. An even greater affect on throughput is the inadequate number of academic staff in (the department) to handle to current student numbers, let alone considering any growth in future”.12

“Yes, in the sense that the quality of the teaching (and hence student success rates) will go down if we fail to fill these vacancies. Delay or failure to fill the vacancies will overload existing staff, leaving them with less time to give one-to-one tutorial support to students and to pursue their own research”.13

“National statistics on the throughput efficiencies of the South African tertiary education system are in the form of the HEQC cohort study of the intake of students to the national higher education system in 2000. This study shows that only 32% of the students who enter four year engineering programmes graduate within the minimum time, and for three year Science programmes the proportion is even smaller, at 22% for programmes classified as ‘mathematical Sciences’ and 24% for ‘life and physical Sciences’. For national diplomas in engineering, the statistics are of even more concern with 9% having graduated four years after commencing the three year diploma.

These figures suggest that current teaching and learning practices are not producing the desired results and that there is substantial room for improvement in the system. The poor throughput of students from these programmes also needs to be seen against the quality of the intake to these programmes; whichever way you look at it, students enrolling for degrees in Science and engineering represent a good portion of the ‘cream of the crop’ of national matriculants. Institutions have been refining and improving their selection techniques, and there is no question that these programmes continue to draw from the best within the pool of potential tertiary students. It is very unlikely that there is another hidden pool of students that we might magically discover if we change or further improve our selection procedures. There remain ongoing concerns about the quality of the school system but it is clear that we are unlikely to see substantial improvements here in the short term”.14

7. Reasons for vacancies

11 HoD, Mining Engineering
12 HoD, Chemical Engineering
13 HoD, Civil Engineering
14 Learning as acquiring a discursive identity through participation in a community: A theoretical position on improving student learning in tertiary Science and engineering programmes, A position paper by the Centre for Research in Engineering Education (CREE)
Heads of Departments were further asked to identify what demands added pressure to academic staff and contributed to the high level of staff vacancies in their departments.

Figure 5 indicates the most common problem areas identified by Heads of Departments.

![Figure 5: % departments identifying problem areas]

Non competitive salaries were cited as the main reason for vacancies in engineering departments.

"Low salaries by comparison with engineers in Industry, high teaching load, high student/staff ratio, academics overloaded with administration, limited (and full of internal difficulties) procedures in employing staff, forcible retirement of staff after reaching age of 60 and limited time to do research".\textsuperscript{15}

They further agree that the ever increasing workload as a result of large student groups, increasing administration, poorly prepared students, poor facilities and having too few support staff, add further demands on academic staff.

\textsuperscript{15} HoD, Chemical Engineering
“Excess admin and the challenge posed by less well prepared students; conflicting need to increase research output while dealing with increased student numbers and no increase in staffing budgets”.\textsuperscript{16}

Each of these areas will be discussed in detail.

### 7.1 Non-competitive salaries (66%)

Poor remuneration was highlighted by 66% of the departments as the major reason for not retaining current staff or attracting new staff.

“However, in the process of trying to fill these vacancies, we are finding that the perception overseas (where the largest pool of potential candidates lies) is that the academic salaries in South Africa are not internationally competitive”.\textsuperscript{17}

“The remuneration packages of staff have always been in the region of 80% of that offered by Industry. This has slowly deteriorated to less than 50% offered by Industry. This situation must be turned around immediately as very competent staff have left the academic world and it will be virtually impossible to lure them back. Staff that remain must now handle more classes/students making it impossible for them to do consultation work”. \textsuperscript{18}

“…the low government subsidy, non-competitive academic salaries and shortage of competent engineers create a situation where engineering departments find it hard to attract (and finance) top lecturers”. \textsuperscript{19}

In terms of the skills available, an opinion survey conducted by the South African Federation of Civil Engineering Contractors (SAFCEC) revealed that the majority (96%) of respondents indicated that a skills crisis does exist, to the extent that it takes longer to source skilled workers. This surge in demand is, however, also resulting in premiums being paid in an effort to retain skilled personnel, since the Industry believes that there is no substitute to retaining and protecting current human resources and attracting new skilled entrants, than increasing cost to company levels. SAFCEC has indicated that anecdotal evidence suggests that Industry is incurring increases of up to 30% per annum to retain and attract people in scarce skills areas such as engineering.\textsuperscript{20}

### 7.1.1 The impact of academic qualification requirements

The demand for academics, even at Universities of Technology to hold Master or Doctoral qualifications limits the pool from which academic staff can be sourced. To grow the pool by encouraging young people to continue their studies and take up lecturing posts requires that significantly higher salaries or scholarships should be offered.

\textsuperscript{16} HoD, Electrical Engineering  
\textsuperscript{17} HoD, Civil Engineering  
\textsuperscript{18} HoD, Mechanical Engineering  
\textsuperscript{19} Chairman, Process Engineering  
\textsuperscript{20} SAFCEC, 2007 State of the Civil Industry, March 2007, pg 7
“The biggest limitation in my view is the shortage of PhD graduates. If we had funds to appoint PhD students as Junior Lecturers with starting salaries near to what they would have earned in Industry, we would have more people considering an academic career”.21

“All academic and technical staff that resigned indicated that the remuneration packages offered by Industry was the major reason for them leaving. Secondly the level of qualifications required for promotion is too high, when comparing the remuneration packages offered in Industry. Thirdly the young persons, mainly technicians, indicated that they opted for positions in Industry to get more practical experience”.22

7.1.2 The impact of consulting

Although academic staff have an opportunity to earn extra through consulting, their increasing workloads do not allow them time to supplement their salaries in this way. Some HoDs mentioned that consulting takes the focus away from research and other academic issues and that staff should not have to supplement salaries but, should invest all their time into academic work.

“It should be unnecessary for academic staff to work in Industry (under the pretence of gaining experience) to supplement their salaries. This consultation by lecturers is (in some cases) becoming more important than teaching, learning and research, to the detriment of students”.23

The more liberal view is that consulting is essential to ensure relevance of teaching examples and the nature of consulting should be such that is supports research. “Good” consulting work will lead to journal papers and increased income to departments.

7.1.3 The impact of subvention

In mining departments where salary subvention through the Mining Qualification Authority is implemented, 89% of positions are filled (10% higher than the average).

“The main reason for the stability in our department is salary subvention that took place since 1987, initially by the Chamber of Mines (COM) and more recently this was taken over by the Minerals Education Trust Fund (METF). We are, however, under pressure. Both staff members that left in 2007 were offered double their salary out in Industry”.24

(The initial rationale for the Chamber of Mines to subvent salaries was to ensure that high calibre academic staff could earn at similar levels to their peers working on the mines, and would not be lured away by higher salaries)

21 Chairman, Dept of Mechanical and Mechatronic Engineering
22 HoD, Mechanical Engineering
23 HoD, Civil Engineering
24 HoD, Metallurgical Engineering
7.1.4 Salaries required to retain and recruit staff

Heads of Departments were asked to indicate the cost to company increases required to retain and recruit new staff. Figure 6 summarises the responses.

![Figure 6: % Suggested cost to company increases](image)

The data shows similar trends between the engineering and technology programmes except for professors. This should be seen in the context that there are very few of these posts in technology programmes. They can therefore be better remunerated than peer positions in engineering programmes. See Figure 7 & 8.

![Figure 7: Number of Professors in Technology and Engineering programmes](image)
The recommendations shown in Figure 6 translate into the following suggested packages:

<table>
<thead>
<tr>
<th></th>
<th>Current average cost to company/annum (R)</th>
<th>Suggested average cost to company/annum (R) for 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>500 000</td>
<td>750 000</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>400 000</td>
<td>600 000</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>350 000</td>
<td>450 000</td>
</tr>
<tr>
<td>Lecturers</td>
<td>270 000</td>
<td>390 000</td>
</tr>
<tr>
<td>Junior Lecturers</td>
<td>250 000</td>
<td>320 000</td>
</tr>
</tbody>
</table>

Table 2: Suggested cost to company

Clearly a significant boost in earnings is needed. Whilst academics have in the past not earned top dollar, it appears that the erosion of income, coupled with the reduction of time available for research and development as an academic, means that an academic career is no longer aspired to. The status of academics has been eroded due to the burgeoning bureaucratic and lecturing load and significantly below average earnings.

To test whether the figures suggested are realistic, the cost to company in other sectors employing civil engineers was investigated. Given that no lecturer should hold less than a B Tech, means that the cost to company of technologists and engineers needed to be determined. The tables below reflect earnings recently researched in consulting, local government and where available, the Industry as a whole.
Table 3: Comparative cost to company payments in consulting and civil engineering in general.25

Table 3 reflects the findings of research carried out by PE Corporate Services SA in the consulting Industry in 2007 (on behalf of SAACE – the South African Association of Consulting Engineers), adjusted by the predicted increase of 8.5% for 2008. An update to this research is currently underway. It is thought that the increase of 8.5% predicted last year may have been too low and that increases will be closer to 10% in 2008. Increases in the private sector are generally awarded every March.

It should be noted that the figures include annual and performance bonuses but exclude the value of shares held or dividends paid to staff who have become shareholders (usually partners and associates, but increasingly black staff members and in some instances staff across the board). These payments can significantly boost income. Anecdotal evidence suggests that earnings at senior level are well over R 1 million per annum.

PE Corporate Services SA also carries out an annual survey of all industries, and includes the detailed SAACE research in their expanded model, hence the fourth column in Table 3. It is interesting to note that the general survey which would also cover contracting, mining, manufacturing, suppliers and the public sector, reflects significantly higher average cost to company than those found in the consulting sector.

25 P E Corporate Services SA (Pty) Ltd, An evaluation of current remuneration practices and market rates, June 2007

JIPSA Report on Vacancies at Eng Dept 31 August 2008.doc
It is also interesting to note the importance placed on professional registration by the consulting sector. Staff earn some 20 to 30% more when they are registered, as this is a well recognised measure of competence.

If one were to compare professors with directors, the suggestion of R 750 000 would be on par. Senior lecturers would equate to engineers or technologists with 12 or more years experience, whilst lecturers would align with engineers and technologists with 8-12 years experience and junior lecturers with those having only 4-7 years experience. Thus there is good alignment between the suggested cost to company and earnings in the consulting sector.

The local government figures gathered from four metros shown in Table 4 are more or less equivalent.

<table>
<thead>
<tr>
<th>Metro - cost to company 2007</th>
<th>Metro 1</th>
<th>Metro 2</th>
<th>Metro 3</th>
<th>Metro 4</th>
<th>Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Director</td>
<td>R 715 000</td>
<td>R 800 000</td>
<td>R 690 000</td>
<td>R 735 000</td>
<td></td>
</tr>
<tr>
<td>Director</td>
<td>R 500 000</td>
<td>R 700 000</td>
<td>R 500 000</td>
<td>R 700 000</td>
<td>R 360 000</td>
</tr>
<tr>
<td>Chief engineer</td>
<td>R 445 000</td>
<td>R 560 000</td>
<td>R 420 000</td>
<td>R 475 000</td>
<td>R 500 000</td>
</tr>
<tr>
<td>Engineer</td>
<td>R 352 000</td>
<td>R 450 000</td>
<td>R 347 000</td>
<td>R 400 000</td>
<td>R 400 000</td>
</tr>
<tr>
<td>Senior technician</td>
<td>R 241 000</td>
<td>R 325 000</td>
<td>R 250 000</td>
<td>R 275 000</td>
<td>R 300 000</td>
</tr>
<tr>
<td>Technician</td>
<td>R 178 000</td>
<td>R 245 000</td>
<td>R 190 000</td>
<td>R 215 000</td>
<td>R 176 000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assume 10% Increase 2008</th>
<th>Metro 1</th>
<th>Metro 2</th>
<th>Metro 3</th>
<th>Metro 4</th>
<th>Ave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Director</td>
<td>R 786 500</td>
<td>R 880 000</td>
<td>R 759 000</td>
<td>R 808 500</td>
<td></td>
</tr>
<tr>
<td>Director</td>
<td>R 550 000</td>
<td>R 770 000</td>
<td>R 550 000</td>
<td>R 770 000</td>
<td>R 396 000</td>
</tr>
<tr>
<td>Chief engineer</td>
<td>R 489 500</td>
<td>R 616 000</td>
<td>R 462 000</td>
<td>R 522 500</td>
<td>R 550 000</td>
</tr>
<tr>
<td>Engineer</td>
<td>R 387 200</td>
<td>R 495 000</td>
<td>R 381 700</td>
<td>R 440 000</td>
<td>R 440 000</td>
</tr>
<tr>
<td>Senior technician</td>
<td>R 265 100</td>
<td>R 357 500</td>
<td>R 275 000</td>
<td>R 302 500</td>
<td>R 330 000</td>
</tr>
<tr>
<td>Technician</td>
<td>R 195 800</td>
<td>R 269 500</td>
<td>R 209 000</td>
<td>R 236 500</td>
<td>R 193 600</td>
</tr>
</tbody>
</table>

Table 4: A sample of Metro cost to company

It should be noted, however, that the figures exclude long service payments, performance bonuses etc which can add significantly to total earnings of long serving high performers.

