The gender and racial transformation of mining engineering in South Africa

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Synopsis

With the end of the official apartheid legislation in the early 1990s, South Africa was heralded as a non-racial country. However, racial awareness has been reintroduced into the country with the Affirmative Action and Black Economic Empowerment legislation. Gender and racial transformation are the current order of the day. All organizations are required to reflect in their make-up the demographics of the population as soon as possible. Scorecards have been drawn up to measure the rate of transformation for gender and race in organizations.

The mining industry in South Africa has been in the forefront of this transformation legislation and scorecards.

This paper seeks to show the effect of gender and racial transformation on mining engineering education and professionalism by analysing the changing demographics of graduating mining students at both the South African universities offering a degree in mining engineering, the professional registration of mining engineers with the Engineering Council of South Africa (ECSA), and the membership of the Southern African Institute of Mining and Metallurgy (SAIMM), the vocational institute for mining engineers.

It also demonstrates the absurdity of gender and racial quotas based solely on the demographics of the current population of the country.

This paper shows the degree to which mining engineering has transformed in both gender and race.

History of mining engineers in South Africa

For over a century, South Africa has been known as a mining country and its mining engineers have enjoyed world renown.

Since formal mining engineering education began in 1896 at the School of Mines in Kimberley, South Africa has produced mining engineers of the highest calibre. At the turn of the twentieth century, the Kimberley School of Mines translocated to Johannesburg, where it became the forerunner of the University of the Witwatersrand. For the next sixty years, this university remained the sole South African academic institution to offer a degree in mining engineering. In the mid-1960s, the University of Pretoria started to offer a degree in mining engineering with the first mining engineering students graduating in 1965.

To date, these are the only two South African universities to offer the mining engineering degree course. Both courses are accredited for professional status by the Engineering Council of South Africa (ECSA).

History of gender and racial employment on the mines

In the past, mining was viewed as a 'man's game'.

In fact, women were expressly barred from being employed underground by the 1911 Mines and Works Act. This was driven by the altruistic view of that time, that women and children should not be exploited in the workplace.

Not only was mining an all-male preserve, but also in South Africa the upper echelon of mining was an 'all-white' bastion. This stemmed from the so-called 'Colour Bar Acts' of the 1911 Mines and Works Act (promulgated in response to Lord Milner's importation of Chinese labour on the mines), the 1926 Mines and Works Amendment Act (promulgated in response to the 1922 Miner's Strike) and the 1956 Mines and Works Amendment Act (which reinforced the apartheid era's racial discrimination on the mines). This legislation stated that

'Any regulation under paragraph (n) of sub-section (1) may provide that in any Province, area or place specified therein, certificates and competency in any occupations likewise specified, shall be granted only to persons of the following classes:

(i) Europeans
(ii) persons born in the Union and ordinarily resident therein, who are members of the class or race known as Cape Coloureds or of the class or race known as Cape Malays
(iii) the people known as Mauritius Creoles or St. Helena persons or their decendants born in the Union.'

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One presumes that these were the people currently holding certificates of competency in those early times—no other explanation seems credible.

This single piece of legislation effectively barred a person from any other racial group from obtaining a 'blasting ticket' or any other certificate of competency, and this created a promotional ceiling above which a person could not progress. Without a Blasting Certificate, a person could not become a miner. A person could not become a shift boss if he had not been a miner. He could not be permanently appointed as a mine captain if he had not first been a shift boss and he did not hold the Mine Overseer's Certificate of Competency. He could not be appointed as a mine manager if he had not been mine captain and he did not hold a Mine Manager's Certificate of Competency. All of these positions required the incumbent to be a scheduled person and the holder of the requisite certificate of competency.

Thus, a single requirement of the Mines and Works Act, namely the racial requirement in order to hold a certificate of competency, effectively discriminated against the black mineworkers. These black mineworkers were thus, in the main, kept to the position of labourers, whereas whites, in the main, were able to rise through the ranks to manager status.

The fast track to manager status and beyond in the mining industry was seen to be dependent on the acquisition of a mining education at a university. Therefore, although the universities had a non-racial admissions policy, it was not surprising that the only applicants to read for a mining degree were whites.

