TRAINING METROLOGISTS
A SOUTH AFRICAN PERSPECTIVE

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Abstract

In line with South Africa's need to provide internationally acceptable calibration results, the vast majority of calibration laboratories have been accredited by the South Africa National Accreditation System (SANAS). These laboratories were first accredited to a local document published by the National Calibration Service, NCS 2, as far back as 1981. This was long before the emergence of the internationally harmonised document, ISO Guide 25. Soon after the local accreditation process began, it was identified that the personnel in these labs required specific metrology training.

The South African experience in this area therefore stretches over more than 25 years and quite justifiably those involved believe that the model that has evolved is 'fit for purpose' and meets the requirements of the vast majority of the needs of the laboratories.

This paper builds on earlier contributions and will provide the reader with an overview of the South African calibration laboratory market, the needs for metrology education, how the training has evolved, and what present programmes are being offered.

It will also attempt to give an insight into the success of the current training being provided by the National Laboratory Association's training arm CMeTSA and what direction it may take in the future.

Introduction

The need for a robust accreditation service in South Africa was first identified during the 1970's and this ultimately resulted in the establishment of the National Calibration Service (NCS) by April 1980. Since the responsibility for the country's standards was governed by an act of parliament and the Council for Scientific and Industrial Research (CSIR) a state supported institution, the custodian; the NCS was initially part of the division known as the National Institute for Physical Research (NPRL).

The need for internationally acceptable traceability was soon identified as a critical aspect and as early as 1983 visits by various members of the European community began; all with a view to establishing mutual recognition for the Calibration Laboratories.

Right from the outset it was clear that those who did the assessing were not only impressed with the capabilities of the laboratories but were also impressed with the calibre of the laboratory staff that they came into contact with, and although there were various issues that were raised as non-conformances, they were for the most part considered 'minor'.

Given the fact that these initial assessments were for a small number of labs it became clear that training for those personnel whose labs had not been accredited was of paramount importance.

History of metrology training activities in South Africa

Initially the NCS provided training on an informal and ad-hoc basis with staff members providing the courses. In addition various supplier organisations also presented training courses up until the late 1980's.

By this time a formal arrangement with a tertiary education provider had been put in place and the courses had to a large degree been regularised.

All along the NCS had battled to establish credibility for these activities and although the Pretoria Technikon, as mentioned above, had become involved there was still no formal recognition for the courses that were being presented. Interestingly enough this did not change even when a Diploma in Metrology was offered by the institution. This finally resulted in the program being dropped, with unfortunately not even a single candidate having been awarded the qualification.

It should be noted that whilst initially these courses had very much a theoretical focus, over time and more especially during the 90's the practical or 'hands-on' approach was adopted.

During this period between the late 80's and up until 1999 various role players including the CSIR and the Technikon organised and ran these courses with ultimately the CSIR doing so during 1997 until 1999.

At this point the manager of what has become the National Metrology Laboratory (NML) of the CSIR, decided that training was not a core focus of the NML, and approached the National Laboratory Association (NLA) to take over the role of organising and presenting theses courses.

A new era in metrology training

The author was approached to consider whether this would be viable and in the process developed and wrote a business plan, complete with budget, which proposed that the NLA be the organiser and promoter of the metrology courses.