As mentioned in the introduction to 7.1, the contracting sector is paying a premium for engineering skills. Anecdotal evidence suggests that many civil engineering academics are being enticed to take up project management positions both in consulting and contracting. As far back as 2004, the contracting sector was found to pay a premium for civil engineering skills. At the time, the premium was of the order of 26%. At present this figure is said to be much higher, with many project managers said to be earning between R 750 000 to as high as R 1,5 million!
Figure 9: Results of the 2004 SAICE/IPET cost to company survey

Comparing like with like from each of the surveys emphasizes the lack of alignment of academic cost to company with those in various industries. See Figure 10.

Figure 10: Tertiary current and proposed cost to company compared with consulting and metros

An international comparison of academic cost to company delivered the following:
The significant increases suggested for tertiary engineering cost to company would not elevate academics beyond the average of consulting and local government in most cases, and would certainly not offer contracting or shareholder level of income. It should also be borne in mind that civil engineering professionals generally make up the engineering staff in consulting and local government. ‘Cost to company’ surveys consistently show other engineering disciplines to be higher paid than civil engineering. Furthermore, when considering the figures to be adopted going forward it must be noted that packages outlined above relate to 2007 and 2008, hence a further increase should be considered for 2009.

7.1.5 Direct access to funding

Should specific funds be raised or allocated to address the plight of engineering departments, in support of lecturing staff, scholarships, research etc, Heads of Departments emphasized that these funds should be paid directly to their departments. Accessing funding from a general contribution to the institution is a lengthy, cumbersome process. Furthermore, significant fees (up to 40% in some cases) are charged by Corporate Services of the HE Institutions for administration, so often a much reduced percentage of the initial funds raised make their way to departments.

7.2 Shortage of suitably qualified and experienced applicants (24%)

7.2.1 Qualifications

Engineering is identified as a priority skill required for the accelerated economic growth of the country. The whole world is seeking these skills and it is becoming increasingly difficult to attract suitable applicants. Academic staff are not only expected to have post graduate qualifications but also many years of experience in the workplace and in research.

“It is increasingly difficult to attract staff with the necessary qualifications. Even though we actually require staff to have PhDs and practical experience, the salaries of such engineers in Industry is more than double what we can offer them. We are therefore forced to appoint staff that have too little professional experience and do not have PhD’s. The low number of vacancies are therefore misleading since we are appointing the people we can afford, not the people we need”.

Dr Andrew Cleland, Chief Executive, FIPENZ

P E Corporate Services SA (Pty) Ltd, An evaluation of current remuneration practices and market rates, June 2007

Lawless A, Numbers & needs: addressing imbalances in the civil engineering profession, SAICE, 2005

Chairman, Mechanical and Mechatronic Engineering

26 Dr Andrew Cleland, Chief Executive, FIPENZ
27 P E Corporate Services SA (Pty) Ltd, An evaluation of current remuneration practices and market rates, June 2007
28 Lawless A, Numbers & needs: addressing imbalances in the civil engineering profession, SAICE, 2005
29 Chairman, Mechanical and Mechatronic Engineering
The benchmarks set by the DoE require that:

- Institutions must increase the percentage of academic staff with doctorates.
- The minimum qualification for anyone to teach is at least a Master's Degree (to be implemented by 2010).

This poses many challenges.

(i) The number of academic staff required to have PhDs

The severe pressure to recruit staff has also resulted in the appointment of less post graduate qualified academics than required. Considering that a PhD is required for Senior Lecturers, Associate Professors and Professors a total of 550 academic staff (data from Table 5) should hold PhDs. However, considering Figure 11 there are only 328 staff with PhDs (or equivalent).

If the percentage staff with PhDs in the graph below is further compared to the DoE’s benchmark of 40% it is clear that Universities of Technology are way behind the DoE requirement. This will impact on the ability of Universities of Technology to increase research.

![Figure 11: % Academic staff with PhDs](image)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Agr</th>
<th>Chem</th>
<th>Civil</th>
<th>E&amp;I</th>
<th>Ind</th>
<th>Mech</th>
<th>Metal</th>
<th>Min</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>25</td>
<td>17</td>
<td>10</td>
<td>14</td>
<td>13</td>
<td>17</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>67</td>
<td>72</td>
<td>72</td>
<td>58</td>
<td>66</td>
<td>80</td>
<td>27</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Professor</th>
<th>Agr</th>
<th>Chem</th>
<th>Civil</th>
<th>E&amp;I</th>
<th>Ind</th>
<th>Mech</th>
<th>Metal</th>
<th>Mining</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Professor</td>
<td>0</td>
<td>15</td>
<td>14</td>
<td>40</td>
<td>1</td>
<td>19</td>
<td>2</td>
<td>1</td>
<td>92</td>
</tr>
<tr>
<td>Director</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>Senior Lecturer</td>
<td>3</td>
<td>43</td>
<td>58</td>
<td>111</td>
<td>12</td>
<td>63</td>
<td>16</td>
<td>13</td>
<td>317</td>
</tr>
</tbody>
</table>

Table 5: Academic staff required to have a PhD
Only 34% of engineering academic staff have PhDs. These findings correspond with the NRF findings which state that “the national average of University staff in South Africa without PhDs is estimated to be 60%”.

This is very low compared with international standards. For example: "the Government (of Nigeria) is very concerned that 30% of their academic staff at Universities do not have PhDs. The Government is so concerned that it is proposing a programme of action against this finding".\(^{30}\) This implies that 70% of academic staff in Nigeria have doctorates.

\begin{quote}
“I am a product of Sputnik. When the Russians launched the first satellite, the US Congress got very excited about the US falling behind in Science and engineering, and passed legislation (the National Defense Education Act) establishing a major fellowship program to attract BS engineering and Science students back into graduate school to get PhDs. The fact that the fellowships provided full support, and that catching up with the competition was a national priority, attracted a whole generation into the doctoral pipeline -- with many ending up in academic institutions. Perhaps South Africa needs a similar incentive program”.\(^{31}\)
\end{quote}

(ii) The number of academic staff required to have Masters Qualifications

Considering the 2010 target, the balance of academic staff should have masters qualifications i.e. 634 academics. At present only 332 have such qualifications.

(iii) The number of academic staff with a first qualification

A total of 302 staff hold only first qualifications such as NDip(Eng), or BSc(Eng) or BEng. This is a major challenge in terms of the CHE and ECSA requirement that academics should have a qualification at least one higher than the course they are teaching. Figure 12 shows the extent of the challenge.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure12.png}
\caption{Figure 12: % Qualification composition}
\end{figure}

(iv) The plight of Universities of Technology

\(^{30}\) Lecturers without PhDs to Lose their Jobs, www.universityworldnews.com

\(^{31}\) Dr. Russell Jones, President, Capacity Building, World Federation of Engineering Organisations
Universities of Technology staff do not agree with the need for large numbers of academics with Masters or PhDs.

“The department has 30% (6 out of 20) vacancies in academic positions and one lecturer has resigned today. We have advertised three times during 2007 in the national press and only got applications from foreign candidates who were in most cases not suitable for appointment. In my view, candidates should be qualified at B Eng, M Tech or BSc Hons level to teach at National Diploma and B Tech level. Lecturing staff (at any level) should have at least 5 years experience (in a design office and on site, with South African design codes and site experience) to teach effectively in South Africa. Under the present circumstances it is unrealistic to expect a senior lecturer to have a doctorate.”

“Many lecturers have been lecturing for many years and with the new requirements needs to do research; therefore a higher qualification is needed. This leads to time that the lecturer can spend on increasing the quality of lecturing will be spend on own studies. In some cases staff will complete their studies just before retirement, which is counter productive. The subject content did not change, why is the higher qualification needed”.

Even requirements for technical support staff seems to be high: “At present a minimum of M Tech is required for a lecturer to be appointed and B Tech for Laboratory Technicians. Where vacancies are advertised, there are often no applicants with suitable qualifications. Sometimes there are no applicants at all. We need to note that the country needs hands on type of skills in the guise of Technicians and Artisans”.

As discussed later in 8.1.11, the overall feeling is that management is placing too high an emphasis on research outputs vs. teaching outputs and is placing unreasonably high qualification demands on teaching appointments, particularly in technology programmes. This is “a disaster in the making” as it undervalues the important outputs of technology programmes, namely well educated graduate technicians and technologists.

The Council for Higher Education (CHE) Accreditation criteria suggest that the minimum qualification should be “one-above” the level being taught. When evaluating engineering programmes ECSA recognise registration in an appropriate professional category as being equivalent to a qualification one level higher.

Clearly a more realistic view on the required qualifications for academic staff in technology programmes should be considered together with an acknowledgment of the value of professionally registered academic staff.

A further disparity between Universities and Universities of Technology in terms of advancing qualifications and carrying out research is the issue of sabbaticals. Whilst sabbaticals are normal practice at Universities no evidence could be found of sabbaticals being offered to academics in Universities of Technology.

---

32 HoD, Civil Engineering
33 HoD, Mechanical Engineering
34 HoD, Electrical Engineering
35 HoD, Civil Engineering
(v) Enhancement of teaching skills

Qualification levels in engineering should also not be the only emphasis when focusing on the academic’s ability. Appropriate staff development should be encouraged to address the educational challenges they currently face. This will require more than improved teaching methods but also a deeper understanding of the systems in which they work.

“Many of the current responses towards improving student success seem to rest on anecdotal wisdom, or at best on a set of pedagogical theories that are not necessarily well-suited to understanding the situation at hand. With better ways of understanding student learning, we will be more equipped to develop context-sensitive and effective ways of providing occasions for effective learning to take place. This is intended towards a fuller realisation of the notion of ‘research-led’ undergraduate education which has gained recent currency in many of our institutions.” 36

7.2.2 BEE Requirements

Engineering departments struggle tremendously in achieving broader political objectives such as appointing previously disadvantage individuals. See Figures 13 & 14.

Figure 13: Racial composition of academic staff in engineering and technology (by number)

36 Learning as acquiring a discursive identity through participation in a community: A theoretical position on improving student learning in tertiary Science and engineering programmes, A position paper by the Centre for Research in Engineering Education (CREE)
It is important to note that engineering departments which had capacity to respond the fastest to this JIPSA survey (an example of additional workload) had several well qualified and experienced academic and support staff, who were largely long serving white males. The high ratio of white male staff members should not be seen negatively. They should be retained and harnessed to mentor young academics as well as develop future management capacity.

“Unwilling to employ white males due to equity targets, but people from designated groups who are extremely scarce and command large salaries in Industry, means that few or no applications are received for the advertised positions”.37

The reason for the low number of pdi academics is that insufficient individuals comply with the Mathematics and Science minimum criteria to enter HE engineering and technology courses. Those that graduate and are successful are so sought after that they are appointed in very well paid senior positions in Industry. Many departments eventually appoint qualified staff from other African countries and further afield to fill vacancies.