The Mines and Works Act of 1911, Section 8(1) states 'No person shall employ underground on any mine a boy apparently under the age of sixteen years or any female.' Again, although the universities did not officially discriminate according to gender, women were actively discouraged from taking engineering as a profession, and more especially mining engineering, as the legislation effectively prevented further development in their career. Hence, it is not surprising that all South African graduates in mining engineering for nearly a century were white males.

The racial discriminatory section in the Mines and Works Act was repealed in 1988.

The discriminatory section of the Mines and Works Act which did not allow women to work underground was repealed in 1996.

The first 'Historically Disadvantaged South African' (HDSA) to enroll for a mining engineering degree in South Africa was an Indian, who enrolled as first year student at the University of the Witwatersrand in 1978. He graduated in 1981. The first black South African to graduate in South Africa as a mining engineer was in 1986. The first woman to graduate in South Africa as a mining engineer was in 1992. The first black woman graduated in South Africa as a mining engineer in 2004. All of these mining engineers graduated from the University of the Witwatersrand.

Transformation at the University of Pretoria occurred slightly later. The first woman to graduate as a mining engineer was in 2002. The first black to graduate as a mining engineer was in 2004. The first black woman graduated as a mining engineer in 2005.

History of professional registration for engineers

Professional registration for South African engineers was first promulgated in the 1968 Professional Engineers' Act, which set up the South African Council for Professional Engineers (SACPE) as the statutory body to register engineers. This statutory body was succeeded by the Engineering Council of South Africa (ECSA) as a result of the 1990 Engineering Profession of South Africa Act. This Act was subsequently superseded in 2000 by the Engineering Profession Act.

To become a registered professional engineer a candidate is required to have obtained a degree in engineering which is recognized for professional status by ECSA and a minimum of three years postgraduate appropriate experience.

It is not surprising therefore that, in the first few decades following the promulgation of the Engineering Act, all the registered professional engineers in mining were white males. This was the case from 1968 up until 1992 when the first black mining engineer (who was a graduate from Ghana) was registered as a professional engineer with ECSA. The first black mining graduate from a South African university was registered as a professional engineer by ECSA in 2005.

The first female mining graduate to be registered as a professional engineer by ECSA was a Swedish graduate in 1997. The first female mining graduate from a South African university was registered as a professional engineer by ECSA in 2004. The first black female mining graduate was registered as a professional engineer by ECSA in 2010.

History of the vocational institution

The vocational institution for mining engineers and metallurgists in South Africa is the Southern African Institute of Mining and Metallurgy (SAIMM). It was established in 1894 as the Chemical and Metallurgical Society of South Africa (known irreverently as the 'Cyanide Club' for its interest in the gold extraction process), and over the years, it has gone through a number of name changes to reflect its membership in mining and metallurgy. The current name, The Southern African Institute of Mining and Metallurgy is in recognition of its branches in neighbouring states.

The SAIMM is a non-racial organization and does not record the race of its members. However, as the membership was originally only for graduates (although it is now open to other members of the mining and metallurgical industries), members have historically tended to be predominately white males. The members of the SAIMM Council are elected by the corporate members of the SAIMM (i.e. Fellows and Members, not Associate or Student members). The Council of the SAIMM consists predominately of 'pale, stale males' i.e. senior white men in the mining industry. The first black to be elected as President of the SAIMM was in 2002. The first woman to be elected as President of the SAIMM was in 2008.

Transformation

'The times they are a'changing' (Bob Dylan).

Transformation in mining engineering is moving at a fast pace.

Due to historic factors of mining legislation and consequent timing factors of engineering education, followed by engineering registration and vocational membership,

transformation of the latter two bodies cannot happen overnight. One cannot have national demographics superimposed on populations which do not reflect those demographics. It takes time to develop into a professional engineer.

It takes a minimum of four years to get a mining engineering degree. Ignoring the foundation and preparatory years, the average student currently takes about five years to graduate. It takes a minimum of three years of applicable postgraduate engineering experience before a graduate can apply for professional registration. Historically, mining engineers are in no hurry to register, for reasons given later in this paper. The average time period from graduation to professional registration for black mining engineers from South African universities has historically been nine years with a minimum of six years. It probably takes a further ten or so years before an engineer attains the stature and gravitas to be elected to committees on the vocational institutes or committees on the Engineering Council. So a minimum period of twenty years is probably required from placing a matriculant into university to being ready to take his or her place in the professional and vocational committees of the engineering community. It is only sixteen years since the 'new democratic South Africa' came about. It is ten years since blacks graduated in significant numbers. It is four years since women graduated in significant numbers. Thus, it is not surprising that gender and racial transformation is lagging in the professional and vocational bodies for mining engineering

However, there is a lot happening in transformation in mining engineering about which very little is known by the broader public. For example, in racial terms, the universities have transformed with the University of the Witwatersrand having 100% black graduates and the University of Pretoria having 70% black graduates in the class of 2010. On the gender transformation front, the universities have made great strides with women constituting a quarter to a third of 2010 graduates.

