

# THE TRAC PROGRAMME IN SOUTH AFRICA

by

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## **ABSTRACT**

*TRAC is a pre-college programme aimed at increasing awareness of career opportunities in the transportation industry. The programme, developed by AASHTO, the FHWA and other affiliated US societies, has been operating in South Africa since 1994, as an extended US regional centre.*

*An initial investigation of participating schools found that security risks, limitations in terms of student access, poor levels of qualification and computer literacy of teachers, and a shortage of syllabus relevant TRAC teaching material, was hindering the effective implementation of the programme in South African schools.*

*The study also indicated that three primary stakeholders were involved: namely industrial partners, teachers and students. Since the programme was designed for the transportation industry, successful implementation in schools addresses industry needs. Consequently students with an interest in science and technology benefit from an enriched learning experience and exposure to career opportunities in transportation and civil engineering.*

*However it became clear that the programme did not sufficiently meet the needs of South African physical science teachers. These findings led to the establishment of a TRAC research team and construction of a TRAC laboratory. The aim of the research and development programme is to investigate the effectiveness of the TRAC PAC in meeting stakeholder needs, and enhance the TRAC activities for South African conditions. Particular attention is being given to capitalising on the education potential of the TRAC technology, in order to achieve successful transfer of the technology to the teacher.*

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## 1. INTRODUCTION

The vision for education in South Africa is that all its people will have equal access to lifelong education and training, which will contribute towards improving their quality of life and building a peaceful, prosperous and democratic society. It is the responsibility of all governments to ensure that a favourable climate exists in which investment in technology and innovation, is attracted.

Therefore, governments worldwide have a responsibility to promote a science culture, science education and functional literacy among both children and adults to keep abreast with the impact of new technologies. To develop areas that are strategic to the economy, requires close co-operation between government, industry and research institutions. Government's role is expanded to supporting the human resources and entrepreneurship required to promote a knowledge thirsty society. To keep up with technological advances, requires a pool of trained personnel who understand the processes of scientific research, technological development and innovation.

In South Africa mathematics and science education are seen as the "gateway" subjects to everything from zoology, engineering to accounting, yet South Africa is ranked, worldwide, as one of the countries with the least skills in these subjects. Of the 281 304 learners who sat for the maths higher-and standard-grade matric exams in 1999 only 43.4% passed. A shortage of between 4000 and 12000 teachers in these subjects is experienced in South Africa. There is a debate in South Africa whether effective education - in particular, effective science education - can contribute to social and economic development in South Africa. In the Green Paper (strategic plan which eventually leads to a draft Bill) on further Education and Training, it is argued that perhaps the most visible legacy of apartheid is a distorted labour market;

*"evident in the poor articulation between education, training and work, in the phenomena of jobless growth and mass unemployment, in continuing racial obstacles to occupational mobility, in the paradox of continuing skills shortage at a time of declining investments in training, and most devastatingly, in the collapse of the youth labour market. These problems are exacerbated by low enrolments in science, engineering and technology - fields essential to the achievement of higher levels of technological innovation and productivity"*

The South African Government recognizes its role in the promotion of a science culture, science education and functional scientific literacy amongst children and adults and attempts are therefore being made to achieve equity by providing incentives for disadvantaged groups to study science. The Transportation and Civil Engineering Programme (TRAC) in South Africa is seen as an innovative tool to achieve the education goals of government and to eradicate the imbalances that exists amongst learners. TRAC SA is an example of co-operation between government and industry to address the education needs and the shortage of skills of our country.

## **2. TRAC SOUTH AFRICA**

The TRAC Programme was introduced to schools in South Africa during 1994, and was developed under the auspices of the American Association of State Highway and Transportation Officials (AASTHO), the United States Federal Highway Administration (FHWA) and other affiliated US organisations and societies.

TRAC is an innovative way of enhancing physical science and mathematics for high school learners, by means of computer technology. The aim is to stimulate learners' interest in applied science, enabling and encouraging them to enter technological careers, more specifically, the fields of Transportation and Civil Engineering.