Published by Engineering News, 3 Oct 07
By: Olivia Spadavecchia

“Updated findings from the Centre for Development and Enterprise’s (CDE’s) study into education’s role in skills development, the empowerment of black South Africans and economic growth, confirm that far-reaching reform is sorely needed in the areas of Mathematics and Science education.”

37 Executive Head, Electrical Engineering
The CDE found that government's goal of doubling the number of senior certificate higher grade (HG) Mathematics and Science passes, from about 25 000 to 50 000, was nowhere near being achieved.

Executive director Ann Bernstein reviewed some figures related to education's poor performance; in 2004, 467 985 learners wrote the senior certificate examinations, with 39 939 learners writing HG Mathematics. Of these, only 5%, or 24 143 learners, passed HG Mathematics, only 1.5%, or 7 236 of the passes, were obtained by African students, and only 0.5% (2 406 learners) achieved a grade of 'C' or better.

An overwhelming 81% of South African secondary schools achieve only one HG Mathematics pass on average, according to the CDE.

Bernstein noted, that the fact that students were not able to pursue Mathematics and Science-related degrees at Universities was a significant problem, and that the skills shortage would continue to deepen as a result.

7.2.3 Registered professionals

Engineering activity encompasses initiatives, services and the solution of problems that are of importance to society and the economy. While these activities support economic activity, the creation and maintenance of infrastructure generally bring benefits to society, each has accompanying risks to the health and safety of people or the environment. Because of these risks, work must be performed without compromising safety, health and environmental standards and taking sustainable development imperatives into account. While minimizing the risks, engineering work must also be effective: enhancing benefits commensurate with costs. Safe, environmentally sound and effective engineering work depends on the competence of practitioners.38

Engineering is a regulated profession to assure that engineering practice is in the public interest. Regulation involves setting standards for qualifications, practice, and ethics; assessment against the standards, award of professional titles to persons assessed competent; promoting best practice and the investigation of complaints and imposing sanctions in the case of misconduct.

With the implementation of the Identification of Engineering Work (IDoEW) it has become important for engineering practitioners to be registered.

The engineering work, including “Overseeing the planning, design and delivery of education and training programmes accredited by ECSA at the exit level” has been identified for persons who are registered with ECSA in any of the professional categories mentioned in Section 18(1)(a) of the Engineering Profession Act”.39

ECSA reflects this fact in their Accreditation Criteria: “The staff members responsible for leadership, planning and assessment at the exit level are professionally and technically competent in the respective disciplines. Registration with ECSA in the appropriate professional

---

category provides the norm for professional standing”. This does not preclude staff being unregistered – they can’t, however, take leadership roles.

Considering the data in Figure 15 on average only 40% of academic staff at Universities and 26% of staff at Universities of Technology are registered with ECSA.

![Figure 15: % Full time academic staff who are registered with ECSA](image)

All staff should be encouraged to become professionally registered. This will ensure professional input in courses and academics would serve as role models in terms of professionalisation in engineering.

Unless adequately structured, the academic environment may not provide sufficient practical experience for young people and therefore potential academics leave the environment to gain the practical experience necessary to register. The registration process is an essential component in designing the career path of academics. Several recommendations on developing young academics towards registration are outlined later in the document.

Those who are in the system must be encouraged to stay at all costs. Retention strategies should include paying professional registration fees, and assisting staff to retain their professional registration (standard practice in the private sector). This requires Continuous Professional Development (CPD). Professionals must be supported to attend appropriate courses, workshops etc to keep up-to-date and earn the points required to retain their registration.

7.2.4 Foreign academic staff

High levels of vacancies as well as the need to appoint staff with PhDs have forced HE Institutions to appoint foreign academic staff. See Figure 16.
Data indicates that an average of 9% of academic staff in technology programmes and 14% of staff in engineering programmes are foreign. Whilst these lecturers certainly offer relief, there are a number of challenges in employing foreign lecturers as follows:

- In many instances limited command of English or poor accents which students struggle to understand.
- Poor command of English also means that marking of some papers takes longer or the results may not be reliable.
- In design courses, no knowledge of local codes of practice or national standards, which means that it takes longer for foreign academics to settle in and pick up the load.
- In practice, limited knowledge of local legislation impacting on issues such as labour, health, safety, environmental, compliance etc reduces the areas in which foreign skills can be harnessed, or significantly increases the time it takes for such lecturers to become effective.
- It takes a long time to process work permits as well as to settle in the new environment.

It is therefore not surprising that a lower percentage of foreign lecturers are being used in technology programmes as practical topics require more local knowledge and experience.

“Currently only three members of our academic staff were actually born in South Africa, only one is under 55. By way of comparison, four were born in Zimbabwe (including me!), the remainder are not from Africa at all. However, we can’t even recruit Zimbabweans now. If we continue to take foreigners to the exclusion of local people we will rapidly move to a point where the education of the next generation of engineers will be in the hands of foreigners who might be technically excellent, but have no understanding of the culture or environment of South Africa - and to make matters worse, are not even English first-language speakers”.

“The situation is much worse than indicated as 4 staff members that have been appointed but who are awaiting work permits are only due to start in the next few months”.

---

40 Deputy HoD, Civil Engineering
41 HoD, Civil Engineering
7.3 Insufficient Funding (21%)

Funding impacts on most of the problems identified and was therefore identified as an area which could solve many problems.

“\textit{It is expensive to run a chemical engineering department with state-of-the-art practical equipment and laboratories, as the current government subsidy per student is not sufficient to cover the real costs related to the education of chemical engineers. Therefore, in order for a chemical engineering department to operate successfully and effectively (on a financial basis), significant contract research work and related industrial interaction is required}”.\textsuperscript{42}

“We need two complementary components for funding: (a) ‘rising tide’ for all universities, simply to put them into a reasonable ‘ballpark’; (b) then, allow universities to follow differentiated routes/strategies to pursue their own particular niches”.\textsuperscript{43}

Funding is not only a problem in terms of lecturers not being paid adequately but in terms of there being insufficient funding for an adequate number of lecturers to be deployed. Engineering programmes are expensive to run but they are not categorized as such in the funding formula. The number of subjects in engineering degrees and diplomas is significantly higher than in most other qualifications. The funding formula awards a subsidy per full time student. The measure is known as a Full-time Teaching Equivalent (FTE), and is based on one student enrolled full-time in contact mode for a whole academic year. A student studying full-time for a six-month semester would count as a 0.5 FTE. Adjustments are made to the subsidy based on the number of subjects being taught, but the adjustment as currently calculated in inadequate for most engineering courses. Typically to date 8 to 10 subjects were taught per semester i.e. 16 to 20 per annum. This translates on the whole to 3 or 4 times the number of subjects delivered in other courses, but the adjustment factor (known as the Teaching Input Grant Adjustment Factor) is 2.5. Thus departments cannot afford the number of lecturers required to deliver the range of subjects.

To ensure that they break-even, departments have removed many fundamental subjects from their curricula which impacts on throughput and the calibre of the graduates. As another cost saving measure, departments have reduced contact time by making some subjects self-study. Whilst learning of soft subjects may be possible, the ability of students to develop an understanding of structural analysis and other complex theoretical subjects is questionable when adopting this approach. Sadly in many instances the more complex and therefore more expensive to teach subjects have suffered in the interests of cost savings. One must question the long-term effect of these measures as they will ultimately impact on the health and safety of those for whom infrastructure is developed.

Engineering should be funded at the highest subsidy level, if not higher and the adjustment factors must be reviewed as a matter of urgency.

A related problem is the trickle down of funds into the departments. Few report receiving the full value of additional funds raised to support their departments.

\textsuperscript{42} Chairman, Process Engineering
\textsuperscript{43} Senior Lecturer, Civil Engineering

JIPSA Report on Vacancies at Eng Dept 31 August 2008.doc
7.4 Retirement

Although there is a desperate need for new blood, tertiary institutions cannot afford to lose experienced teaching staff at the prescribed retirement age of 60. This is younger than the official retirement date used in Industry (normally 63). Consideration should be given to raising this age, and offering post retirement contracts coupled with mentoring duties for those willing to continue.

7.5 Ineffective recruitment processes (10%)

"Replacement often takes a lot of time due to administrative bottlenecks."\(^{44}\)

The recruitment and retention of suitably qualified and experienced engineering professionals in our booming economy is a major challenge for the whole country. This is even more difficult for Universities and Universities of Technology who have high qualification requirements for lecturing positions and do not offer market related cost to company.

Recruitment processes fall outside the engineering departments. This was identified as a major problem as it lengthened the time to identify and approach successful candidates and in many instances HR departments exert pressure on who should be employed. Applicants are often totally unsuitable but are imposed on departments. As a result the load on existing staff increases further.

7.6 Lack of promotion (8%)

The lack of an academic career path together with the lack of Industry experience required for registration is a reason young students do not pursue an academic career and leave the academic world for Industry.

"The staff structure needs a hierarchy of positions. There is very little opportunity for promotion with the existing flat structure."\(^{45}\)

8. Challenges associated with the changing environment

8.1 An ever increasing workload (52%)

The second area of concern mentioned by 37 engineering departments was the issue of an ever increasing workload. In order to understand their comments it is necessary to first understand what is expected of HE Institutions by considering what they will be audited against. The following areas are listed as core activity areas\(^{46}\):

---

\(^{44}\) HoD, Civil Engineering
\(^{45}\) Executive Head, Electrical Engineering
\(^{46}\) Criteria for Institutional Audits, CHE, June 2004
1. Teaching and learning

- **Teaching and learning** including the management of the quality of teaching and learning, academic support services, short courses, exported programmes, partnership programmes, programmes offered at tuition centres and satellite campuses and certification.

- **Programme development, management and review** including programme management programme design and approval, staffing, programme review.

- **Student assessment and success** including management of assessment, moderation system, explicitness, fairness and consistency of assessment practices. Security of recording and documenting assessment data, recognition of prior learning.

2. Research: Assuring, developing and monitoring the quality of research and postgraduate education.

3. Community engagement: Community engagement should be discharged through a range of activities, including service learning. Quality considerations for institutional engagement with the local and broader community should be formalised within an institution’s quality management policies and procedures. These arrangements should be linked to teaching and learning and research, where possible, and given effect through the allocation of adequate resources and institutional recognition.

These generic activities should further be considered, in the context of engineering education which requires the following three learning components:

- Knowledge through lectures.
- Skills through practical work.
- Experience through Work Integrated Learning/Industry related projects.

All three learning components require time to administer, plan, develop, review, prepare, assess, moderate, mentor, support and record. Additional time is required for research, post graduate studies as well as community engagement.

The HoD’s had strong views on these requirements.

“There is an underlying expectation (as per official performance appraisals) that a lecturer must be excellent in all undergraduate teaching, postgraduate teaching, research, professional engineering, community interaction and administration in order to be rated as truly “high quality”. This leads to an un-focused and ineffective work approach. It is partly, as a result of the new bureaucratic, auditor-driven regulation of academic institutions, but also a result of inadequate funding. Engineering departments can no longer afford the luxury of having excellent undergraduate lecturers with only a few post-graduate students per lecturer and it is quite normal to see top undergraduate lecturers also having to supervise more than ten postgraduate students (after having sourced related contract funding and bursaries from Industry), while also being seriously involved in administrative and managerial processes typical of academic institutions.”

---

47 Community includes industry
48 Chairman, Process Engineering
In addition to regular duties, the following extends the workload:

- Vacancies.
- High staff turnover.
- Increasing administrative demands.
- High numbers of external lecturing staff.
- Too many subjects to lecture per academic.
- Poorly prepared student groups.
- Requirements to improve own qualifications.
- Requirements to supplement salary through consultation.
- Additional requirements for Work Integrated Learning.
- Too few support staff within departments to handle administration, laboratory support and tutoring.