In the vocational institution, the SAIMM, black members currently constitute 30% of membership.

These facts are generally not known to the public at large.

This paper seeks to rectify this situation.

Demographics and populations

Demographics and populations are not uniform and are not static. They will vary with applicability and time.

Which population to use?

The current Black Empowerment vogue is the simplistic view that all institutions should have the same demographics as the demographics of the country at large, and that it should be implemented immediately. This is an absurd notion as will be shown when applied to mining engineering. How is it possible to have 50% female component of a 16 person committee, namely the Professional Advisory Committee for mining engineers, when there are only two female mining professional engineers? Similarly, when the demographics of the mining graduates are 100% black, as is currently the case at the University of the Witwatersrand, how does one reduce this to represent the demographics of the country. These two real-life examples present an argumentum ad absurdum to demonstrate the futileness of the premise that all institutions should reflect the demographics of the country at large.

The question is asked again—which population to use when determining demographics of institutions?

For instance, for first year mining students, the population should be those students who have attained university entrance criteria for mining engineering and have applied to read for a mining degree. The demographics of this population will most probably differ markedly from the demographics of the country at large.

For professional engineers, the population should be those mining engineers who are currently professionally registered. Due to time lags, which take into account previous demographics of registered professionals, the demographics of this population most probably differ markedly from the demographics of the current students, and certainly will differ from the demographics of the country.

For the vocational institute, the population should be those of its corporate members i.e. those members who are eligible to vote. Again, the demographics of this population will most probably differ from any of the previously mentioned ones.

Like the country's population, all three of the above populations and demographics are not static and can be expected to vary with time.

Transformation at the universities

At the University of the Witwatersrand, the student body in mining engineering has transformed markedly. The pendulum has swung completely from all-white graduates to all-black graduates within 25 years. Similarly, at the University of Pretoria, the pendulum is swinging towards black graduates. The transformation from all-white to 70% black graduates at the University of Pretoria has occurred over the short period of six years. Thus, at both universities, what were once all-white bastions are now predominately blacks, who currently constitute over 90% of all mining engineering graduates in South Africa. This racial transformation is now more than complete.

With regard to gender in mining, transformation has been unexpected. Mining, with its tough working conditions, was always considered to be a male occupation. Female engineers were seen as an anachronism. Female mining engineers simply did not exist. Therefore, the gender transformation at South African universities, where women now constitute over 30% of all South African mining graduates, is little short of miraculous.

At the University of the Witwatersrand, racial transformation began in 1978 with the registration of an Asian. Gender transformation started in 1990 with the registration of a woman. The first black to register for mining engineering was in 1983. Since 1985, the number of first year enrolments shows a progressive increase in numbers from 32 in 1985 to 228 in 2010. This is a seven-fold increase in 25 years. The following table shows the five-year period progression of first year enrolments of 'Historically Disadvantaged South Africans' (HDSA) and women in mining engineering at the University of the Witwatersrand.

Year	Total	HDSA	(%)	Female	(%)
1985	32	6	(19%)	-	(0%)
1990	50	20	(40%)	2	(4%)
1995	52	34	(65%)	-	(0%)
2000	48	43	(90%)	9	(19%)
2005	103	102	(99%)	28	(27%)
2010	228	222	(97%)	75	(33%)

This bodes well for the supply of mining engineers for the South African mining industry in the near future. For too long demand far outstripped supply.

Gender ratios of South African mining graduates

The gender transformation of South African mining graduates has occurred most rapidly with significant transformation in the past four years. From the first female graduate in 1994, there was only a sprinkling of women graduates until 2007. For the thirteen years from 1994 to 2006, there was a sum total of 25 female graduates from the two South African universities. Over the last four years from 2007 to 2010, there have been 94 female graduates. The following table gives the complete numbers of graduating female mining engineers.