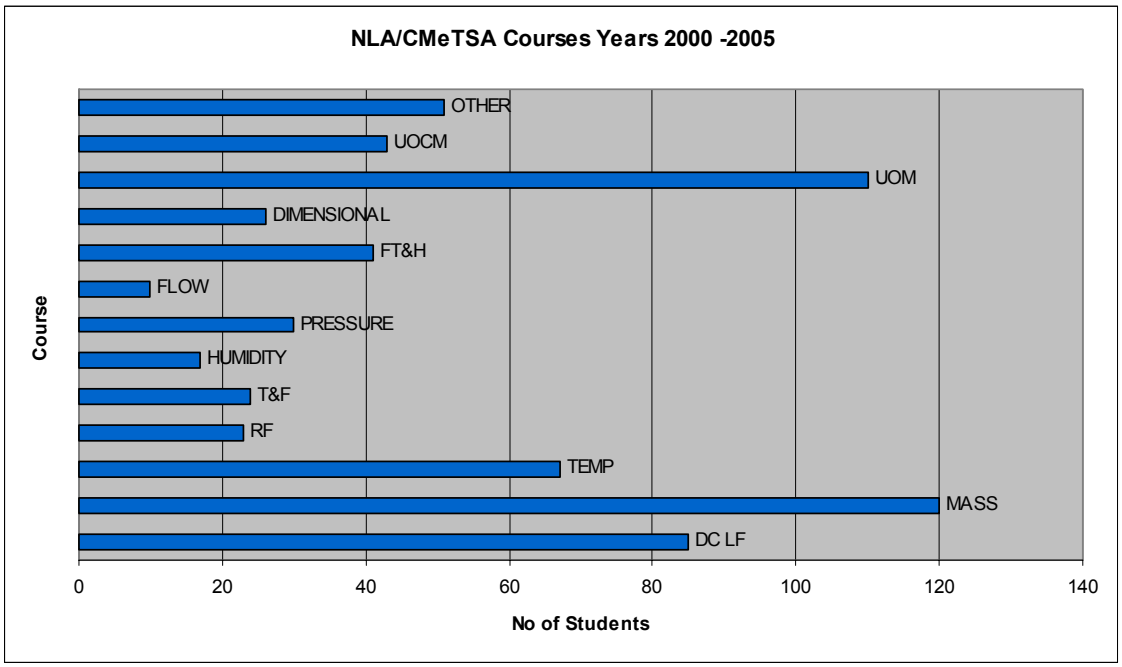
The key part of this strategy was that the NLA would not look to employ lecturers on a permanent basis and would look to use experts either from the NML or industry as training officers.

In addition, it would over time look to have the courses formally recognised in terms of South Africa's new approach to skills development as well as how they may be structured into a National Qualification.

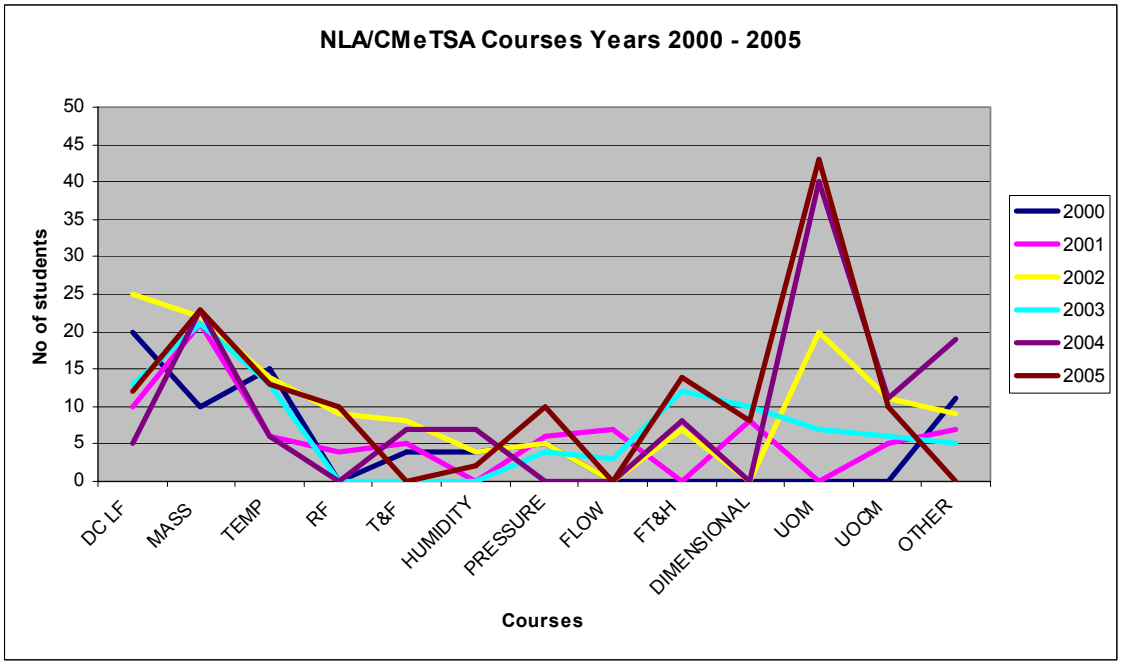
This new approach was accepted by the NLA board of directors in 1999 and by 2000 the first NLA organised courses began.

