CAREERS IN STATISTICS

What is Statistics?

Even though you may not have realized it, you probably have made some statistical statements in your everyday conversation or thinking. Statements like "I sleep for about eight hours per night" and " You are more likely to pass the exam if you start preparing earlier" are actually statistical in nature.

Statistics is a discipline which is concerned with:
- designing experiments and other data collection,
- summarizing information to aid understanding,
- drawing conclusions from data, and
- estimating the present or predicting the future.

Examples of problems where Statistics plays an important role can be found in almost all spheres of science:

- The study of the occurrence and spread of disease, and of the effective treatment of diseases cannot be undertaken without contributions from a statistician.
- The development of new farming methods relies heavily on statistical techniques.
- When designing and testing new machinery, engineers make extensive use of statistical principles.
- In the collection of information concerning the quality of life of a country's population, the planning, implementation and processing of nationwide surveys rest largely on the statistician.
- Long as well as short term insurance is extremely dependent on the correct use of Statistics.

Who should consider a **career** as Statistician?

Pupils and students with a strong mathematical ability and interest, often find that the science of Statistics can lead to a challenging career, providing job satisfaction and excellent opportunities. Characteristics of a career in statistics include the following:

- use data to solve problems in a wide variety of fields,
- apply mathematical and statistical knowledge to social, economic, medical, political, and ecological problems,
- work individually and/or as part of an interdisciplinary team,
- travel to consult with other professionals or to attend conferences, seminars, and continuing education activities,
- advance the frontiers of statistics, mathematics, and probability through education and research.

If you enjoy any of the above characteristics, a career in statistics may be right for you!

What **fields** employ **Statisticians?**

One advantage of working in statistics is that you can combine your interest with almost any other field in science, technology, or business, such as:

Agriculture	Insurance	Biology
Law	Chemistry	Manufacturing
Computer Science	Marketing	Economics
Public Health	Education	Sports
Engineering	Telecommunications	Epidemiology
Finance	Genetics	Health Science

THE **SOUTH** AFRICAN **STATISTICAL ASS**OCIATION

What Job **title** might I have **other** than **Statistician?**

Business Analyst
Professor
Economist
Software Engineer
Mathematician
Risk Analyst
Quality Analyst

Investigator
Environmental Scientist
Pharmaceutical Engineer
Researcher
Data Analyst
Project Manager
Manager

Career **opportunities** for Statisticians

As awareness of the value of Statistics grows, large companies increasingly tend to employ people with some degree of statistical training. Places where people with statistical training are to be found range from organizations where Statistics is applied sporadically to organizations with well structured divisions for statistical consultation and research.

In this brochure information is supplied concerning a few sectors that should give the reader a good idea of the variety of employment possibilities available to statisticians.

Statistics in …
Business &
Industry

Statisticians in the
Automotive
Industry

Statisticians in the vehicle production and retail environment provide valuable assistance in

- designing the best possible product, ensuring customer satisfaction and retention
- analysis of current model warranty issues and identify corrective actions
- the reduction of variability in the transition from design to manufacturing to deliver robust products
- supply-chain optimization solutions and part scheduling coordination
- quality control to ensure a consistently excellent product
- market research and customer satisfaction surveys
- financial forecasting, planning, risk assessment and pricing
- analysis of vehicle maintenance costs and part life duration
- data mining of production, warranty and used parts data
- analyses of cost abnormalities in various models
- production, maintenance and repair profiles analyses for all models