Year	University of the Witwatersrand		University of Pretoria	
	Female	Male	Female	Male
1994	1	36		
1996	1	17		
2000	1	27		
2001	1	21		
2002	1	19	1	11
2003	2	20	-	16
2004	5	21	-	19
2005	7	26	1	9
2006	1	24	3	30
2007	16	41	6	18
2008	12	32	2	21
2009	16	37	7	21
2010	20	40	5	18

A further breakdown of numbers at the University of Pretoria, shows the gender and racial mix of the graduating class since the first female graduated as a mining engineer in 2002.

Year	White Males	White Females	Black Males	Black Females
2002	11	1		
2003	16	0		
2004	16	0	3	
2005	5	0	4	1
2006	25	2	5	1
2007	13	1	5	5
2008	18	1	3	1
2009	18	0	3	7
2010	7	0	11	5

Standards

Every five years the Engineering Council sends an accreditation team to the universities to monitor standards in the engineering education. From personal experience on those teams for the past twenty years, I can state without fear of contradiction, that the standards have risen consistently at each five-yearly accreditation evaluation at both universities. The quality of the standard and calibre of South African mining engineers remains world class.

International supply and demand for mining engineers

At the Conference for Mining Professors held in Tallinin, Estonia in 2010, where there were 61 participants from 40 countries worldwide, it was highlighted that not only was there a shortage of mining engineers in the world, but also that the average age of mining engineers in the English speaking world was close to 60. Therefore, with a significant number of current mining professionals retiring in the next five to ten years, the current shortages will become more acute. It was also highlighted and acknowledged that South Africa still remains one of the highest producers of mining engineering students in the English-speaking world.

From the tables of first year enrolments and final year students graduating from South African universities, it is apparent that South Africa will be supplying not only the South African mining industry with mining engineers, but also the English-speaking world.

Professional engineer demographics

The relationship between the mining engineer and ECSA has been an interesting one since 1968. Unlike consulting engineers and civil engineers whose professional status was recognized in their workplace, the mining engineer gained no additional status or remuneration with professional status. What was far more important to the mining engineer was to obtain the government certificates of competency, i.e. the Blasting Certificate, the Mine Overseer's Certificate of Competency and the Mine Manager's Certificate of Competency. The status of Professional Engineer was a 'nice to have' appendage of little or no value in the workplace on the mines. It is only when mining engineers enter the consulting field that their professional status became important. This explains the relatively large number of 'mature' candidates who apply for professional status.

An additional factor for the low conversion rate from graduate mining engineer to professional engineer, is the fact that most companies will pay for only one professional registration. So after membership of the Association of Mine Managers and the Southern African Institute of Mining and Metallurgy, registration of the Engineering Council comes a distant third.

Until the 'Identification of Engineering Work' becomes law and acts as a bar to persons without professional status for certain categories of work, the relationship between the mining engineer and ECSA will most likely remain the same. This goes some way to explain the current low number of mining professional engineers as opposed to the much larger number of degreed mining engineers in the industry.

ECSA is able to produce statistics according to racial classification. The following table gives the racial demographics of mining Professional Engineers registered with ECSA in December 2010.

Race	No. of professional engineers in mining
Whites	453
Blacks	41
Coloureds	2
Asians	0
Total	496

The first black mining engineer to receive professional status was a graduate from Ghana in 1992. Up until 1992, all the mining professional engineers were white males. The first black mining engineering graduate from a South African university to receive professional status was in 2005. The following table gives the chronological build-up of black professional engineers in mining.

Year	No. of black mining engineers registered	Total no. of black professional engineers in mining
1992	1	1
1996	1	2
1998	3	5
2000	2	7
2001	2	9
2002	1	10
2005	3	13
2006	6	19
2007	3	22
2008	7	29
2009	7	36
2010	5	41 (including 1 female)

The first female mining engineer to receive professional status was a Swedish graduate in 1998. The first female mining engineering graduate from a South African university to receive professional status was in 2004. The first black female mining graduate to receive professional status was in 2010. She was a graduate from the University of the Witwatersrand. The following table gives the chronological registration of female professional engineers in mining.

Year	No. of female mining engineers registered	Total no. of female professional engineers in mining
1997	1	1
2004	1	2
2010	1	3

Thus, there are only three female professional engineers in mining, of which only two remain in South Africa.