At the heart of the programme is the TRAC PAC – a self-contained laboratory pack consisting of a microcomputer, software, sensor equipment, a digital interface for collecting data and other apparatus. It consists of 42 structured experiments, which are designed to involve learners and illustrate how the theoretical principles taught in school, are applied in engineering to solve real problems. It also demonstrates the link, in science and maths, between these subjects and everyday life. A TRAC PAC is established at a school subsequent to the appropriate training of mathematics and physical science teachers at that school. These teachers then use the TRAC PAC as an educational tool to support their syllabus work. In addition to this, schools receive technical support, school visits and career guidance from the TRAC team

TRAC SA has expanded considerably since its inception and now includes four of its own regional centres, namely the Western Cape (University of Stellenbosch), Gauteng (Pretoria Technikon), KwaZulu-Natal (Civil Engineering Careers Forum) and the Eastern Cape (Port Elizabeth Technikon). The head office is based within the University of Stellenbosch's Institute for Transport Technology.

Seventy-nine TRAC PACs are currently operational in the country (54 packs are placed at schools, with the remaining packs at tertiary institutions). From the annual progress reports received from TRAC schools, 7 500 learners participated in the programme in South Africa in 1999. An estimated 20 000 South African learners have participated in TRAC activities since the programme's inception. To date, fifteen industrial partners from the private and public sector, both local and international, have provided over \$500 000 for the programme in South Africa.

Much energy has been focussed on the development of human resources for the programme. As such, a full-time executive director and secretary have been appointed at the head office. On a regional level, three qualified and experienced physical science teachers were appointed as regional centre managers, to assist participating teachers to integrate the programme successfully into the classroom environment

The establishment of a TRAC research programme, a co-operative venture between the University of Stellenbosch's Faculties of Engineering and Education, has created unique

collaborative research opportunities into industry relevant school curricula and related education technologies.

A direct result of the co-operation with industry, is the establishment of a TRAC Laboratory at the University's Department of Civil Engineering. This "TRAC Lab" will serve as a state of the art research and development facility for the programme, as well as exposing student and teacher groups to career opportunities in transportation and civil engineering.

### **3. TECHNOLOGY TRANSFER AND LESSONS LEARNT**

It is well known that in order to achieve successful technology transfer, the product or service provided must directly benefit the user. The TRAC Programme is well designed to cater for the needs of the transportation industry in terms of increasing awareness of transport related career opportunities. The hands-on nature of the activities and exposure to information and education technology appeal to those learners with an interest in the field of science and technology. However, it has been found that the imported programme does not sufficiently address the needs of South African physical science education, as the imported software and the specific experiments do not address the curriculum developed for South African schools. This has led to the adaptation of the TRAC USA package to a TRAC SA version which addresses the needs of the learners and the teachers. A technology based outreach programme like TRAC complicates matters in that the client, user group and ultimate beneficiary are represented by three different groups/stakeholders; respectively industrial partner, teachers and learners. These three stakeholders can be considered to be primary role players.

A secondary group of role players include state education departments, tertiary education institutions, future employers, school governing bodies, parents and the community. The influence of these role players on the needs of the primary role players must also be taken into account.

To better understand the required functionality for the programme in South Africa, the research team is conducting a needs analysis for the three primary role players. The preliminary findings, obtained through interviews with role-player representatives are described briefly below. It is noteworthy that many of the points listed below are in line with the critical outcomes for the Outcomes Based Education model.

### **3.1 Needs of Industry**

Through interviews with industry representatives, it has been found that public and private organisations and institutions have a variety of reasons for providing pre-college programmes like TRAC with financial support. Some of the industrial partner needs relating to TRAC are discussed briefly below.

Organisations may be willing to support programmes that develop the generic skills they are looking for in future employees. These life skills may include the ability to communicate technical information, analytical thinking, creative problem solving, group work, and the practical application of theoretical principles, planning and decision making.

The objectives of the programme may fulfil corporate social responsibility agendas, particularly with organisations that have the State as a client. Philanthropism results from individuals in positions of influence, with a strong sense of social responsibility, who support causes they relate to on a personal level.

Supporting a programme like TRAC creates opportunities for favourable exposure. Although media coverage of the programme is very limited, industrial partners often produce their own social reports and newsletters. The industrial partner may also wish to support schools in areas where they are active.

School programmes such as TRAC can provide organisations with valuable information pertaining to scholarship candidates and future employees who have, while participating on TRAC activities, demonstrated the necessary interest in and potential for a career in the field of transportation

### **3.2 Needs of South African High School Learners**

Following interviews conducted by researchers with learners participating on the TRAC programme, a number of observations were made regarding the needs that could be satisfied with the TRAC PAC. These are discussed briefly below.

Physical science and mathematics are required subjects for further study in the fields of science, engineering and technology. The final grade 12 examinations measure the learner's level of proficiency in these subjects. Institutions for further education stipulate minimum entry requirements, based on performance in the final examinations, particularly in mathematics and science. As such, learner's wishing to follow transportation careers have a need to improve their conceptual understanding of related subjects.