In discussions since issuing the research questionnaires two further concerns have been raised as follows:

1. **Absenteeism**: is a frustration, placing further load on those who do take their responsibilities seriously. If further research is carried out, the impact of this behaviour should be measured.

2. **Community engagement**: the introduction of Community engagement is of great concern. In speculating on the scope of this engagement, suggestions that students will be building bridges etc displays a distinct lack of understanding of the experience required to deliver infrastructure. Whilst students may assist with the process, experienced staff must be involved in the design, supervision and skills transfer associated with this type of activity. To date most Universities of Technology have struggled to find adequate Work Integrated Learning opportunities for their students due to the lack of capacity to manage and train young people in industry. This additional demand for what is effectively Work Integrated Learning in communities will add to the existing load as lecturers will be required to supervise this training phase.

### 8.1.1 Vacancies

An average of 22% vacancy means that the reduced staff are required to carry even heavier loads due to the extended scope of work.

> "Current staff complement numbers were designed for a pure teaching environment (while this Institution was still a Technikon). Since the institution has become a University, the “goal posts” have changed and it has become important that we get involved in research. However, no time (and hence no opportunity) is made available for this change. In addition, a low staff complement as well as a high staff turnover rate exacerbates this problem and staff are over worked. Importantly, the complement numbers were never adjusted to suite the new university goals."  

---

49 HoD, Mechanical Eng Technology
8.1.2 High staff turnover

In addition to the pressure caused by the vacancies in engineering departments the high turnover of staff in the filled posts must be noted. New academic staff, from lecturing to management can take years to adapt to the academic environment, particularly when the first task is obtaining a higher degree. Establishing a research profile and obtaining funding can take 10-15 years if one is starting from scratch. This affects the operation of the rest of the department.

Institutions are short sighted when resisting increases as part of their retention strategy, since it is well researched and documented that separation, replacement and training costs associated with staff turnover is very costly. It is estimated that the recruitment process costs the employer 100% to 250% of the current annual cost of the exiting worker.

My school has not lost a staff member to another South African university – we lose them to Industry (8 in the past 10 years) and overseas (4 in the past 10 years). 10 years ago the staff complement was the same as it is now.

“In 2007 we had only 5 full time academic staff members. The high staff turnover is a serious concern re the maintenance of standards.”

8.1.3 Onerous administrative responsibilities

39% of respondents indicated that administration, paperwork, meetings and red tape seem to demand too much time from academic staff. The pressure to design, market and sell programmes, and record and report in more detail than in the past, in the name of quality assurance and accountability, conflicts with the need to support increasing student numbers and pursue own research interests.

“Constant bureaucratic administrative procedures, too large undergraduate classes, inefficient HR and financial systems in the university and a lack of initial research report at the start of an academic career are pressures which academic staff have to cope with and which hamper their work and progress”.

“An incredible increase in paperwork associated with quality assurance has added greatly to pressure on the staff”.

“Inadequate academic support systems, e.g. lack of support from Admin Dept, difficulty in accessing information from ITS, registration process being dragged out resulting in it taking too long to process student information, lack of understanding of complexities of offering engineering courses by support sections of university”.

52 HoD, Civil Engineering
53 HoD, Civil Engineering
54 HoD, Chemical and Metallurgical Engineering
55 Chairman, Mechanical and Mechatronic Engineering
56 HoD, Electrical Engineering
“Numerous non-academic tasks, such as registration, entering and checking marks on a clumsy computer program, attending an ever-increasing number of marketing/promotional functions, etc”.  

“A huge administrative load because the support staff and support departments do not deliver support. They usually set deadlines for the academic staff to supply them with information and then either rearrange it, or simply pass it on as is. So the academic staff do the work anyway, while the support staff are paid to duplicate what has already been done.

Alternatively, when the academic staff need some support, it is not forthcoming or takes too long to arrive. So the academics end up doing the work - often duplicating what other people are paid to be doing - because the academic staff can’t afford to wait for the support that may or may not come.

The IT support is archaic, as are administrative procedures. Information is not available “at the touch of a button”. There are multiple, non-compatible systems leading to incorrect and incomplete information. Access to information is “over-protected”. Academics tend to set up their own individual or departmental systems because they don’t trust the university system or can’t get the information they require from it. This leads to further proliferation of systems and duplication of work.

Policies and procedures are continually being written and rewritten, but are usually verbose, unclear and far removed from the “real world” of the academic in the classroom, laboratory or assessment venue”.

8.1.4 Increasing student numbers

46% of respondents indicated that the increasing student numbers add pressure to the working conditions of academic staff.

“In the current situation our staff complement deals with double the number of students that it should be. Current market estimates require a triple output of graduate engineers”.  

“Student/staff ratios must be held at realistic levels (i.e. about 20) – this requires increased staffing levels if we want to enroll more students, which in turn requires more funding. Note that the University allocates funding based on criteria that has nothing to do with scarce skills etc. If the Government wants more engineering graduates they must talk directly to the Engineering Faculties”. 

Over the past few years engineering departments have increased their student intake significantly in order to produce more graduates for the Industry. Engineering education incorporates practical experience and workplace learning which places a further burden on the lecturing staff as numbers increase. Not only does this place pressure on the academic staff to

57 HoD, Electrical Engineering
58 Executive Head, Electrical Engineering
59 Acting HoD, Industrial Engineering
60 HoD, Civil Engineering
mentor and assess the growing number of students but also on facilities such as laboratories, equipment and lecturing venues. Furthermore, splitting groups to accommodate inadequate facilities requires more lecturing time of the same staff member.

Data from Figures 17 & 18 shows that 962 academic staff are responsible for teaching and mentoring 52 735\(^{61}\) engineering students.

![Figure 17: The number of posts per discipline per category](image)

![Figure 18: Number of engineering students per engineering faculty](image)

Although the DoE recommends an average student:lecturing staff ratio of 20:1\(^{62}\) the survey has found an average ratio of 55 students to every full time academic staff member (Figure 19).

---

\(^{61}\) HEMIS indicates that 58 191 students were enrolled for engineering programmes during 2006.

\(^{62}\) In discussions with the Enrolment Planning section at the DoE it was explained that the DoE average target is 20:1 based on 16:1 for SET programmes and 24:1 for other programmes.
Comparing data from each department to the average ratio of 55:1 the following 16 departments (of which 81% are offering technology programmes) have higher student:academic staff ratios than the average:

271 students per lecturer, Industrial Engineering, TUT
201 students per lecturer, E& E Engineering, TUT
158 students per lecturer, Civil Engineering, CUT
147 students per lecturer, Mechanical Engineering, UJ
121 students per lecturer, Chemical Engineering, UJ
111 students per lecturer, Chemical Engineering, TUT
92 students per lecturer, Civil Engineering, CPUT
90 students per lecturer, Civil Engineering, NMMU
80 students per lecturer, E&E Engineering, MUT
76 students per lecturer, Mechanical Engineering, UKZN
72 students per lecturer, Civil Engineering, TUT
68 students per lecturer, E&E Engineering, CUT
66 students per lecturer, Mechanical Engineering, UP
64 students per lecturer, Industrial Engineering, UP
64 students per lecturer, Chemical Engineering, MUT
63 students per lecturer, Metallurgical Engineering, UJ

These programmes require urgent attention in order to ensure quality teaching.

A comparison with other SET based programmes revealed that the ratios of students to academic staff are much closer to the DoE targets.
Amazingly only four engineering electrical and electronics departments can boast of ratios of less than 25. All other engineering departments nationwide are above the DoE suggested figure of 20:1 and above the 25:1 found in science departments. See Figures 20 and 21.

Figure 20: Number of students per academic staff member per technology programme

Figure 21: Number of students per academic staff member per engineering programme

63 HEMIS, 2006, DoE
International comparisons revealed the following:

"Just back from Canada where I discussed student:lecturer ratios with US and Canadian colleagues. There is no theoretical basis for a ratio. For public funded Universities there are between 18 and 22 students per lecturer, whereas private Universities such as MIT have a ratio of about 8. And their fees reflect that!"

For example, University of Illinois at Urbana Champaign Dept of Civil Engineering has about the same number of students as University of Pretoria, about 1000 and the undergrad and post-grad mix is about the same. They have 42 lecturers whereas UP has 16, and additionally we offer service courses to other departments and Statics for all the first year engineering students".  

“Student faculty ratios (in the USA) vary considerably depending on the goals of the institution. A research driven graduate program may have a ratio of 10 or lower, while a two-year community college might find 30 acceptable. The reported ratio of 60 is certainly not acceptable in any quality school".

“(New Zealand’s) Tertiary Education Institutions (TEI) employed 28,338 staff in the 2003 year, to teach 266,674 EFTS as well as to perform research and non-academic services. TEIs employ academic and non-academic staff, with the proportion of academic staff ranging from 46% in universities and wānanga to 55% in polytechnics in 2003”.

The latter quote would seem to indicate a ratio of around 19:1 for students to academic staff in New Zealand.

**8.1.5 Intake of poorly prepared students**

33% of respondents complained about the weak student intake - specifically referring to proficiency in English and Mathematics. Inadequate competency in these two fundamental learning areas requires additional support through foundation programmes as well as extra mentoring time.

“*The high school system does not prepare candidates satisfactorily (specifically with Mathematic and Physical Science and English). This is evident throughout their studies and causes many students to repeat subjects*”.

“We are increasingly of the opinion that a C for HG Mathematics is inadequate; under the NSC, we are looking for Level 6 or better (broadly a B). Recent years have shown that very few schools prepare their students adequately for university. The situation is likely to get worse with the relegation of key subjects like geometry to the optional Paper 3 in the NSC. This will continue to greatly restrict eligible candidates - not that we are having a problem with candidates at present*.”

---

64 Prof. Alex Visser, Civil Engineering  
65 Dr. Russell Jones, President, Capacity Building, World Federation of Engineering Organisations  
66 Report on the Scope and Methodology, Strategic Review of the Tertiary Education Workforce, NZ Tertiary Education Commission, June 2005  
67 HoD, Mechanical Engineering  
68 Deputy HoD, Civil Engineering
“Staff need to invest more and more time with students who are under prepared or who need additional and individual attention”. ⁶⁹

Figure 22, a survey conducted in all first and final year civil engineering classes in October 2004 clearly indicates the relationship between achievement in English and Mathematics. Sadly a significant portion of all students at Universities of Technology achieved low symbols for English and thus the majority enter tertiary studies with standard grade C and lower symbols which are totally inadequate for engineering studies.

![Figure 22: The relationship between Mathematics and English grades achieved by first and final year civil engineering students, October 2004](image)

Clearly tertiary institutions need to develop multi-faceted skills to deal with the diverse range of students entering the environment.

A fascinating paper assessing the competences of individuals, groups and populations relates these competences to the levels of literacy of those being assessed ⁷². “Literacy skills are learned and with the appropriate educational environment, almost all members of a population (except those with learning disabilities) are able to acquire literacy skills”. In addressing literary, it is asserted that cognitive differences can be diminished

To support students to develop adequate foundation knowledge to cope with applying the theory being taught, additional support is required by way of more comprehensive foundation training and extended tutoring.

---

⁶⁹ HoD, Mechanical and Aeronautical Engineering

⁷⁰ Lawless A, Numbers & needs: addressing imbalances in the civil engineering profession, SAICE, 2005

⁷¹ The Mathematics symbols where grouped in terms of minimum entry requirements (HG A,B,C) for engineering programmes and (HG D, E, F & SG A,B) for technology programmes.

⁷² Marks DF, IQ variations across time and race are explained by literacy differences, Nature Proceedings, Posted 3 Nov 2007
(i)  Foundation training - Addressing the disadvantage gaps

From research carried out in the preparation of Numbers and Needs\textsuperscript{73} it was found that the majority of technikon students came from disadvantaged backgrounds. These students generally experienced inadequate parental support and limited pre school development. According to many international researchers the quality of parenting and pre-school training “\textit{are associated with cognitive development}”\textsuperscript{74} and form the basis for future education experiences. Moving on to inadequate schools means that many enter tertiary institutions with inadequate grounding to cope with the advanced concepts presented in engineering studies.