From the above tables, it can be calculated that out of a population 496 professional engineers, the racial demographics are 91.3% white, 8.3% black and 0.4% coloured. Similarly, the gender demographics are 99.4% male and 0.6% female.

Of the 41 black professional engineers in mining, only 18 (43%) graduated from South African universities. Non-South African blacks should not fall into the South African classification of 'historically disadvantaged'. This is purely a South African definition and one should not impose one's country's racial discriminatory legislation on citizens of another country. Therefore, if it is assumed that all black graduates from South African universities are HDSA and those blacks from other universities are non-HDSA, then South African blacks constitute only 3.6% of mining professional engineers registered by ECSA. All 18 of these black professional engineers were registered by ECSA in the last six years.

These demographics of the population of mining professional engineers registered with ECSA, demonstrates the inappropriateness of the racial quotas requested by the ECSA Council for ECSA committees based on the population of the country at large and the impossibility of applying similar gender quotas due to the physical lack of bodies. However, since the selection of committee members is not by a democratic process, but a process of appointment to represent certain categories of engineers namely, academic engineers, consulting engineers, contracting engineers and production engineers, the selection can be manipulated to skew the demographic away from the demographic of the body of professional engineers. For the Professional Advisory Committee (PAC) for mining, this has been done to include a greater ratio of blacks (41%) than is the ratio of blacks as professional engineers (8%). As there are currently only two women mining professional engineers in the country and they are recent graduates, it is impossible to have any significant representation on the PAC for mining.

From the lack of black and female mining engineers applying for professional status, it is patently obvious that the relationship between black mining engineers and ECSA is no different now from that of the historical relationship between mining engineers and ECSA, i.e. that professional status remains only a 'nice to have' appendage of little or no value in the workplace on the mines. With the onset of the Identification of Engineering Work, however, this attitude should change. The number of mining graduates applying for professional status should increase markedly. Following the increasing number of graduates and their demographic transformation at the universities, the gender and racial demographics of registered mining Professional Engineers should change rapidly.

The tide is turning.

Vocational institute demographics

The SAIMM is a non-racial institute.

Therefore, the compilation of accurate numbers for racial demographics is not possible. However, by viewing the surnames of members one can attempt to classify members as white, black or other. In this unsatisfactory manner, the racial numbers can probably be expected to have an accuracy of some 90 to 95%.

The tables presented below represent the entire membership of the Institute and not just the mining engineers. For the sake of comparisons with mining education and professional registration in this paper, it may be erroneously assumed that the racial ratios are similar for mining engineers in the Institute, as to that of the Institute as a whole. Further, the Institute represents not only South Africa but also the neighbouring states of Botswana, Namibia, Zambia and Zimbabwe. In addition, the Institute has many members who live overseas in Australia, Great Britain, the United States of America, Canada, etc. In perusing the statistics presented, these above qualifiers should be borne in mind.