Working in Industry as a Statistician entails many challenges and rewards. Researchers and Developers rely on the Statistician for making recommendations. In the Process Industry decisions has to be made regarding the significance of new products, significance of process improvements and optimization of products and processes. For example, the Statistician is part of the project team tasked to develop a new catalyst for a chemical process. The first main responsibility of the Statistician is to recommend an experimental program to be followed for investigating all the possible compositions of the catalyst. The Statistician also needs to understand the process in order to negotiate the physical restrictions of experimentation. Data such as the selectivity of the catalyst towards certain chemical products, or the conversion ability of the catalyst, need to be statistically evaluated and recommendations need to be made about the optimal catalyst composition. The performance of continuous production plants also needs to be improved and optimized. Statisticians are involved in evaluating data from production plants and needs to recommend operating conditions for the improvement of the process. Statistical modeling, linear and non-linear, as well as distribution fitting, of complex data sets constitutes a huge part of the daily activity of an industrial statistician. The Statistician is also involved in simulation studies, i.e. simulating production plants for the purpose of identifying significant trends among the process parameters. The Statistician in Industry is involved in many different kinds of projects on a daily basis. This brings about the application of many different statistical techniques. These techniques involves, among others, statistical inference, design and analysis of experiments, regression modeling and distribution fitting. For the Industrial Statistician, every day yields its own challenges.

Statistics in …
Mining
and the
Earth Sciences

The important contribution of mining to the South African economy is well known, from gold, platinum and diamonds to coal, iron and manganese. Statistics and probability play a valuable role in the mining industry. To establish a new mine, or to expand production into an unexplored area of a mineral deposit, can be very costly and risky, particularly in the developmental stages.

Statisticians in a mining environment are often called upon for advice on a sampling strategy that will provide the maximum information with the minimum of expenditure and time. An appropriately designed sampling campaign will help the mining industry to learn more about the mineral deposit, and thereby reduce the risk. Sampling can tell us about different zones in the deposit distinguished, for instance, by geology, grade or depth. It can also be used to determine properties of the rock (mineral bearing or otherwise) like density, size and hardness, as well as the grade and quality of the mineral. At the end of the day, the grade and quality translate into money the mining company will make if it embarks on the new project. Should that happen, samples may also be taken at the production plant (where the mineral is extracted) to determine issues of efficiency and quality control. There are similar reasons to take samples at the laboratories associated with the prospecting, exploration and mining processes.

Statistics plays a critical role again when it comes to the analysis of the sampling results. Take grade as an example. Statistical measures such as the mean and standard deviation can be calculated to give an idea of the typical or average sample grade, and how the grades spread out around this central value. Confidence intervals (or hypothesis tests) provide an indication of what the true population grade parameters (for the entire deposit) are. These statistical inference techniques often

require knowledge of the underlying grade distribution, which can be approximated by a histogram of the grade data. Q-Q plots, as well as goodness-of-fit tests and other maximum likelihood approaches, help in fitting an appropriate population distribution (normal, lognormal, compound lognormal, etc.). It is important to note whether the distribution is skewed (many low-grade values and a few high-grade values, or vice-versa), because this will affect mining decisions and strategies. It is equally important to identify potential outliers and anomalous data: the inclusion of data which have been measured or recorded incorrectly, or that are biased or unrepresentative can have potentially disastrous results. Bivariate and multivariate analyses are also appropriate in a mining context. For example, the possibility of a relationship between grade and rock density may be investigated by means of a scatter diagram, correlation coefficient and regression analysis.

The problems associated with mining are often challenging because underlying statistical "textbook assumptions" are not met, so the statistician needs to be innovative in searching for a solution, that may include nonparametric approaches, bootstrapping or Monte Carlo simulations.

Geostatistics:
Mining and **Beyond**

There is another challenge for the statistician in the mining and petroleum industries, as well as in earth science and other applications (meteorology, hydrology, forestry, earthquakes and volcanoes, etc.). Most classical statistical methods do not incorporate the spatial framework in which earth science measurements are usually taken.

Geostatistics or spatial statistics is necessary in addition to classical statistics to account for the spatial continuity that is present in many natural phenomena. Spatial continuity (correlation) may be described by a variogram. Kriging is a generic name for a family of generalised least-squares regression algorithms (based on knowledge of a variogram model) that are used to estimate spatial variables, such as grade, at locations where measurements were not taken. The term kriging is in recognition of the pioneering work of the South African, Danie Krige, who applied the technique to gold mining valuation problems.

South African gold ore reserves were also considered in work by Herbert Sichel who laid the theoretical foundation for the use of the lognormal distribution in their evaluation. The t-estimator associated with this distribution bears Sichel's name, as does a medal awarded by SASA annually to a member who has published the best statistical paper during the year. "... a fitting memorial to a great founder member and Past President of the Association, whose seminal research contributions are recognised internationally" (SASA Newsletter, December 1996).