Foundation or support courses generally try to cover a large range of issues and do not offer the intense ‘catch up’ training necessary to develop the enquiring and problem solving skills required for tertiary engineering studies. Thus once again more staff should be made available to develop students to their full potential and ensure higher throughput.

(ii)  Increased tutoring

Having grasped the principles, practice is the best teacher.

As far back as 1997, Professor Les Clarke, Professor of Civil Engineering at Birmingham University, made the following observations\textsuperscript{75} “\textit{Secondary education is very different from the traditional education which many of us would have experienced. There is far less teaching of facts and techniques, and the associated hard work of practicing techniques through completing numerous examples}”

His view is that foundation maths and physics must therefore be taught at tertiary level and extensive tutorial sessions are necessary to ensure that students finally grasp concepts which had eluded them at school level. Intensive tutoring should continue for all subjects to ensure that students learn how to apply the theory learnt, in practice.

\begin{quote}
\textit{“Improvement of academic support systems (will increase throughput), e.g. improved and expanded tutoring systems, additional language proficiency classes, and soft skill training (incl. basic technical & life skills) as well as improved access to computer lab facilities. Improve skills of lecturing staff in teaching & learning. Improve methods of monitoring student progress and application of early warning systems with availability and resourcing of the necessary mechanisms to provide support to academically needy students”}.\textsuperscript{76}
\end{quote}

8.1.6  Too few support staff

25 % of respondents indicated that the lack of sufficient support staff add pressure to the working conditions of academic staff.

\textsuperscript{73} Lawless A, 2005. Op cit.
\textsuperscript{74} Paxson C, Schady N, Cognitive development among young children in Ecuador: the roles of wealth, health and parenting, World Bank, 2005
\textsuperscript{75} Prof Clark LA, 1998, Presidential Address Evolution or Decay, The Institution of Structural Engineers, United Kingdom, pages 7-9
\textsuperscript{76} HoD, Electrical Engineering
In order to increase throughput and provide quality learning, it is essential that support services and staff are increased. This ranges from equipment, computer facilities, telecommunication systems and other supports, such as administration staff, tutors, markers, postgraduate students (who act as research assistants) and technical staff in laboratories etc. These underpin a university’s instructional and research environment. The ratio of students to technical support staff was offered by some departments and varied from around 70:1 to 150:1 and could possibly be more. This has been a challenge for some time. Research carried out in the late nineties showed this figure to be 153:1 in the civil engineering department at the University of Pretoria at a time when the ratio was 15:1 in Dar Es Salaam and Nairobi and 20:1 in Surrey!

"Increased tutorship assistance will most probably increase throughput. The students also need the latest equipment to learn what is relevant in today’s Industry. There needs to be adequate student support services such as computer and printing facilities. The campus itself must be an environment which is conducive to teaching and learning in order to maintain high levels of staff and student motivation."  

Most of these can be achieved through funding. Another area that would require additional input is that of the artisans assisting in the laboratories. The scarcity of artisans has not left the HE Institutions untouched and would require Institutions to train these artisans through structured learnership in their labs.

"The current complement of competent artisans and technicians in workshops are ageing white males and we will soon be in deep trouble! There are no positions or time to train the next generation artisan. Universities require very competent and skilled artisans and technicians. Also, in many instances the required skills level for technical assistance to staff and students has risen over time and many of the current artisans and technicians did not keep up with technology and new developments. HEI’s cannot afford competent artisans and technicians anymore and at the same time they requires even higher skills levels."  

8.1.7 Research

The White Paper places strong emphasis on the need to develop research capacity and increase research productivity to ensure both open-ended intellectual inquiry and the application of research activities to social development. The DoE has set an increase in postgraduate enrolments and research outputs as a strategic goal for the South African higher education system.

11 % of respondents indicated that research requirements add pressure to the working conditions of academic staff.

---

77 HoD, Chemical Engineering
78 HoD, Electrical Engineering
79 Criteria for Audits, CHE, June 2004
“The staff perception is that this University of Technology is moving away from the requirements of the Industry that it serves. Since this institution is now a University, staff members are now expected to conduct research in addition to their existing full work load (laid down standards)”.

“This goal creates pressure at both Universities and Universities of Technology: “Misalignment between the University’s Strategy, performance management system and operational requirements. (The) University wants to be internationally regarded as “Research focused and driven”; the market demands “Degreed Engineers” and Lecturers need to provide for their family’s “Income need”. The reality is performance & promotion is based on “Research”, the market on student volumes i.e. “Teaching capacity” and lectures look for “Third stream income”. These three drivers are not aligned or balanced to deal with reality”.

Since technikons have become Universities of Technology their output requirements now include research. This is causing additional pressure as they further feel that there is limited administration and technical support for research.

The debate rages over whether it is practical to place such an emphasis on research in Universities of Technology. There is a clear need to advance the frontiers of technology through research. This requires an advanced theoretical understanding of the subject in order to develop improvements or alternative technology. Under graduate courses at Universities are more theoretical and provide the foundation for such research.

Universities of Technology, on the other hand, are tasked with training technicians and technologists who are relied on in the engineering team to apply their practical knowledge and experience to turn concepts into reality, and manage and maintain infrastructure. Thus the emphasis in Universities of Technology should be on skills development rather than research output.

8.1.8 External and contract staff

Many departments rely greatly on external part time lecturers to supplement their capacity due to the high vacancy levels. Refer Figure 23. These lecturers do not have administration responsibilities which must once again be carried, by the over burdened permanent staff.

The quality management systems also require that question papers from external personnel be quality assured by the permanent staff.

“In addition to the high workload of departmental staff, for every contract lecturer there needs to be one permanent staff member to Quality Assure their work before processing, i.e. examination papers, tutorial letters etc”.

---

80 HoD, Electrical Engineering
81 Acting HoD, Industrial Engineering
82 HoD, Industrial Engineering
Whilst the questionnaire asked about external lecturers, the status of employment contracts was not considered for full-time staff. It has since been established that staff are also employed on a contract basis which does not offer long term security and contributes to turnover. Future research should investigate the extent of this practice.

8.1.9 Too many subjects to lecture per individual

The data in Figure 24 indicates that academic staff in engineering programmes, lecture an average of 1.6 subjects (given on 2nd, 3rd and 4th year level) and those in technology programmes 2.6 subjects. This is a result of the responsibility of vacant posts being shared amongst the remaining staff. This either dramatically increases their load, as they are required, to study new subjects in depth, to gain the required understanding of the subjects, in which they are not specialists, or it affects the quality of lecturing and graduates if the subject is not adequately understood or covered.

Figure 23: % Part time lecturers

Figure 24: Average number of subjects lectured per individual
In discussions with SAFCEC it was confirmed that many of their member companies did not employ graduates from various Universities of Technology, as these institutions did not have lecturers who could adequately cover the subjects addressing their needs. In extreme instances, the contact time on these subjects, was reduced to a minimum, as lecturers were not confident to offer the subjects.

The large subject load carried by lecturers at Universities of Technology means that they spend most of their week lecturing, which leaves little time to improve their qualifications or carry out research. Staff at Universities generally spend less time lecturing, but still struggle to find adequate time for research.

This load also reduces the amount of one-on-one time available for assisting weak students which is critical for their progress, as outlined below.

“Shortcomings in student learning can only be identified if the instructor rigorously assesses the students’ performance, with respect to learning objectives. And performance assessment can only result in improved learning if it is accompanied by constructive feedback oriented towards improving those shortcomings.”

8.1.10 Work Integrated Learning (WIL)

Work Integrated Learning forms part of the National Diploma in engineering and comprises one year’s experience at an employer against specific outcomes. The purpose of WIL is to empower students to apply their acquired knowledge, understanding, skills, attitudes and values in the work environments in South Africa.

In order to become a registered technician, graduates must gain a further three years of work experience as candidate technicians.

Unfortunately there are many difficulties in the implementation of WIL. The major reason is that it is not a funded year and although HE Providers are responsible for the quality of WIL, they do not have the capacity to support the system in terms of:

- Finding placements for the students.
- Quality assuring WIL including:
  - Supporting and monitoring the employers.
  - Supporting and visiting the students.
  - Ensuring that students do obtain the appropriate level of experience.

It then becomes the students’ responsibility to find placement and if they are unsuccessful they cannot complete their qualifications. As time goes by they find it more difficult to succeed in finding work.

Furthermore, students who have outstanding study debts are unable to register and gain their log books for WIL. Even if they do find a WIL opportunity this experience does not count unless

---

83 ExCEED : A model for instructional design, Civil Engineering, June 2007
they are officially registered for the WIL year. They thus find themselves in a catch 22 situation where they cannot graduate and get into the job market to pay back their debt or loans.

Those students who do find placement are often not given the opportunities to work at the level of a technician but are expected to do manual labour, deliveries, office administration or worse still make the coffee, which does not support them in achieving the learning outcomes. Due to the non possession of driver’s or learner’s licences they often do not get to site which further impacts on their ability to complete their studies.

A debate is currently taking place whether the one year WIL should not be moved and added to the 3 year post graduation work experience.

This situation will hopefully change when the new HE Framework will allow for qualifications without WIL. Those institutions that do include it as part of their qualifications will have to take on the responsibility of placing students.

“It is the responsibility of institutions, which offer programmes requiring WIL credits to place students into WIL programmes. Such programmes must be appropriately structured, properly supervised and assessed”. Implementation date for this policy is 1 January 2009”.

It is clear that WIL should become a funded year to empower HE Providers to provide quality WIL by investing more resources into this large component of the National Diploma.

**8.1.11 Improved qualifications required**

20 % of respondents indicated that additional pressure is exerted on academic staff from Universities of Technology to further their studies, in order to comply with new requirements for the different posts. This has caused many to feel unappreciated as they feel that the academic requirements are too advanced for the positions.

“Many lecturers have been lecturing for many years and with the new requirements need to do research; therefore a higher qualification is needed. This means that lecturers will spend their time on their own studies instead of improving the quality of their lecturing. In some cases staff will complete their studies just before retirement, which is counter productive. The subject content did not change, why is the higher qualification needed”?

Furthermore, considering that Universities of Technology are required to produce practical hands-on technicians and technologists it would be more appropriate for lecturers to be professionally registered, experienced practitioners than theoretical ‘boffins’. The new qualification requirements for lecturers at Universities of Technology combined with the current curricula means that technicians and technologists are likely to become inadequately trained “engineers” rather than well trained technicians and technologists.

---

85 HoD, Mechanical Engineering
In terms of qualifications for academic staff, the emphasis at Universities of Technology should be on professional registration and practical experience.

8.2 Insufficient and under equipped facilities (16%)

The lack of sufficient, well equipped lecturing as well as practical facilities was identified by 11 departments. They also highlighted that this was not restricted to the engineering faculties but other facilities such as the Sciences which deliver the fundamental courses in the early years of engineering studies.

“(It is a) Continuing struggle to obtain modern research facilities and equipment, endless forms and applications take up time” 86

“The staff vacancies do not limit the intake as such but it is more the physical resources such the laboratories including computer laboratories that can be under pressure if our intake is increased without them being expanded” 87

“Staff cannot even be assured of functioning projectors, air-conditioning, chalkboards, or even chairs and desks in venues and so are very demoralised”. 88

“Inadequate and poorly maintained facilities & resources e.g. funds for provision of lab facilities are limited and it is difficult to get funding to maintain equipment and get latest technology for practicals”. 89

“The teaching environment should be conducive to teaching and learning. The lecturer should be able to use technology in teaching (laptop and data projector). All students should be able to be seated comfortably at a place where they are able to see the displays in front of the class. It is thus important to have proper and appropriate lecturing facilities and laboratories. Since the merger (in 2005) we had difficulty in obtaining large venues for teaching purposes, resulting in lecturers having to present lectures two or three times to different small groups (50 -75). Large venues will make it possible to teach a subject to a large group (200) and not frustrate lecturing staff”. 90

8.3 Others

Other issues were also listed as problem areas: merger consequences (4%), rural sites (3%), poor status (3%), lack of confidence in senior management (3%), personalities (1%) and load shedding (1%).