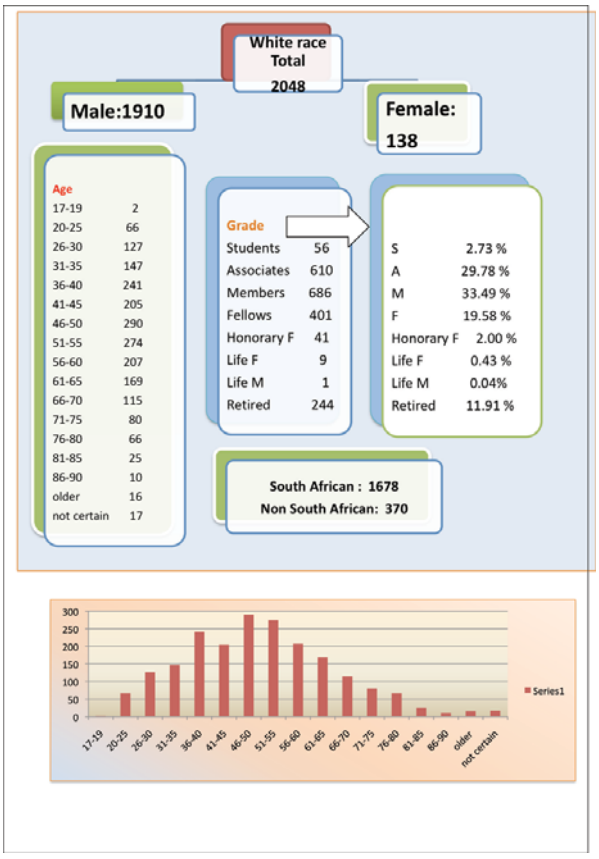

Figure 1—White race demographics/and age distribution

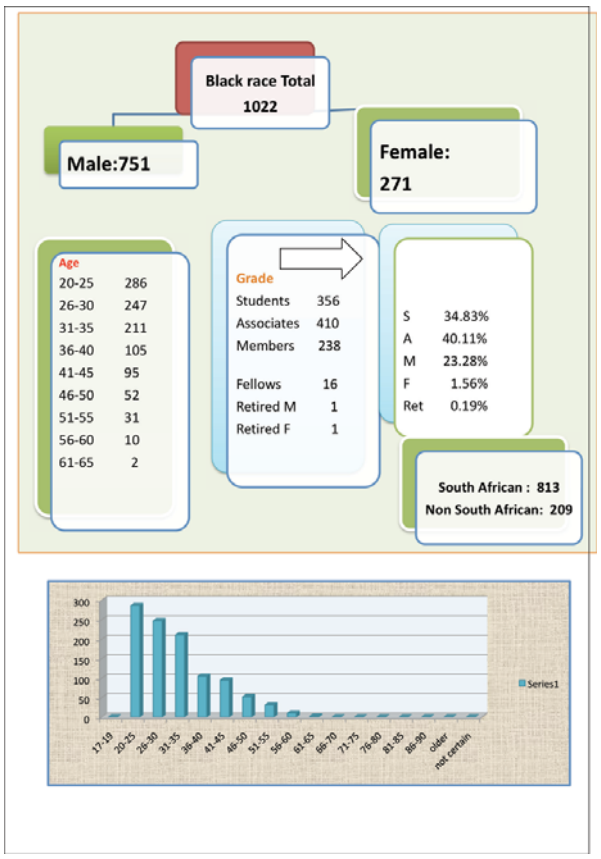

Figure 2—Black race demographics/and age distribution

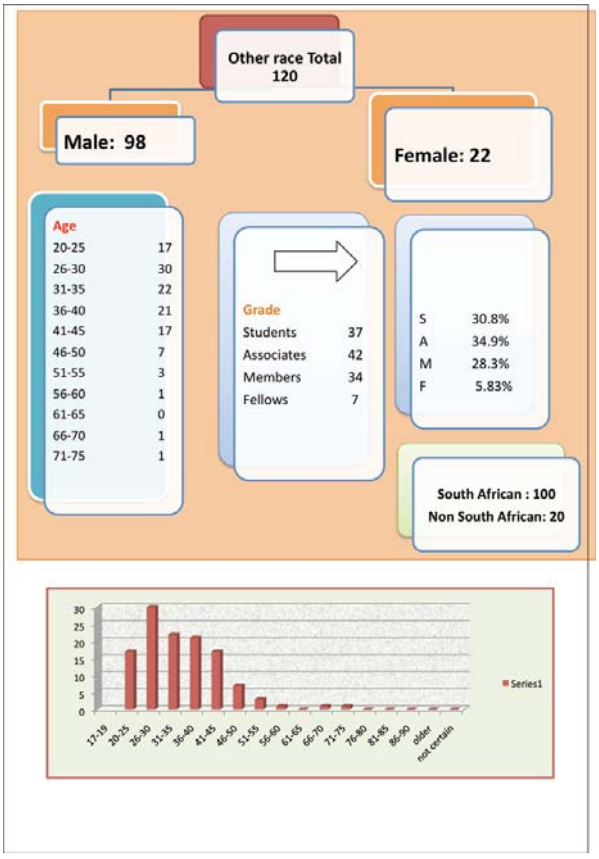

Figure 3—Other race demographics/and age distribution

From the figures shown previously, it should be noted that 32% of the members are black and 14% are female. Of the black members 27% are female, whereas only 7% of the white members are female.

What is of interest is the age distribution of the members in the various racial groups. The white group follows an expected 'bell' distribution curve. The black group, on the contrary, is severely skewed to the left, i.e. to the lower age group.

Composition of the council of the SAIMM

The gender and racial composition of its Council was of concern to the Council of the SAIMM. It can be seen that 32% of the members are 'black' and yet only 9% of the Council are black. Females constitute 14% of the members of the Institute, and yet only 3% of the Council is female. Not only is the SAIMM Council not representative of the demographics of the country, but it is not even representative of the demographics of its members.