Information on the Geostatistical Association of Southern Africa, and the South African Institute of Mining and Metallurgy can be found on the Web at http://www.gasa.org.za/ and http://www.saimm.co.za respectively.

Graduates with a solid background in practical and theoretical statistics and related mathematical sciences can add value to mining companies through their expertise and specialised knowledge of the field, and of statistical software packages.

THE **SOUTH** AFRICAN **STATISTICAL ASS**OCIATION

Statistics in …
Naval Operations
Research

At the Institute for Maritime Technology (IMT) a statistician has some freedom to build his/her own career around one or more of a wide spectrum of naval decision problems. Typical broad areas are:

- Data mining: Various large databases within the naval environment require analyses. These databases mainly come from the following fields:
  - Engineering: radar, sonar, infrared
  - Oceanography
  - Logistics
  - Intelligence

- Modelling and Simulation: Due to rising costs of naval exercises and diminishing defence budgets, modelling and simulation has become an extremely important tool for providing answers to questions around tactics, comparisons of different weapon systems, and strategic decision problems.

- Operational test and evaluation (OT&E) of weapon systems: New and upgraded weapon systems are required to undergo structured and detailed testing before it can be accepted and used. The statistician plays an important role in assisting with the planning, execution and analysis of OT&E trials.

- General statistical assistance for engineers, oceanographers and others working on problems relating to strategic decision making.

Statistics in …
the **Natural World**

A biometrician differs from the traditional statistician in that he or she is confronted by a wider range of problems dealing with all the phenomena that affect animals nutrition and breeding, plant breeding and crop production, as well as diseases and pests on both plants, animals and the environment. Quite often surveys are conducted on an equally wide range of temperate and tropical practices in agriculture and animal husbandry.

Biometricians may advise researchers who are planning experiments, or they may analyse data for differences between different applied treatments, or for trends and underlying relationships. Sometimes they forecast future conditions of resources like forests or watersheds. Often they work as part of a team. The biometrician's skills are important to quality control and assurance in research and operations management. In a large organisation, biometricians may conduct their own research to improve statistical methods or the understanding of subjects such as crop development or climate change.

Essential attributes are an inquisitive mind, an ability to think quantitatively, an interest in applying statistical methods to biological problems and the will to learn about related sciences. Furthermore, good communicating skills, good computer skills, and a personality or mental disposition that encourages close working relationships with collaborators from many fields of science.

Consulting makes out a large part of the biometrician's tasks and good communicative skills, orally and in writing, are essential. A biometrician must also be a good teacher and willing to teach short courses to researchers.   Biometricians become totally involved in the projects on which they are working. They learn about the subject matter, how the data are collected, what the goals of the project are, and what the constraints are in terms of time and resources. They then help formulate a plan of action that tries to ensure that reliable data will be collected and that proper analyses are carried out on the data collected. They help document the conclusions reached by the investigation.

The statistical techniques mainly used are experimental design and analysis of variance. This method assesses whether the variation among a group of treatments is greater than would occur if all the observed effects were due to chance. Many other techniques are used to supplement or replace analysis of variance (ANOVA) and its derivatives. Regression analysis techniques are also frequently used on quantitative data, as well as many multivariate analysis techniques, such as principal component, discriminant, and cluster analysis.

Statistics Education
as a
Career Choice

A qualified school teacher with a background in Statistics is sure to be in great demand with the introduction of the new school syllabus in South Africa.

The new school curriculum has vast amounts of basic statistical principles integrated into the various learning areas. In fact, statistical principles are taught in the Data Handling section of Mathematics, at all levels creating a desperate need for teachers with knowledge of statistics.