86 Chairperson, Department of Industrial Engineering
87 HoD, Chemical Engineering
88 Acting HoD, Mechanical Engineering
89 HoD, Electrical Engineering
90 HoD, Civil Engineering
9. Numbers

9.1 National requirements

The question was then posed whether additional academic staff would be required if all vacancies were filled - 59% of engineering departments responded with a resounding “YES”.

“There are no vacancies as such – but we would like more staff at all levels. Benchmarking with similar institutions outside of South Africa suggests we have too few academic and research staff for the student numbers we deal with”. 91

“The department has experienced major growth in student numbers over the past few years. For example, 2008 figures are up by 41% from 2007 and with the low staff numbers makes our task in teaching rather difficult. To answer the question, even if all the positions are filled there is a need to increase the staff compliment in order to meet the growing intake of students in the department from a teaching point of view”. 92

Since data from 10 engineering departments was not received, the totals were extrapolated using the 2006 DoE student number of 58 191 93 and the current student:lecturer ratio of 55:1. This calculation suggests that some 1035 permanent academic staff positions are filled compared with the total of 962 in the survey.

It must be noted that although the survey has determined an average ratio of 55 students to every lecturer the 2006 DoE data reflects a ratio of 64:1 (58 191 students to 911 academic staff). This may indicate that the 10 engineering departments which did not respond to this survey have larger student numbers and limited academic capacity. Thus the 2008 ratio may be higher than 55:1.

In order to calculate the actual number of permanent academic staff required the ratio of 25:1 recommended by ECSA 94 when accrediting engineering programmes at HE Institutions, is used. This is less demanding than the recommended DoE target of 16:1 for SET programmes.

292 vacant posts (22% of 1035) still need to be added to the 1035 filled posts to calculate the number of currently funded permanent posts. Using the 25:1 student lecturer ratio, 2 326 posts need to be funded which translates to approximately 1000 MORE funded posts.

It must be emphasised that the 2006 student enrolment figure is lower than the 2008 enrolment figure and the ratio of 25:1 is higher than the DoE target for engineering programmes. The 2 326 calculated number of staff required should therefore be seen as an absolute MINIMUM VALUE.

91 HoD, Electrical Engineering
92 HoD, Industrial Engineering
93 HEMIS, www.education.co.za, 2006
94 Chairperson, Education Advisory Committee, ECSA
“Marking is also a major time-consumer for academics. We try to get postgraduate tutors to help us wherever possible, but increasingly tutors are hard to come by as the number of undergraduates rises and the number of postgraduates drop. The overwhelming majority of our postgraduate students are foreign. If they were educated outside of SA they don’t always understand our courses and methods. This is once again an indication of an excessive student : lecturer ratio.

A lecturer did some research on the records of the civil engineering department here and came to the conclusion that the optimum student : lecturer ratio was 4.5 qualifiers : lecturer (i.e. a graduating class of 45 per annum suggests a staff of 10). Less than 4.5 and the department became increasingly uneconomic to run, over 4.5 and research suffers. 4.5 qualifiers : lecturer works out at about 22 undergraduate students : lecturer at an average time to graduation of 5 years, but remember that we also have postgraduate students to deal with. The optimum number of postgraduates is probably in the order of about 5-6 full-time students : lecturer.”

9.2 The international perspective

Testing whether these numbers are realistic, questions were posed to a number of academics abroad. It seems that in the UK the ratio of students per lecturer is about half of that in South Africa. A further benefit for these departments is that since lecturers do not carry the same teaching load they can devote more time to research and consulting. UK institutions, did however, concede that they were battling to attract young academics and were suffering increases in workload due to increased administration and bureaucracy.

UNESCO responded that the problems which South Africa is facing are not unique and they would like to expand the number of countries participating in this study! Responses from a couple of institutions in Africa indicated that the student to lecturer ratios were above 40, although throughput is significantly higher than in South Africa.

It is interesting to note that the “Ivy League” is now also placing new emphasis on engineers. See the quote below.

“IVY LEAGUE PUTS NEW EMPHASIS ON ENGINEERS
Harvard and Yale are boosting their engineering programmes because of competition from China, where more engineering degrees are awarded each year than in the US. Both academic institutions, following the lead of Princeton University and Columbia University, have added to the status, staffing and visibility of their engineering schools in the past year. Yale is enlarging its faculty by 17% to 70% during the next five years, while Harvard is expanding by 43% to 100 professors within a decade. The growth in engineering reflects increased hiring needs of firms as diverse as biotechnology developer, Genzyme and solar cell maker, SunPower. The US labour department anticipates an 11 % rise in engineering employment between 2006 and 2016”.

95 Deputy HoD, Civil Engineering
96 Dr Tony Marjoram, Programme Specialist responsible for Engineering, UNESCO
97 Business Report, 20 June 2008
10. Conclusions

Considering the current state of affairs in engineering departments it is clear that there are common challenges including:

- High levels of vacancies affecting the intake and throughput of students.
- Noncompetitive cost to company resulting in further vacancies and inability to attract and recruit suitable applicants.
- Ever increasing workload (resulting from increasing student numbers, onerous administration duties, poorly prepared student intake, too few support staff, research and community service demands, high numbers of part time staff, Work Integrated Learning requirements and DoE qualification requirements for lecturing staff) resulting in demoralised staff, further vacancies and less support for students.
- Insufficient and under-equipped facilities impacting on the quality of teaching and research.
- Ineffective recruitment processes resulting in vacancies not being filled.
- Lack of promotion (well defined career path).

The severity of these challenges varies between Universities and Universities of Technology as well as amongst departments.

These challenges are interrelated and need attention from government, the HE Institutions as well as Industry. Teaching and lecturing must be taken seriously if South Africa is to develop a new cadre of engineering professionals. One HoD summed up the challenge.

“To my mind this country has absorbed the traditional Anglo-Saxon contempt for teaching as a profession. Elsewhere in the world, teachers are respected and rewarded, but not here. As a result we are gradually moving to a point where the whole debate around staffing at the universities will be moot; there will be no Science and Mathematics teachers to teach the school kids, let alone lecturers to teach the university students. According to the newspapers, SA is losing 15,000 teachers net a year - and is training hardly any Mathematics and Science teachers”.

This echoes the thinking of the “Ivy League”.

It is quite extraordinary that management does not seem to be monitoring trends and demands per department or faculty, as the dramatic increase in enrolments over the past five years should have raised alarm bells and strategies should long since have been put in place to increase the number of academics in engineering departments.

The limited attention given to the ‘delivery arms’ (i.e. faculties and departments) of tertiary institutions by corporate structures, the tendency for output or results to be seen as operational rather than strategic and the conflicts between corporate Human resource (HR) strategy and operational requirements contribute to the difficulties currently being faced by engineering departments and faculties.

It is time to deal with the situation.

---

98 HoD, Civil Engineering
Recommendations on how to address these issues are discussed in the sections below. Recommendations fall into two categories.

- The first section addresses the initial topic of this research, being measures to improve retention, attraction and development of academic staff.
- The second section discusses ideas relating to throughput. Since the research was not focused on this challenge a comprehensive picture cannot be painted at this stage. It is clear that further research is required to determine improved or appropriate pedagogical techniques and support required to address the challenges of throughput. The ideas presented here will however contribute significantly to the national debate.

11. Recommendations - Attraction and retention strategies

Engineering education is a national priority and therefore needs intervention at the highest level. The recommendations discussed in detail below reflect the need for stakeholders to critically engage and agree on a way forward. This will include high level policy decisions including funding, criteria for appointment of academic staff at Universities of Technology, research requirements at Universities of Technology, development of academic staff, tax incentives for research as well as more detailed implementation issues relating to the needs of each engineering faculty and department.

11.1 Increase funding

Increase and ring fence funding to engineering departments in order to:

- Increase cost to company (which must be pensionable to ensure that there is a benefit after retirement for staying in education. To pay only a non-pensionable allowance as a "critical skill" will only provide short term relief and not long term income security).
- Increase number of permanent staff.
- Increase technical staff.
- Increase administrative staff.
- Increase and improve lecturing venues.
- Improve laboratory facilities (for both engineering and Science departments).

This will reduce:

- Workload per individual.
- Student numbers per academic.
- Administration per individual.
- Number of subjects to be lectured per academic.

This will increase:

- Intake of students.
- Throughput of students.
- Time for staff to improve their qualifications.
- Research output.
- Post graduate student numbers and success.
- Community service including quality consulting to Industry.
The current cost to company bill of R353 190 000 (Table 6) should be increased to R 514 370 000 to retain current staff (Table 7) by offering substantially increased packages. To attract new staff to fill current vacancies an additional R 144 430 000 (Table 8) including the recommended increases should be ring fenced.

<table>
<thead>
<tr>
<th>% composition</th>
<th>1035 filled posts</th>
<th>Current ave cost to company/annum (R)</th>
<th>Cost to company bill per category (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>13</td>
<td>135</td>
<td>500 000</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>12</td>
<td>124</td>
<td>400 000</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>34</td>
<td>352</td>
<td>350 000</td>
</tr>
<tr>
<td>Lecturers</td>
<td>36</td>
<td>372</td>
<td>270 000</td>
</tr>
<tr>
<td>Junior Lectures</td>
<td>5</td>
<td>52</td>
<td>250 000</td>
</tr>
<tr>
<td><strong>TOTAL CURRENT COST TO COMPANY BILL</strong></td>
<td></td>
<td></td>
<td><strong>353 190 000</strong></td>
</tr>
</tbody>
</table>

Table 6: Current cost to company

<table>
<thead>
<tr>
<th>% composition</th>
<th>1035 filled posts</th>
<th>Increased ave cost to company/annum (R)</th>
<th>Cost to company bill per category (R) at 2008 suggested rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>13</td>
<td>172</td>
<td>750 000</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>12</td>
<td>159</td>
<td>600 000</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>34</td>
<td>452</td>
<td>450 000</td>
</tr>
<tr>
<td>Lecturers</td>
<td>36</td>
<td>477</td>
<td>390 000</td>
</tr>
<tr>
<td>Junior Lectures</td>
<td>5</td>
<td>66</td>
<td>320 000</td>
</tr>
<tr>
<td><strong>TOTAL INCREASED COST TO COMPANY BILL</strong></td>
<td></td>
<td></td>
<td><strong>514 370 000</strong></td>
</tr>
</tbody>
</table>

Table 7: Increased cost to company bill (without vacancies filled)

<table>
<thead>
<tr>
<th>% composition</th>
<th>1035 filled posts+ 291 vacancies</th>
<th>Increased ave cost to company/annum (R)</th>
<th>Cost to company bill per category (R) at 2008 suggested rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>13</td>
<td>172</td>
<td>750 000</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>12</td>
<td>159</td>
<td>600 000</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>34</td>
<td>452</td>
<td>450 000</td>
</tr>
<tr>
<td>Lecturers</td>
<td>36</td>
<td>477</td>
<td>390 000</td>
</tr>
<tr>
<td>Junior Lectures</td>
<td>5</td>
<td>66</td>
<td>320 000</td>
</tr>
<tr>
<td><strong>TOTAL COST TO COMPANY BILL(WITH VACANCIES FILLED)</strong></td>
<td></td>
<td></td>
<td><strong>658 800 000</strong></td>
</tr>
</tbody>
</table>

Table 8: Increased cost to company bill with vacancies filled

To expand capacity to 25 engineering students per lecturer as recommended by ECSA, the budget should further be increased to appoint another 1000 academic staff. This means a further R498 040 000 (Table 9) should be allocated to engineering departments to appoint additional staff.
## Table 9: Increased cost to company bill with vacancies filled and additional staff to adjust student to lecturer ratio to 25:1.