Over the past 5 years more than 600 laboratory personnel have been trained under the auspices of the NLA and the following graphics highlight some key aspects which will be discussed.

Graphic 1



Graphic 2



It can be seen that whist there is a steady, if not increasing demand for training, the interesting feature of these numbers is the growth in interest by all sectors in the area of Uncertainty of Measurement. The challenge for most of the South African laboratories, like there counter parts in the rest of the world, has been their ability to understand and reliably

estimate uncertainties and significantly many of those attending emanate from the testing laboratory community highlighting the fact that this is very much a cross-cutting issue.

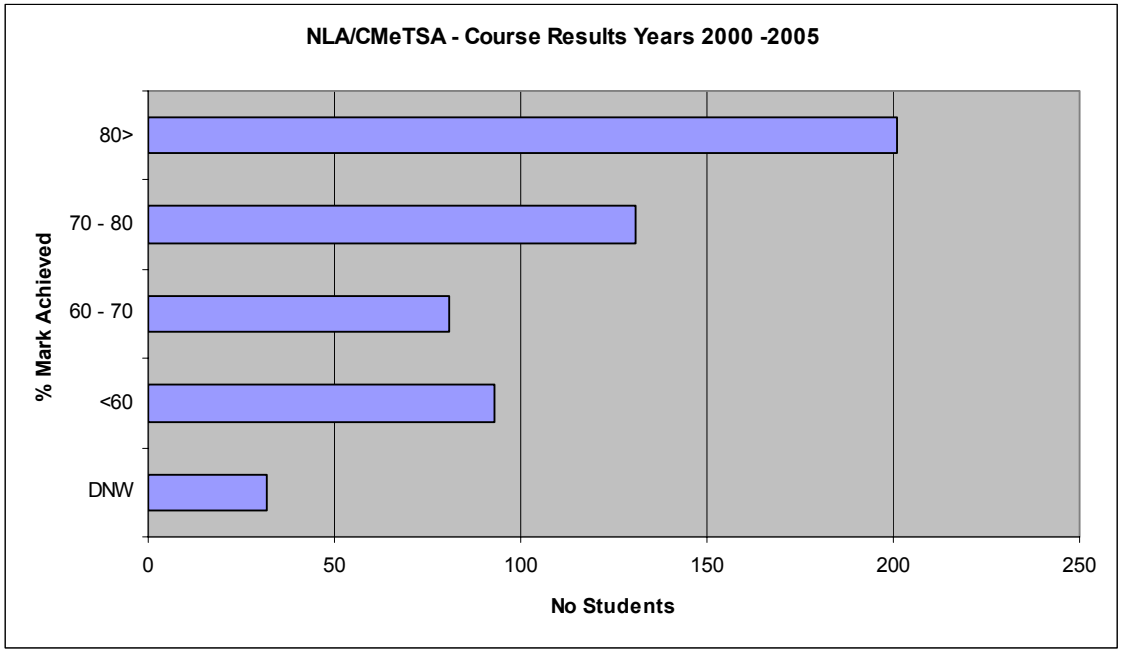
When looking at these numbers the reader should also bear in mind that all the courses mentioned in the graphs are examined. The NLA also provides a number of training activities which are not examined, and at least 200-300 attendees could be added to the figures reported.