Statistics
in …
Banking

Statistics in banking is becoming increasingly important. The reason for this is that the key issues and the management challenge in banking are competitiveness and increasing profitability in more difficult and competitive markets. This requires the adoption of a customer-centric approach - focusing on optimizing the life time value of the customer, and this approach is penetrating the whole decision making process. Speaking about decision making, the good decision-maker is the informed one. Consequently, a proper delivery of customer-based information and conclusions is crucial for proper customer-centric decision making. Usually the information delivery process starts at the Data Warehouse or Data Mart, goes through Business Intelligence and Business Reporting & Graphics, and ends with more informed Business Decisions. The Business Intelligence step consists mainly of On-line Analytical Processing (OLAP), Executive Information Systems (EIS), INTERNET/INTRANET Exploitation and Data mining. The latter, Data Mining, incorporates the entire variety of statistical techniques for data exploration, analysis and forecasting, from the basic to the most advanced ones, as well as model-free techniques like neural networks, genetic algorithms and tree-based techniques. This is also the step where a professional statistician or, better, a statistical expert group is absolutely necessary. The presence of such a professional person or expert group will also save a significant amount of money, making it possible to avoid the very expensive external local or overseas vendors.

Some application areas of statistical conclusions and techniques are listed below:

- Customer Relationship Management - includes Customer Retention and Customer Acquisition, Market Segmentation and Cross-Selling, Application (Credit) and Performance (Behavioral) Scorecards Development, Development of Loyalty Programs, Queuing Analysis of Customers and Optimization of the Branch Network and POR, Credit-related and Risk Assessment of Commercial Bodies and Industries, Analysis of Various Customer Questionnaires and Marketing Campaigns;
- Risk Management - includes Credit Risk Management, Limits Development and Assessment, Contribution and Profitability Analysis, Fraud Detection;
- Financial Markets Operations - include Securities Trading and other Treasury Operations, Pricing Strategies, Forecasting of Financial Markets Trends and Volatility, Development and Marketing of New Products, Portfolio Management;
- ATM Operations - include Service and Cash Replenishment Optimization, ATM Profiling and Segmenting, Recognition of Fraud Patterns;
- Human Resources Management - includes Human Resources Planning, esp. Forecasting of Future Needs, Analysis of Various Staff Questionnaires, Staff Optimization;
- General/Other - include Market Research, Statistical Consultancy, Ad hoc Statistical Analysis for Specific Problems, Data Quality Control and Integrity in Enterprise Data Warehouses, Assistance in Business Process Redesign and Improvement and Queuing Optimization of customers calls for Telephone Banking.

A Career
in **Biostatistics**

The science of statistics became an integral part of scientific research in the 20th century and will strengthen its role in this century through specialisation. Biostatistics is an example of such a specialisation and has had major impact in the conduct of medical and health research. One example of this is the role of biostatisticians in the pharmaceutical industry in the design, modeling and reporting of drug trials.

Biostatisticians are statisticians working in the field of health and health research. In South Africa you will find biostatisticians working in the National and Provincial Departments of Health, in Medical Schools at Universities, at research institutions such as the Medical Research Council (MRC), at private companies in the pharmaceutical, health care and health insurance industries. There are two main areas of application with biostatisticians working on clinical research projects and public health research projects.

For any career in biostatistics a good basic training in statistics is needed which entails a B.Sc. degree with a major in statistics. An honours degree with some specialisation into subjects such as general and generalised linear models, survey sampling, experimental design, survival analysis and epidemiology will be a good basis to launch your career in biostatistics.

Other skills that are required is the ability to communicate and work with people. You are usually a part of a team working on a project. You have to understand the problem being investigated and define the statistical issues involved such as the design of the study, the sample size, validity, reliability and bias of measurements and analyses. You must be able to report on your work and have the ability to explain clearly the methods and assumptions that have been used during the course of the project. Computer literacy is an essential requirement for a biostatistician. You must be able to use the computer as a tool in your work. Substantial contributions are usually acknowledged through co-authorship and the statistician has to participate in the preparation of the manuscript to be submitted.

Statistical analysis can vary greatly in complexity. Some projects can be handled through standard statistical methods and software. Other projects may require methodological development and research on the part of the statistician and the development of specialized computer programmes. These methodological developments are usually used for presentations at conferences, first authored publications and as a research topic for a post-graduate degree.