Cost to company scales need to be developed based on these figures, defining lower and upper notches in such a manner that there are not overlaps of cost to company scales of staff at different levels. Overlaps have been found to breed complacency as they do not incentivise lecturers to improve their qualifications.

Funding is required on two levels:

- To ensure that engineering faculties comply with the minimum requirements.
- To allow engineering departments to follow differentiated strategies to pursue their own particular niches.

A team effort is required by the HE Institutions, Industry, DoE, and government as a whole to improve the funding streams as follows:

- **HE Institutions need to rework their budgets to:**
  - Offer a Scarce Skills allowance in the short term.
  - Increase the total cost to company in the long term so that staff gain all benefits associated with the increases.
  - Offer incentives for professional registration (this should be set to ~20% of the cost to company to align with Industry).

- **Industry needs to be called upon to consider:**
  - Subventing Chairs.
  - Offering scholarships for junior research posts.
  - Investing more in departments to carry out research.
  - Funding experienced staff as visiting lecturers for subjects in which they have particular expertise.
  - Funding specialist equipment.

- **The DoE needs to:**
  - Look at short term funds which can be made available to offer relief.

<table>
<thead>
<tr>
<th>% composition</th>
<th>1035 filled posts + 291 vacancies + 1000 additional posts</th>
<th>Increased ave cost to company/annum (R)</th>
<th>Cost to company bill per category (R) at 2008 suggested rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>13</td>
<td>302582</td>
<td>750 000</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>12</td>
<td>280</td>
<td>600 000</td>
</tr>
<tr>
<td>Senior Lecturers</td>
<td>34</td>
<td>792</td>
<td>450 000</td>
</tr>
<tr>
<td>Lecturers</td>
<td>36</td>
<td>838</td>
<td>390 000</td>
</tr>
<tr>
<td>Junior Lectures</td>
<td>5</td>
<td>116</td>
<td>320 000</td>
</tr>
<tr>
<td><strong>TOTAL COST TO COMPANY BILL (INCL VACANT &amp; ADDITIONAL POSTS)</strong></td>
<td></td>
<td></td>
<td>1 156 840 000</td>
</tr>
</tbody>
</table>
- Review the funding formula to ensure the flow of additional funds in the long term.

- Government as whole needs to be sensitised to the problem, so that capacity can be secured from supporting countries or funding from donor agencies. For example:
  - Negotiations with the international community carried out by JIPSA could be expanded to canvass for experienced lecturers to come to South Africa on 3 or 5 year contracts, whilst the challenges and recommendations outlined are being addressed.
  - Arrange for young academics to further their studies at international institutions or participate in short term exchange programmes to enhance research skills or gain exposure to specialist fields.
  - Locally, JIPSA needs to engage with HE Institutions and Big Business to motivate for investment as outlined above.

11.2 Develop an academic career path

Over and above attracting experienced engineering professionals into academia as a result of improved packages and conditions, it is necessary to attract young researchers to develop a new cadre of engineering academics. For this to be achieved, an academic career path must be in place which requires much attention as follows:

11.2.1 Ensure progression

Develop an academic career path progressing from Tutors to Junior Lecturers, Lecturers, Senior Lecturers, Researchers, Associate Professors and Professors. At every stage adequate remuneration as well as time to improve qualifications, gain Industry experience and carry out research should be accommodated.

11.2.2 Practical training and ECSA registration

From the discussion in sections 7.2.1 and 7.2.3 it is clear that Universities and Universities of Technology (in particular) should be encouraged to recognise professional status as valuable for teaching engineering students. Practical input helps to make lessons more relevant and more memorable for students.

It is also important to note that when ECSA accredits programmes they accept registration in an appropriate professional category as being equivalent to a qualification one level higher than the tertiary qualification held by the academic.

To register professionally, academic staff must perform practical engineering work in addition to their lecturing work as outlined by ECSA as follows:

- Consulting work in which the applicant has demonstrated ability at a professional level to identify engineering problems and produce solutions which can be satisfactorily implemented.
- Planning, design development, commissioning and/or application of research equipment or processes associated with engineering projects.
- Be responsible for the management of workshops, laboratories and ancillary facilities; and
- Execution of research projects and results (preferably published).

---

99 ECSA Policy Statement R2/1A, Acceptable Engineering Work for Candidate Engineers for Registration as Professional Engineers, September 2004
These requirements could be attained through one or more of the following which must be developed to support the ECSA requirements:

(i) Centres of Excellence

Creating Centres of Excellence where departments offer specialist industry consulting and research will allow junior academics to work on projects under the mentorship of experienced staff. This will also contribute towards the CPD points required by experienced staff to maintain their registration, as points are awarded for mentoring, research and working in new areas.

Registration is a requirement for mentors, hence before academics can assist junior staff to become registered, they too must have achieved this status.

(ii) Research

Research (including publishing results) which forms part of the basic activities at HE Institutions is recognized for purposes of registration provided that is contains adequate practical content.

(iii) Rotation in Industry

Relationships between Industry and academia need to be struck to allow academics to gain experience in the workplace in support of the areas in which they wish to specialise. This should be structured in such a way that this contributes towards the outcomes required during the candidate phase. Such Industry insight will greatly enhance the academic’s approach to lecturing and research.

(iv) Community service

Many opportunities exist in communities for engineering research, problem solving and implementation of these solutions. Time needs to be allocated to staff to engage in community projects and Industry should be encouraged (through their CSI\textsuperscript{100} budgets) to provide financial support for such projects.

(v) Recognition of advanced study

Recognition of up to 12 months of advanced study may be considered in respect of practical training. If an applicant after at least one year of post-graduate study passes a post-graduate examination in engineering which ECSA recognises for this purpose, and the study contains an acceptable practical component or suitable research work with adequate practical content this may be considered as a suitable substitute for one year’s workplace training.

11.2.3 Staff retention for mentoring

Universities often recruit promising graduates and try to grow them into academics. They require mentoring from experienced staff. Although the profiles of the mentors are currently largely white males, it is impossible to transfer their qualifications and years of experience without pairing them with young staff for a long period. Thus retirement ages should be increased, and post retirement contracts should be offered which are dedicated to mentoring, expanding research capacity and developing Centres of Excellence.

\textsuperscript{100} Corporate Social Investment as called for in the Construction, Mining and other Charters.
11.2.4 Qualifications

The issue of the DoE setting "ideal" qualification targets for teaching staff is working against any attempt to recruit, and address equity. Whilst it is desirable that all teaching staff at Universities and Universities of Technology hold PhDs, this can only be considered as a very long term goal.

The CHE Accreditation criteria suggest that the minimum qualification is “one-above” the level being taught. This should apply in engineering for at least the next 10-15 years whilst we create higher qualification capacity. This would mean that to teach at N Dip level would require academics to hold at least a B Tech; to teach at B Tech would require a Masters; to supervise research (independently) would require a Doctorate. In this way qualifications can slowly but surely be enhanced, without removing access to entry level academics, who handle the bulk of the work.

A pyramid qualification structure for technology departments could be implemented as an interim measure based on the number of teaching positions. For example a departmental staff complement of 10 academic staff could be composed of:

- 1 Doctorate
- 3 to 6 Masters
- 3 to 6 First degree entry level BEng/BTech (i.e. Junior Lecturer)

As the staff complement increases (i.e. the bigger departments) these numbers would increase at the higher end, slowly but surely inverting the pyramid. At least in the short term some structure and mentorship would be possible. If a department is much smaller than 10 teaching staff, then some flexibility will have to be permitted to ensure the department functions with whatever staff they can get!

It is important to set goals that are actually achievable and then strive to exceed them and not set goals that simply cannot be reached and are counter productive.

Recognition must also be given to registration as an enhanced qualification.

11.3 Develop technical support staff through skills programmes, learnerships and apprenticeships

The dearth of artisans & laboratory technicians in the country requires that tertiary institutions grow their own capacity. This will require registering incumbents to apprenticeships and learnerships and harnessing master artisans and mentors perhaps on a part-time basis to develop such skills. Engagement with the SETAs will be necessary to develop the required qualifications if not already in place and to access funding for such training. JIPSA should once again be asked to take up these negotiations when research suggested under 11.7 has been concluded.

11.4 Develop appropriate organograms

A critical view of funded and unfunded posts is required. Many frozen posts should be reinstated. Furthermore the structure of existing organograms should be reviewed. Not only are
more subject lecturers required, but more support for foundation programmes, laboratories and field work is required.

11.5 Develop leadership and management

Developing leadership and management competencies of engineering academic staff is an area which needs attention. The current approach of rotating the HoD every 3-5 years is necessary as there are insufficient senior staff and few actually want the job! It is critical that staff are identified who can be developed to offer leadership and sound management and to ensure adequate remuneration to attract and retain the right calibre. Research was not carried out on HoD cost to company. This should be added to the list of issues to be considered further.

Succession planning should also form part of the ultimate attraction and retention strategies developed for engineering departments.

11.6 Identify postgraduate and research departments

Former technikons are being encouraged to become research institutions. Management is setting unreasonable qualification targets for appointment to particular grades to teach technology programmes. Clearly there is not an understanding of the important outputs of technology programmes, namely well educated but practical technicians and technologists. HE Institutions and technology departments should be offered the choice of investing in either a more practical technology approach or expanding their research capacity. They should not be penalized for their choice.

11.7 Further research required on support staff & facilities

Further research is required to quantify the numbers and associated costs of:

- Technical staff
- Admin staff
- Lecturing venues
- Laboratory facilities
- WIL units
- Engineering specific employment units

required to support academic staff.

This would include a detailed financial model; considering income, expenditure and the effect on the subsidy should an improvement in throughput be achieved.

11.8 Set and enforce realistic student to staff ratios

It has been sad to see that there has been little reaction from senior management to the plight of those stalwart staff holding fort whilst student numbers have continued to increase. There have been few offers of budget increase, or acknowledgement of the need to review organograms etc. Staff have simply been told to make do. This approach contrasts sharply with the JIPSA goal of increasing the number of graduate engineers, technologists and technicians over the next few years.
The DoE should consider enforcing compliance of its recommended student to staff ratios to ensure quality tertiary education. The current ratios are totally unacceptable. As a short term target, ratios of 25:1 for engineering programmes and 35:1 for technology programmes may be considered. The distinction in ratios is suggested as practical exercises appropriate in some technology classes may be handled in teams, versus the one-to-one support engineering students may require to grasp theoretical topics. These much improved ratios cannot however be achieved without increased funding to departments.

12 Recommendations – Throughput

Whilst an increase in the number of academics, contact and support time will go someway to improve throughput, the view is that this alone will not effect a complete turnaround in engineering departments. The poor schooling system, facilities, bottlenecks associated with Work Integrated Learning and many other weaknesses also present challenges. Suggestions extracted from the qualitative responses are listed below.

12.1 Attract high quality students

Ensure that engineering departments attract high quality students and not only large numbers to ensure higher funding. Too many weak students are currently blocking the system and draining resources, without success. These students may be attracted through bursaries, low interest rate loans and perceived high cost to company once graduated.

Initiatives to identify, attract and support bright students from rural areas must also be put into place.

Although entrance testing is generally viewed negatively, a well designed national engineering entrance test should be developed to channel learners effectively in terms of their ability and interests e.g. towards engineering or technology programmes or other careers to which they are better suited!

12.2 Improve teaching

Engineering departments should further ensure higher throughput by increasing support to students through:

- Increased contact time with lecturers and tutors.
- Improved lecturing techniques and programmes.
- Exciting or more relevant lectures and exercises including visiting lecturers from Industry, site visits etc.