Results and success obtained

In presenting the following data, readers should note that whilst virtually the same methodology was employed from about mid 1980 onwards, the record keeping was of such a nature that it was not considered feasible, mainly from a time perspective, to try and gather and record the information in the same format. The results shown therefore only reflect the past 6 years.

A measure of the success that this training has had is the consistently high results that have been achieved by attendees, although over the past 6 years one can see that about 23% of

Graphic 3



those that attended did not achieve a Pass mark; either because they did not sit the final exam or they did not achieve a high enough mark

All courses have been designed such that there are daily tests, as well as in most cases various practical tasks which need to be completed. The sum of these, coupled with a final 3 hour exam result in the marks which are reflected above.

Whilst overall these results appear to be a good indicator of the effectiveness of the training, it is of some concern that such a high percentage of attendees obtain a mark of more than 80%. One would have thought that the category of marks between 60% and 80% would

contribute a far bigger total. This is an aspect that will need to be investigated in order to see if there are any specific reason/s that can be attributed to this phenomenon.

Perhaps a better indicator of the success of these courses, is the fact that the SANAS Accreditation Body's assessors, have reported that where laboratory personnel who have been evaluated do not have this formal background, they are usually significantly less competent that those who have undergone this training. In the view of the author this is a much more reliable indication of the ability of those who attend these courses than the results of the tests and exams that they complete. The goal of course is to ensue that the training is effective and the NLA's experience in this regard is the following.

Theory vs Hands-on Training

During the time that the NLA has conducted these training courses a good balance has been struck between providing theoretical information as well as also allowing attendees the opportunity of either doing 'calibrations' or making measurements. As a 'rule-of-thumb' most courses are run on the basis of mornings spent in classroom activities and the afternoons are spent in either a proper laboratory or at least bringing instruments into the classroom. Candidates are usually broken up into smaller groups and given specific tasks to complete. Here they work to a large degree on their own with the lecturer overseeing the activities.

Examinations

Although this type of training is often not associated with formal and structured examinations, from the outset, exams were part and parcel of the courses. It could be argued that since those attending were mature individuals and there should not have been the necessity to impose exams, it is quite clear that this has been one of the aspects that has ensured the success of the training.

One only has to look at those courses where there are no exams, to see how a far less serious approach is taken by many attendees, as opposed to the virtually 'fearful' view of the final exam where applicable.

In just about all cases where the exam in taken, it is scheduled for about two/three weeks after the running of the course. This allows candidates to spend some personal time reviewing the course material and preparing for the examination.

Clearly with the onset of the National Metrology Qualification, the NLA does not intend to change this approach since this will be a requirement if the NLA is to be accredited as a Higher Education Service Provider.