The Medical Research Council (MRC) employs biostatisticians to support medical and health research in South Africa. The Biostatistics Unit is a national unit of the MRC with offices in Pretoria, Durban and Cape Town. The MRC provides a career path for biostatisticians starting with junior statistician and progressing to chief statistician. Vacant posts are advertised in the main newspapers of the country and on the MRC's website (http://www.mrc.ac.za/).

Working in the field of health as a biostatistician will be a stimulating career with many challenges. You will find it interesting and rewarding to work with others on an aspect of life that is important to every human being.

Getting **started**

Recruitment to the profession of statistician is usually at graduate level, so for most people the first step towards the profession is to get a degree in Statistics or in a joint subject such as Mathematics and Statistics which has a high statistical content.

Admission to these degree courses nearly always require a good performance in A-level mathematics. There are also many other joint degrees involving statistics, such as Economics and Statistics, or Statistics and Business Studies, which may well be good stepping stones to a career in statistics and which, in some cases, have less demanding mathematical requirements for entry.

Anyone who would like to have more information with regards to courses can contact their local university:

Contact **details**

U＝University, UT＝University of Technology

Institution	Website	Phone Number
U of Cape Town	web.uct.ac.za/depts/stats/	021-650-3220
U of Fort Hare	www.ufh.ac.za/	040-602-2171
U of the Free State	www.uovs.ac.za/faculties/index.php?FCode＝04&DCode＝117	051-401-2299
U of Johannesburg	www.uj.ac.za/statistics/	011-559-2852
U of KwaZulu-Natal	statsactsci.ukzn.ac.za	031-260-3011
U of Limpopo	www.ul.ac.za/index.php?Entity＝School%20Main%20Menu&school_id＝1	015-268-2170
Nelson Mandela Metropolitan U	www.nmmu.ac.za/default.asp?id＝318&bhcp＝1	041-504-2764
North West U	www.puk.ac.za/fakulteite/natuur/stats/index_e.html	018-299-2550
U of Pretoria	web.up.ac.za/default.asp?ipkCategoryID＝2059&subid＝2059&ipklookid＝11&parentid＝	012-420-3774
Rhodes U	www.ru.ac.za/statistics/	046-603-8346
U of South Africa	www.unisa.ac.za/Default.asp?Cmd＝ViewContent&ContentID＝224	012-429-6877
Stellenbosch U	www.sun.ac.za/statistics/	021-808-2027
U of Venda	www.univen.ac.za/math_natural_sciences/statistics.html	015-962-8437
Walter Sisulu U	www.wsu.ac.za/	047-502-2533
U of the Western Cape	www.science.uwc.ac.za/	021-959-3034
U of the Witwatersrand	web.wits.ac.za/Academic/Science/Stats/Home.htm	011-717-6272
U of Zululand	www.uzulu.ac.za/scie_mat_sci.php	035-902-6079
Cape Peninsula U of T	www.ctech.ac.za/	021-460-3158
Central U of T	www.cut.ac.za/	051-507-3304
Durban U of T	www.dut.ac.za/site/awdep.asp?dealer＝6636&depnum＝22588	031-373-5227
Mangosuthu U of T	www.mut.ac.za/	031-907-7111
Tshwane U of T	www.tut.ac.za/	012-318-4223
Vaal U of T	www.vut.ac.za/	016-950-9635
U of Botswana	www.ub.bw/learning_faculties.cfm?pid＝610	00-267-355-2366/2706
Eduardo Mondlane U	www.uem.mz/	00-258-1-490081/9
National U of Lesotho	www.nul.ls/faculties/social/statistics.htm	00-266-22213606
U of Namibia	www.unam.na/faculties/science/science_index.html	00-264-61-206-3367
U of Swaziland	www.uniswa.sz/academic/socsci/stat/	00-268-518-4011/5108
U of Zimbabwe	www.uz.ac.zw/	00-263-4-303211x1636
Medical Research Council	www.mrc.ac.za/biostatistics/biostatistics.htm	021-938-0328
Statistics South Africa	www.statssa.gov.za/	012-310-8911