Only on closer inspection of the data and an understanding of what it signifies, do the reasons for this anomaly become apparent. The answers lie in the distribution of the various population groups.

The democratic process by which a person becomes a member of Council is by a secret ballot of the corporate members. Initially a person must be prepared to stand for election to Council. In this regard he or she must be a corporate member. If a person is an employee of a company, he generally would have to obtain the permission of that company to stand for election and, if successful, to be given time off to fulfil his duties on the Council. This is normally given to a senior person of longstanding in the company, and not a recent recruit.

A further peculiarity of the mining industry is that young graduates are sent out to obtain their engineering experience on far-flung mines in areas remote from Johannesburg where the SAIMM offices are housed and where the Council meetings are held.

From the distribution tables of membership, it is obvious that the vast majority of black members fall into the category of non-corporate members (i.e. Student Members and Associate Members), whereas the majority of white members fall into the category of corporate members (i.e. Members and Fellows).

The age distribution tables and graphs show that of the members over the age of 40, only 11% are black, 87% are white and 2% are other. Further, from the membership tables, corporate members constitute only 15% black members, 83% white members and 2% other members. Being a democratic Institute, where members are elected through secret ballot, it is not surprising that the current racial demographic of the Council mirrors closely the racial demographics of the members over the age of 40 and that of corporate membership of Fellows and Members.

The age distribution graphs indicate that the demographics should change rapidly in the near future, and commensurate with that change, will come the required change in the racial composition of the SAIMM Council. However, this is an organic change which will take time. The ageing process cannot be rushed.

Conclusions

The demographics of mining engineering education and professional registration is changing rapidly after stagnating for almost a century. No longer is mining engineering in South Africa the sole preserve of white males. Mining engineering is transforming into the racial and gender demographics of the country. The biggest transformation can be seen at the universities which have been racially transformed. Gender transformation has made huge strides in an incredibly short time. In the vocational Institute, the encouragement of students and young mining and metallurgical engineers in recent times has seen black membership rise markedly. Due to the time lag between university and qualifications to register, and the lack of necessity to register for professional status for mining engineers, the professional registration of mining engineers has lagged behind that of the universities and the vocational Institute.

In summary

- The universities have had the greatest transformation racially. The current class (2010) of mining engineers at the University of Pretoria now constitutes 70% black graduates; this exactly represents the racial demographic of the country. At the University of the Witwatersrand the pendulum has swung in favour of black graduates, who now constitute 100% of the mining engineering graduating class (2010). The racial demographic of the first year enrolment of mining engineering students indicates that current racial transformation at the universities will remain intact for the foreseeable future.
- The universities have made great strides over an extremely short period of time in gender transformation. Over the past four years an average of 20% of all mining engineering graduates at the University of Pretoria are women, whereas over the same period at the University of the Witwatersrand 35% of all mining engineering graduates are women.
- Membership of the SAIMM currently has an apparent black component of 32%. The majority have recently been aggressively recruited among students and young mining engineers who are now predominately black. These young people are not yet corporate members of the SAIMM and, in many instances, are working in places remote from Johannesburg. Therefore, although a third of the membership of the SAIMM is black, the age demographics of the black members mitigates against them being elected to the SAIMM Council. However, age demographics indicate that, where black members are in the majority among young members, with time the black majority will mature and so will become the majority in the Council.
- Mining engineers continue to view professional registration as a 'nice to have' rather than a

requirement which will advance their careers on the mines. In this respect, there is no apparent difference between white and black mining engineers. Should professional registration become a 'must have', as should be the case when the Identification of Engineering Work becomes law, then it can be expected that there will be a flood of applications for professional status. When this happens, the demographics of professional engineers will start to resemble the demographics of current mining engineering graduates. This gender and racial transformation cannot happen overnight and due to the time that is required to develop a competent and experienced professional engineer, the transformation can occur only after a period of time.

Mining engineering education at university level has led the way in gender and racial transformation, which has occurred organically. Although membership of the SAIMM is transforming rapidly through aggressive recruiting, it will be some time before the SAIMM Council transforms, due to its democratic election process. Conversely, although the professional registration of mining engineers shows little sign of transforming in the near future, the Professional Advisory Committee for mining is undergoing transformation through directed appointments.

The winds of change are blowing strongly in mining engineering.

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