Curricula

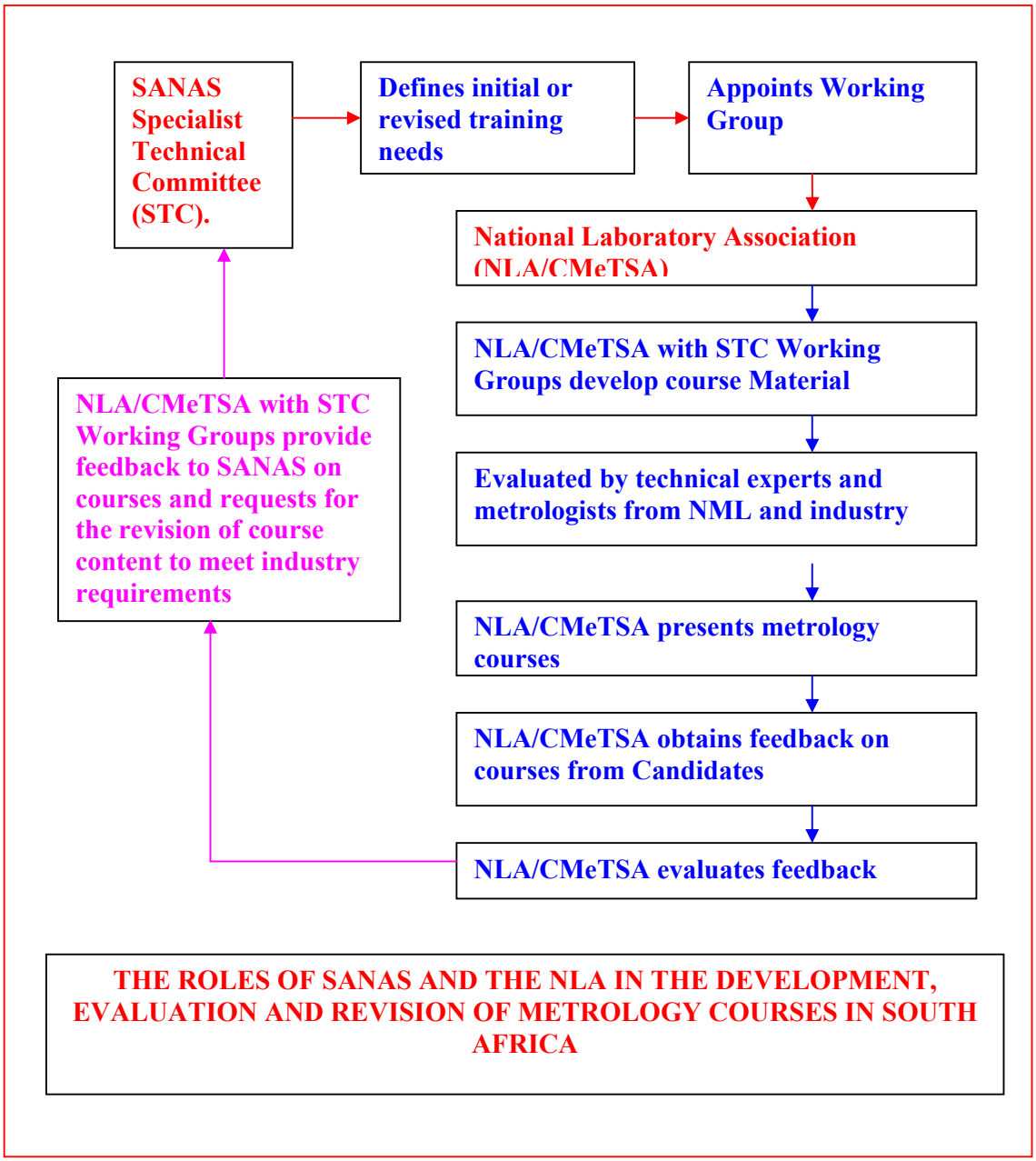
From inception the approach taken by the NLA with regard to curricula of the training courses offered, was to use metrology experts either employed at the National Metrology Laboratory or academia and industry to ensure that the various discipline specific subjects were adequately covered in terms of historic and fundamental information as well the latest techniques.

This approach has proved to be successful since it has, in general terms, provided a good balance between a highly theoretical or academic approach versus a purely hands-on one. Of

course it is true to say that purely academic institutions may not entirely agree with this methodology, but it was always felt that since personnel employed in industrial calibration laboratories were the ultimate benefactors of this training, it was essential that it primarily satisfy those needs.

Graphic 4

Course Development Process



From Graphic 4 above, it can be seen how SANAS and the NLA have interacted to both design the courses and ensure that they meet the needs of the laboratories.

In order to give the reader some sense of what is covered, three of the current course curricula are listed below.