Practical hands on experiments, demonstrating theoretical principles, is often one of the reasons why learners select physical science as one of their subjects choices. Real world transportation applications of theoretical principles satisfy the learners desire to contextualise what they are learning. Group work stimulates the exchange of ideas and challenges learners' conceptual understanding. It also creates a less intimidating environment to defend the group's conclusions, rather than personal understanding. Some learners have indicated a desire for interaction with learners from other schools. This gives them an opportunity to

benchmark their progress against that of the other schools. The TRAC Lab offers these opportunities.

Teachers must demonstrate a satisfactory level of proficiency with the theory being handled in class, and be knowledgeable about the relation of the theory to the real world. This helps develop learner confidence in their understanding of the concepts. Where learners find difficulty in linking related theories in mathematics, physical science, technology and language, many of the TRAC activities, by default, achieve this and thereby creating an understanding for theories.

A critical shortage of vocational information exists in South African schools. As a result most learners are unaware of what the various engineering disciplines entail, opportunities for financial assistance and entry requirements to tertiary institutions

### **3.3 Needs of South African Physical Science Teachers**

Teachers have been identified as key role-players in achieving technology transfer of the TRAC Programme in South Africa. It is therefore imperative that the TRAC PAC is designed to first meet the needs of the teacher. Only once this has been accomplished will the programme be in a position to benefit the transportation industry and learners. The following list of teacher needs has been compiled from interviews with teachers, observational data gathered from teacher training sessions and input from teachers and the research team.

The science teacher's main priority is to cover the syllabus work set by the Department of Education, since this work is examinable in an external examination. Teachers are under tremendous pressure to cover this work in the available time. This rarely creates opportunities to implement enrichment type activities. Therefore to be useful to the teacher, the TRAC PAC activities must compete favourably with more traditional methods of dealing with syllabus material.

Physical science teachers, particularly those with a more advanced approach to education, need a tool to identify and address misconceptions held by their learners. Although seldom articulated by teachers themselves, many demonstrate misconceptions relating to the theory they are teaching. They therefore have a need to develop their own theoretical proficiency. Regarding the use of the TRAC PAC, teachers need regular training sessions to develop sufficient confidence in using the TRAC PAC in class. They also need on-site support from the regional managers to assist them with integrating activities into the classroom environment. Many have indicated that they benefit from interacting with other TRAC teachers at workshops. A central laboratory with trained TRAC instructors has been found to work well in developing the required level of user confidence. Ease of use and portability of the equipment are an important elements in overcoming the current logistical problems often experienced with using the pack

### **3.4 Lessons learnt from the implementation of the TRAC programme in South Africa**

A study of participating schools conducted in 1998 indicated that a number of factors were resulting in the programme not being effectively utilised.

Ease of access to the equipment, e.g. storage of the TRAC PAC in the administration building or strong room. This extended the time used up by activities, in that teachers were required to collect, set-up, break down and return the pack each time an experiment was to be conducted. These logistical problems often outweighed the potential benefit derived from utilising the pack. Due to the community development objectives of the programme, many of the schools selected to participate were poorly resourced. This led to competing priorities in certain cases, with the TRAC computer being used for administrative purposes, as opposed to the intended education application.

High teacher turnover at schools, teachers' unfamiliarity with this type of technology, general low level of teacher qualifications and often the total lack of basic computer literacy created barriers to transferring the technology, which individuals were often unable to overcome alone. In order to achieve the hands-on objective of the programme, a maximum of six learners per group could be accommodated. With only one computer per TRAC PAC, learner access was limited, and as a result the pack was often relegated to a demonstration activity. It was found that a handful of innovative teachers had overcome this problem by setting up a number of experiment stations, of which one was the TRAC PAC. Schools with computer centres were prohibited by some of the TRAC licensing agreements with vendors, from installing the software on all their machines. In this vein the networking potential of the TRAC PAC is restricted.

While the potential of the TRAC PAC, particularly the sensor equipment and related software, to address the syllabus is apparent, few teachers demonstrated the necessary level of proficiency with the equipment or motivation to develop their own activities.

The appointment of full-time regional centre managers, to provide teachers with intensive technical and educator support, has alleviated many of the above mentioned problems. Through regular contact, the regional managers develop positive working relationships with their teachers. This helps teachers to develop confidence in the educational value of the programme, the regional manager's support and their own ability to use the technology. The regional managers have also spent time developing new activities, specifically to address the syllabus. These new syllabus relevant activities have been well received by most teachers. The individual contact and teacher training workshops provide opportunities for a cross-pollination of innovative ideas for improved utilisation.

