

Applied and Industrial Physics in South Africa
K.A. Meyer¹, J. Padayachee⁴ G. Hough¹, R. Lynch², J. Waltham³

¹ Envirovision Solutions, P.O. Box 1493, Kloof, 3640

² ISS International Limited, P.O. Box 12063, Die Boord 7613, Stellenbosch

³ Thoroughbred Technologies (Pty) Ltd, 34 Columbine Place, Durban, South Africa

⁴ School of Pure and Applied Physics, Howard College Campus, UKZN, 4000

ABSTRACT

Applied Physics is concerned with applying knowledge gained in physics to other areas like engineering, telecommunication, mining and medicine. The Applied and Industrial Physics Specialist Group (AIPSG) of the South African Institute of Physics represents the interests of the South African Applied and Industrial Physics community. This article provides an introduction to the AIPSG and summarises some of the current applied physics activities in academia and industry.

1. Introduction

Physics is that branch of science dealing with the properties and interactions of matter and energy. Applied physics is the application of knowledge gained in physics to other areas like engineering (for example, by improving the design of computers, cellular telephones, home appliances and cars), telecommunication, mining and medicine. This article gives a brief insight into Applied and Industrial Physics in South Africa.

2. Applied and Industrial Physics Specialist Group of the South African Institute of Physics

The Applied and Industrial Physics Specialist Group (AIPSG) of the South African Institute of Physics (SAIP) is one of seven Specialist Groups charged with the advancement and diffusion of the knowledge of specific fields in pure and applied physics. However, unlike the other Specialist Groups, the AIPSG not only represents the interests of physicists from each of the different groups (Astrophysics and Space Science, Condensed Matter and Materials Science, Education, Lasers, Optics and Spectroscopy, Nuclear, Particle and Radiation, Theoretical) but also represents the interests of physicists who are currently employed outside of academia.

The main aim of the AIPSG is to promote Applied and Industrial Physics. Other aims include: to assist academics contact relevant industries to market their services and to assist industrialists contact relevant academics.

More information on the AIPSG is available from:

<http://www.saip.org.za/SGs/Applied.html>.

3. Applied Physics and Medicine

One of the largest applications of physics is in Medicine where the concepts and methods of physics are used to aid diagnosis and treatment of human disease in the fields of Diagnostic Radiology, Nuclear Medicine and Radiation Therapy. Further information on this application of physics can be obtained from the South African Association for Physicists in Medicine and Biology (<http://www.saapmb.org.za/>).

4. Applied Physics Research in South Africa

The wide range of fields covered by Applied physics research is highlighted each year in the Applied and Industrial Physics session at the annual SAIP conference. Over the past few years presentations have included: measurement of concentrations of atmospheric particulate matter and its relation to cancer incidence, investigating brick strengths for housing solutions, and micro-analysis of solar cell responses using focussed sunlight.

There are many university physics departments around South Africa that conduct applied physics research. A few examples include: solar cell research (Nelson Mandela Metropolitan University, U. Western Cape), applied nuclear radiation and environmental geophysics (U. Western Cape), detection of drugs and explosives (including abandoned landmines) using neutrons (U. Cape Town) and measurement of sugar crystal sizes using neural networks (U. KwaZulu-Natal).

For more information on any of these topics, please contact the relevant physics department of the listed university.

5. Applied Physics in Industry

Large South African companies like NECSA, CSIR, Denel and Element Six have had a strong history of applied physics research and have received much coverage of their applications in the past. This article therefore chooses to highlight the lesser-known applications of physics in industry currently taking place in South Africa. The following sections describe the

activities of three companies applying physics to problems in Forestry (EnviroVision Solutions), Mining (ISS International and ThoroughTec) and the Military (ThoroughTec). The table below lists numbers of physics graduates employed and the annual turnover of these three companies.

Company	Physics graduates employed	Annual turnover
EnviroVision Solutions ¹	2	R8 000 000
ISS International ²	10 - 15	R30 000 000
ThoroughTec ³	2	R22 000 000

5.1. EnviroVision Solutions

EnviroVision Solutions (EVS) develops and deploys vision systems for environmental monitoring. Each vision system provides a turnkey solution for the early detection, rapid response and rules-based decision support for:

- Wildland fires in remote areas using satellite links
- Both wildland and informal settlement around the urban fringe
- Pollution events associated with chimney stacks, riverine discharge & marine outfalls
- Timber and cycad theft, poaching control and wide area surveillance for the mining industry

As a software development house focussing on machine vision-based solutions, EVS develops software for partner companies who:

- Monitor breakwaters and coastal structures for storm related damage
- Manage aerial fire bombing operations and ground crews
- Dispatch urban fire fighting resources
- Count coastal whale for census work related to annual migration

EVS's flagship product is *ForestWatch* which received the 2004 ICT Product of the Year Award from the Computer Society of South Africa, and has been deployed in both Canada and South Africa since its October 2003 launch at the International Wildland Fire Congress in Sydney.