NLA/CMeTSA
Curricula

Introduction To Measurement

Introduction
Mankind measures
Categories of measurement / metrology
Industrial and scientific measurement
Technical function
Subject fields
Traceability and calibration
Measurement standards
International organization
The metre convention
National Metrology Institutes
Primary laboratories
Accredited laboratories
European Organizations
SANAS

SABS Legal metrology
Technical function
Directives
Controlled equipment
International organizations ILAC, BIPM, OIML
National Laboratory Association
Metrology information sources
Metrological units
SI base units
SI derived units
Units outside SI
SI prefixes
Writing of SI unit names and symbols
Vocabulary Definitions
ISO 17025
Good Laboratory Practice

Temperature Course

Dc Voltage and Resistance standards
Temperature scales
Liquid in glass thermometry
Resistance thermometry
Thermocouples
Pyrometry/radiation thermometry
Estimation of uncertainties and uncertainty budgets

Introduction to the Estimation of Uncertainty of Measurement

Roadmap/Introduction
Why uncertainty of measurement ?
A uniform approach, introduction to the ISO Guide.
Basic methodology
Definitions
Sources of Uncertainty
Basic Statistics
Reason for Statistical Approach, What is Statistics, Basic Terms
Applying the ISO Guide
Mathematically modeling the measurement
Reporting of uncertainty
Practical worked examples.

These courses have the following durations:

Introduction to Measurement – 2 days
Temperature Metrology – 5 days
Introduction to the Evaluation of Uncertainty of Measurement – 4 days

Whilst we have not instituted rigorous entrance criteria we have over the past 2/3 years encouraged attendees to attend the courses in the above order since there is a logical progression of learning. It is interesting to note that where this advice has not been followed, most candidates have either struggled or have not achieved as good results. This of course underlines the need for careful course construction for maximum benefit.

Finally, the following two observations should be noted

a) In addition to the Temperature course the NLA offers a range of discipline specific courses, and the Intro to Measurement and the Uncertainty Courses are generic.
b) The approach outlined is in line with the new proposed South African National Certificate in Metrology.

The Future

On reflection the past 25 odd years have been incredibly challenging for metrology, and whilst to begin with the training focus was mainly aimed at improving the skill of those employed in calibration labs, today the world wide phenomenon of a reduced pool of entrants into the world of metrology coupled with the downsizing of staff in these labs means that metrology has new challenges.

The biggest of these is how to increase the potential numbers who are attracted in the first place. It is quite clear that whereas in the past the 'military' need in most countries provided not only substantial employment opportunities, but also was a major provider of skills training, this is unlikely to be repeated in the future.

The author is of the opinion that the following initiatives may offer some solutions to this problem.

a) World wide harmonisation of the content of metrology training, following an approach similar to that which the NLA intends to follow in the future.
b) Professional recognition, similar to that enjoyed by other professionals i.e. Engineers, Doctors etc.

This would then enable the world of metrology to offer prospective entrants a progression path as well as a transportable qualification that is recognised by all.

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Biography

Steve Sidney graduated from the Witwatersrand Technikon with a National Diploma in Electrical Engineering Light Current and went on to make a career for himself in the area of Test & Measurement. Initially he worked for Fluke South Africa, which was a wholly owned subsidiary of the American company. Thereafter he started his own business, which was ultimately sold to Altech, a large multi disciplined JSE Listed Electronics/Telecomm's corporation. Steve was subsequently appointed the Managing Director of Altech Instruments in the mid 80's, a position he held until 1997. After spending some time in a recruitment business, he elected to begin a management-consulting practise.

All along, he has been actively involved in laboratory as well as accreditation issues. Steve was appointed a Board Member of both the NLA as well as SANAS in the early 90's and is currently the honorary Treasurer of both organisations as well as the Manager of the National Laboratory Association. In this role he is an active member of a number of organisations such as Eurolab and ILAC's Laboratory Committee (LC) and Accreditation Issues Committee (AIC), in all cases representing the view of the laboratory stakeholders.