Detailed research on pedagogical techniques, including how to assist students become skillful problem solvers, will greatly assist with developing student potential. Furthermore effective teaching aids need to be developed to assist with overcoming schooling weaknesses such as poor numeracy, literacy etc. A review of all foundation and extended programmes should be carried out to determine the most effective approaches, which should then be fully funded as part of the academic programme.
12.3 Improve facilities

Many departments have benefited from funding released by the DoE since early 2007 to improve facilities. Those departments which did not benefit should be assisted to improve their lecturing, laboratory and computer facilities, equipment etc where required.

12.4 Fund, redesign or remove WIL

From the discussion in 8.1.10 it is clear that a change in the structure and/or management of WIL is essential. The options are to:

- Fund the year as an academic year so that suitable workplace opportunities can be found for all students and they can be adequately supported.
- Allow institutions to canvas work from Industry which students should carry out under the supervision of dedicated WIL management staff.
- Expand the curricula of technology courses to include many more practical worked examples, site, manufacturing and supplier visits etc.
- Drop the WIL year and make this part of the candidate phase towards professional registration.

The new Higher Education Qualifications Framework should offer HE Institutions the opportunity to build WIL of some form into the NDip (Engineering) or offer the theoretical training only as an alternative qualification which should be combined with an extended candidate phase, ultimately leading to the same level of registration.

12.5 Licences

Most professional students and graduates are hampered by the lack of driver’s licences. Whenever it is necessary to visit site, be it in the Built Environment or in the accounting profession, students and graduates cannot gain adequate experience to either graduate or register, if their site experience is limited. Even when students and graduates are willing and ready to undergo learners or drivers tests they must wait six and in some cases up to 24 months for a test appointment! Lack of productivity of the country’s tertiary output is costing us dearly!

Since licensing falls under the Department of Transport (DoT) and the registration of testing stations falls under the MEC of Transport per province\(^\text{101}\), it is suggested that negotiations be entered into with the Department of Transport to sanction, and even provide mobile licensing units. These units should travel between campuses per province on a monthly basis to allow students to pass either their learner’s or driving tests in the shortest time possible. This will have the added benefit of improving the WIL opportunities for students.

12.6 Viability of some departments

Given the high student to lecturer ratios, academics with limited academic qualifications or experience, limited facilities etc, the viability of some departments is questioned. The failure rate is high and those that do make it from marginal departments are generally found to be unemployable. Sadly many parents are working extremely hard to ensure that their children gain good tertiary qualifications, only to find their children on the list of unemployed graduates. The

\(^{101}\) Clause 39, National Road Traffic Act (Act 93 of 1996)
performance of several departments requires critical review as their performance impacts on national throughput figures.

12.7 More autonomy

Departments are responsible and accountable for their output, but do not have authority over many key aspects in terms of running their departments. Placements, use of budgets and grants etc are all subject to control which in many instances impedes the progress of departments. Many functions should be devolved to faculty and departmental levels.

13 Review Higher Education

13.1 Industry perceptions

Whilst this study has gathered significant input from HE Institutions, Industry perceptions should also be determined. The quality and usefulness of graduates, relevance of research, etc should be understood from the client’s (user’s) point of view. It is recommended that a perception survey be carried out which not only covers views on the current output, frustrations and needs but tests the relevance and acceptability of the various recommendations emerging from this study.

13.2 Review the HE System

The initial study was aimed at determining why academic staff continue to leave the sector and to develop recommendations to stem the tide and rebuild the academic skills base. It has become clear that there has been a breakdown in the HE system. A number of systemic issues need to be understood and addressed in order to propose interventions to create a nurturing environment.

“The survey assumes that what we are producing at present is OK. All we need to do is to up the funding. I think it is correct, but it is not going to be sufficient. There is a need for substantive and fundamental research and improved understanding on engineering education, including the management of 'skills development system'. What we are facing in skills development is similar to the demographic crisis being faced in developed countries. If a society is not producing children, then it is dying. Similarly, if a society is not producing educated people, and not producing educationalists to educate the next generation, then the society is in serious trouble. It seems to me that education - and skills - are no longer being valued. If that is the case, then the society may be headed for a collapse of culture and civilisation".102

Some of the concerns raised include:

- Top heavy Corporate Service departments.
- Lack of experienced leadership.
- Quality of teaching.
- Quantity and quality of research outputs.

102 Senior Lecturer, Civil Engineering
• Changing work roles and skills.
• Changing institutional roles.
• Quality of facilities.
• Quality of support services.
• Quality of students.
• Changing modes of delivery.
• Ageing tertiary education workforce.

The Review should analyse issues relating to the tertiary education workforce so that a more comprehensive and strategic approach can be taken. This strategic review should for example:

• Carry out a stock-take of the tertiary education workforce and current issues.
• Consider teaching methods to match student intake.
• Advise on major supply and demand trends of the tertiary educated workforce over the next 20 years, and any mismatch.
• Advise on a framework for describing and understanding future workforce requirements.
• Consider structures which would best empower departments to deliver the required output in the shortest possible time i.e. quality graduates.
14 Summary

14.1 Quick fixes

<table>
<thead>
<tr>
<th>Action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Increase cost to company as recommended.</td>
<td>JIPSA to negotiate</td>
</tr>
<tr>
<td>2. Increase number of permanent staff as recommended.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>3. Ring fence additional funding to engineering departments.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>4. Fund WIL where providers choose to offer it.</td>
<td>DoE/SETAs</td>
</tr>
<tr>
<td>5. Set realistic qualification requirements for academic staff in technology programmes.</td>
<td>DoE, HE Institutions and Industry</td>
</tr>
<tr>
<td>6. Pay registration fees and reward professionally registered academic staff.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>7. Support registered staff to retain their registration through CPD.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>8. Reward throughput &amp; enrolment of high quality students, not only large numbers.</td>
<td>DoE</td>
</tr>
<tr>
<td>10. Remove over ambitious research requirements at Universities of Technology.</td>
<td>DoE and UoT Management</td>
</tr>
<tr>
<td>11. Introduce sabbaticals where research and higher qualifications are critical.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>12. Enhance HR systems to effectively recruit new staff.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>13. Address the employability of WIL students and graduates by negotiating with DoT to register mobile licensing units.</td>
<td>JIPSA &amp; DoT</td>
</tr>
<tr>
<td>14. Set up mobile learners and license testing units.</td>
<td>Funders and DoT</td>
</tr>
<tr>
<td>15. Canvass experienced lecturers to come to South Africa on 3 or 5 year contracts.</td>
<td>JIPSA</td>
</tr>
</tbody>
</table>

Table 10: Quick fixes.

14.2 Longer term interventions

<table>
<thead>
<tr>
<th>Action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. Carry out further research to quantify the numbers and associated challenges and or costs relating to technical staff, administration staff, lecturing venues, laboratory facilities, WIL units, engineering specific employment units, sabbaticals, number of lecturing hours, absenteeism, use of contracts, staff turnover statistics, support required for academic staff.</td>
<td>JIPSA</td>
</tr>
<tr>
<td>17. Arrange exchange programmes for young academics.</td>
<td>JIPSA</td>
</tr>
<tr>
<td>18. Develop academic staff for research, succession planning, teaching approaches.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>19. Ensure that research is supported.</td>
<td>HE Institutions and Industry</td>
</tr>
<tr>
<td>20. Develop technical staff.</td>
<td>HE Institutions</td>
</tr>
<tr>
<td>21. Introduce national entrance test for engineering.</td>
<td>HE Institutions and SETAs</td>
</tr>
<tr>
<td>22. Carry out Industry perception survey.</td>
<td>JIPSA</td>
</tr>
<tr>
<td>23. Review of the HE System</td>
<td>DoE</td>
</tr>
</tbody>
</table>

Table 11: Longer term interventions
Annexure A: Generic Letter to Deans

Joint Initiative on Priority Skills Acquisition (JIPSA)

30 March 2008

THE DEAN

Attention:

Dear

RE : ADDRESSING ENGINEERING ACADEMIC STAFF SHORTAGES

The Joint Initiative for Priority Skills Acquisition (JIPSA) has identified engineering as one of the priority skills in South Africa that urgently needs intervention. The JIPSA report (March 2007) includes the following interventions required in engineering education:

- Increase the annual number of engineering graduates for the next four years.
- Improve efficiency of current education and training system.

We are pleased to note that the Department of Education has increased funding to engineering faculties and that outputs are expected to increase. However JIPSA has become aware that faculties of engineering are under tremendous pressure to deliver quality engineering education as a result of staff leaving the academic sector for the private sector with a further consequence that vacancies cannot be filled.

We would therefore like to request you to forward the attached letter and questionnaires to the different Heads of Departments to complete. Could you please request those with multiple delivery sites to complete a questionnaire for every delivery site?

The information will be treated as confidential and will only be reported in a consolidated form which will provide us with the scope and complexity of the national staffing problem at engineering faculties.

As this is an urgent matter to be addressed we would like to request you to send your reply not later than 21 April to lieselkirsten@yahoo.com in order to take appropriate action.

Please feel free to contact Liesel Kirsten at 084 590 4949 for any further information.

Yours sincerely

Allyson Lawless
# Annexure B: Generic Questionnaire

**Name of Institution:** ____________________________  
**Faculty:** ________________________________________  
**Department:** ____________________________

I) Number of under-graduate students: __________  
Number of post-graduate students: __________

II) Total number of posts in department: __________

<table>
<thead>
<tr>
<th>List every post in the department separately</th>
<th>Complete for every post in the department</th>
<th>Complete only for posts filled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacant or Filled (V/F)</td>
<td>Funded or Unfunded (F/U)</td>
<td>Highest most relevant eng qualification</td>
</tr>
<tr>
<td>Current cost to company within R50 000 range</td>
<td>Suggested cost to company</td>
<td>Subject matter expertise</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A. Full Time</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Junior Lecturer</td>
<td>Filled</td>
<td>Funded</td>
<td>BSc(Eng)</td>
<td>Pr Eng</td>
<td>R250 000</td>
<td>R350 000</td>
<td>Structures</td>
<td>Water Survey!</td>
</tr>
</tbody>
</table>

---

102 Agriculture, Aeronautical, Civil, Chemical, Electrical, Electronic, Industrial, Mechanical, Metallurgical, Mining, other: specify  
103 As per approved organogram: Professor, Associate Professor, Head of Department, Senior Lecturer, Lecturer, Junior Lecturer, Researcher, Junior Researcher, Tutor, Demonstrator, Teaching Assistant, Marker, Lab-Technician, others: specify  
104 PhD/DEng, DTech, MSc/MEng, MTech, GDE, BSc(Hons),BSc/BEng, BTech, NHD (S4) ND(T3-T4), NTC (1-5), other: specify  
105 Pr Eng, Pr Tech Eng, Pr Techni Eng, Pr Cert Eng, Not registered  
106 Estimate age within 5 years  
107 African, Coloured, Indian, White  
108 ACCW (ACIW)
B. Part Time

External lecturers sourced from industry

Undergraduate and post graduate students lecturing and providing support services

III) Recommendations and comments (on the department)

A) Please describe what in your view contributes to the high level of staff vacancies in your department (if any)?
B) Please provide your suggestions on a possible retention (including incentives) strategy.

C) If all the positions in your department were filled, would you consider your staff structure adequate or do you believe your department requires additional positions?
D) Share your ideas on how the University/UoT can rebuild and retain young people who would like to pursue an academic career.
E) What demands add pressure to academic staff?

F) Do the vacancies in your department affect throughput?

G) What is required to ensure that throughputs are increased?

H) Do the vacancies in your department limit your intake?
Confidentiality: Please note that all the information will be treated as confidential and the information will only be reported in a consolidated, and thus, anonymous form. In case further information and clarification may be required please indicate the person that can be contacted:

Name: _______________________________  Contact no: _______________________________

Position: _______________________________
Annexure C: Stakeholders invited to comment

1. Deans and HoD at Engineering Faculties
2. DoE
3. ECSA
4. Professional Engineering Institutions and Voluntary Associations (Nationally and Internationally)
5. UNESCO
6. WFEO
7. Tertiary engineering departments internationally