It has become clear that school readiness is a critical success factor for TRAC in South Africa. Not all schools are in a position to successfully implement the programme. As a result, continued non-performance has led to the withdrawal of packs from six schools. It is important that schools wishing to participate on the programme comply with certain selection criteria, such as: basic infrastructure, secure accessible environment for housing the TRAC

PAC, stable learning environment, commitment from the school governing body, general level of computer literacy of teachers and a willingness to explore new education tools.

#### **4. TRAC SA RESEARCH PROGRAMME**

A TRAC SA research programme has been initiated at the University of Stellenbosch as a co-operative venture between the Faculties of Education and Engineering. The research team has been given the mandate to enhance the programme to better suit South African conditions and cater for the needs of the identified stakeholders, particularly teachers, learners, education administrators, tertiary institutions and industry, within the framework of Outcomes-Based Education. Researchers have been recruited and are conducting their research as part of postgraduate degrees leading to M.Ed. or Ph.D. degrees with the University of Stellenbosch.

#### **5. TRAC SA LABORATORY**

A TRAC Laboratory has been developed at the University of Stellenbosch's Department of Civil Engineering, as a dedicated research and development facility for the programme. The TRAC Lab is divided into a computer-based laboratory, containing six TRAC PACs, and an electronic classroom with a data projector and 25 networked computers. Students conduct experiments in groups using the TRAC PAC, and then move to their own computers to analyse data. The TRAC Lab has been designed to serve the following purposes:

- Provide a research and development facility for investigating the application of computer-based education technology and related teaching material. This is the first research facility of its kind in the country.
- Provide a service to the community in terms of student workshops and tutorials.
- Provide a facility for in-service training of physical science teachers.
- Provide a focal point from which the TRAC Programme can be facilitated.
- Showcase state of the art education technology. This will be useful when demonstrating the programme to stakeholders, particularly prospective sponsors.
- Serve as a prototype TRAC Laboratory, which can be reproduced in other regions in due course.

The TRAC Lab concept, although in its infancy is already proving to hold much potential in overcoming many of the obstacles experienced in schools, such as security risks, student access and instructors' proficiency in using the technology. The physical facility has also assisted with improving control over programme implementation, as well as developing a core competency.

## 6. CONCLUSION

The vision for the industry training authority in South Africa is to develop a skilled motivated transportation infrastructure sector workforce, whose skills are recognised and valued, in order to improve competitiveness, employment creation and labour mobility, across the sector. One of the objectives of this authority is to identify and implement strategies to improve the responsiveness of further and higher education and training providers to the needs of the construction and transportation industry. The South African National Roads Agency, Ltd believes that the TRAC SA programme is a valuable and indispensable contribution to prepare high school learners for careers in transportation. The expansion of the TRAC SA programme will depend on the successful duplication of the research programme and the science centre at other tertiary institutions within South Africa.

The vision for building of human capacity for the transportation industry does not only lie within South Africa but also in SADC countries and the South African TRAC team is ready to share their experiences with our neighbours. We are able to advise countries on the adaptation of the programme to suit local needs and we would like to invite countries that are interested to contact us for further information.

## REFERENCES

1. *Green Paper on Further Education and Training*. South African Department of Education, Pretoria, 1998.
2. Ker-Fox, G.M., Green, W.J., Jordaan, A.S., Davids, C.J. *The Trac Programme in South Africa : Experiences and lessons learnt*, University of Stellenbosch , 2000
3. Ker-Fox, G.M., Green, W.J., Jordaan, A.S., Davids, C.J. *The Trac Programme in South Africa : Experiences and lessons learnt*, University of Stellenbosch , 2000
4. Ker-Fox, G.M., Green, W.J., Jordaan, A.S., Davids, C.J. *The Trac Programme in South Africa : Experiences and lessons learnt*, University of Stellenbosch , 2000
5. Ker-Fox, G.M., Green, W.J., Jordaan, A.S., Davids, C.J. *The Trac Programme in South Africa : Experiences and lessons learnt*, University of Stellenbosch , 2000
6. TRAC SA, *Annual Report 1999*, Stellenbosch, 1999.
7. TRAC SA, *Annual Report 1999*, Stellenbosch, 1999.
8. TRAC SA, *Annual Report 1999*, Stellenbosch, 1999.