Much of the early image-processing experience applied in *ForestWatch* was gained through the Space Physics programme at the University of KwaZulu-Natal, which sent expeditions to the Antarctic on an annual basis to run their radar, auroral, ozone and VLF programmes at the SANAE (South African National Antarctic Expedition) base.

Key EVS developers have doctoral degrees in Physics and Computer Science, and focus on “nowcasting” services often spanning wide areas (the largest systems both in Canada and South Africa cover over a million hectares).

5.2. ISS International Limited

ISS International (ISSI), has good ties with the physics community (specifically the Physics Department at U. Stellenbosch) in South Africa. ISSI is the world leader in seismic monitoring for the global mining industry. The work that ISSI does is based on the redistribution of stress when rock is removed from the earth. These stress changes can lead to rock bursts, which are essentially small earthquakes. On the Gutenberg-Richter scale used for global seismology, a magnitude 9 is an earthquake with typical dimensions of 200-400km, and a movement of 10-20m.

The typical seismic events monitored by ISSI range from magnitude -2 to +2, with rupture dimensions of up to a few hundred meters, and movements of up to a few cm. While a magnitude +2 earthquake is many orders of magnitude smaller than a damaging crustal earthquake, these small mining earthquakes can be fatal because the miners can be less than 100m from the source. ISSI designs and manufactures the equipment used to monitor such earthquakes, as well as carries out research into prediction of large mining earthquakes and numerical modelling of the mining-induced stress changes. The majority of ISSI professionals are physicists, and a few physics, mathematics and computer science students are usually employed every vacation.

The problem addressed by ISSI requires a blend of physical insight, technology and business, and physicists are best suited for this.

5.3. ThoroughTec

It is well established that simulation-based training is able to offer cost effective solutions to a multitude of military and commercial training requirements, retaining and often improving competency levels whilst reducing training costs. The wealth of simulator systems available internationally can provide the modern military or commercial organisation (e.g. mines,

port authorities, etc.) with an unprecedented range of training systems across the full training spectrum.

Thoroughbred Technologies (Pty) Ltd (ThoroughTec), a leading Durban-based simulation company, is bringing their extensive simulation experience to address the training requirements of both local and international clients. Over the last 15 years ThoroughTec's simulation team has developed and manufactured over 20 different simulator models and deployed in excess of 300 simulator units.

All too often the term simulator conjures images of major training or prediction devices such as full flight trainers and war-gaming centres, which form but a fraction of the full spectrum of available training simulators. A training simulator may be as simple as a PC-based desktop application training a specific skill or as complex as a full mission rehearsal flight simulator.

At the heart of any simulator unit is the simulation-processing engine (not the CPU, but the reality models and processing engine that process all inputs and transform to meaningful outputs in time). This is the domain of the computational physicist. The modelling of real world systems requires the ability to formulate the numerical or analytical equations / solutions required to describe the system being simulated, to the level of fidelity required.

Simulations will one day be the norm for the training and evaluation of personnel who operate complex and expensive equipment or are required to interact within complex environments, and ThoroughTec is perfectly positioned to address this market need as it evolves.

ThoroughTec has applied all the same principles and technologies that it has learnt in the military market in other markets, such as mining. They have produced simulators for vehicles ranging from underground drill-rigs, load-haul dumpers and roof bolters to above ground haul trucks, shovels and drill rigs. They also have a standard range of truck, car and crane simulator systems.

6. Summary

The "Shaping the Future of Physics in South Africa" report⁴ states that the academic Physics community in South Africa has relatively few links with industry and that some industries do not see the need to employ physicists. These industries seem to perceive Physics graduates as not being very useful in solving their (engineering) problems.

The report further states that: “If it is considered that many graduates would seek employment in industry, that industrial research problems can be challenging and also help fund research (and students), and that physics is the basis of much industrial development, it is disappointing that these links are as few as they appeared to be ...”

The few examples of the various, real-world, applications of physics demonstrate the potential for physicists to find employment in non-academic fields and for industry to benefit from the training that is unique to a physics graduate.

References

1. EnviroVision Solutions website: <http://www.EVSolutions.biz/>
2. ISS International website: <http://www.issi.co.za/>
3. ThoroughTec website: <http://www.thoroughtec.co.za/>
4. International Panel appointed by the Department Of Science And Technology, National Research Foundation and South African Institute Of Physics, "Shaping the Future of Physics in South Africa: Report of the International Panel"
URL: <http://www.saip.org.za/STFOSA/IPReport.html>