Part V

BROADER ISSUES IN RESEARCH

Research affects the world and the researcher should be aware of the possible effects of their research. In this part we discuss some of the social and ethical considerations in research, as well as describing the development of scientific thought in human society.

In Chapter 15 we focus on the issues of ethics and intellectual honesty; in Chapter 16 we describe the evolution of scientific thought; and in Chapter 17 we discuss the role of research in South Africa’s reconstruction and development.
15 Research Issues

Research carries with it responsibilities. A researcher has responsibilities to fellow researchers, to any participants in the research, to society as a whole and, most importantly, to herself or himself. In this chapter we consider some of the issues and ethical questions that may arise in research. In many cases there are conflicting views and all we can do is to explain some of the arguments on each side. As a researcher, you will have to think about these issues and come to your own conclusions.

15.1 ETHICAL QUESTIONS

There are two fundamental ethical questions in research: What are morally acceptable research topics, and what are morally acceptable methods to research a particular topic. Both questions, as with most moral issues, have been and are the subjects of considerable debate and cannot be ‘solved’ in this book.

As researcher you should be aware of these issues and always consider the effects of your research before you start it. If in doubt, you can consult your promoter/supervisor, or refer the problem to the Ethics Committee at your institution (often a substructure of the Research Committee) for expert guidance.

15.1.1 Dubious things to research?

‘Beauty is truth, truth beauty,—that is all
Ye know on earth, and all ye need to know.’
(Keats: Ode on a Grecian Urn).

One school of thought holds that all knowledge is good and therefore there should be no ‘taboo’ subjects. At first glance this may seem attractive to the scientifically inclined. Some might not see why there’s an argument at all. If you fall into this group, consider how you would feel about people conducting research into the following questions:

- Are black people more or less intelligent than white people?
- How regularly do children masturbate?
○ What relationships are there between physical characteristics (‘looks’) and career success?

○ How to clone a human being?

○ How does one make an atomic bomb?

All five questions have resulted in published research, the first three being discussed in Jor89, Lou91 and Bar94. But, for many people, one or more of these questions should not have been the subject of research in the first place—decide for yourself whether all knowledge is good, or whether there are topics that are inherently wrong to research.

15.1.2 Dubious ways to research

Research may be well-designed and procedurally correct, and yet be ethically flawed. Perhaps examples are the best way to show this:

J.B. Watson, the ‘father’ of behaviourism, conducted a series of tests in which a baby was subjected to a loud noise (to scare it) every time it saw a particular toy animal (Wel38). Not surprisingly, the baby eventually became afraid of the toy even in the absence of the noise, and in fact became conditioned to fear a range of other toy animals. Something was proved about conditioning responses—but was it ethically acceptable to do this to a baby?

Carson and Butcher (Car92) report a 1950 study by Keys where conscientious objectors were used to study the effect of food deprivation on humans. After being placed on famine rations for six months, the subjects had an average weight loss of 24 percent, and various mood and temperamental effects were recorded.

The above two cases of research involving human beings would not be approved by Ethics Committees today. One criterion used in that of ‘informed consent’: volunteers, in full possession of the facts, agree to be subjects of the research. This is expected to apply even if there is no chance of the subjects being harmed.

Of course, while humans are in a position to give informed consent, animals are not. It is accepted practice to use animals for a wide variety of clinical tests; examples of which include:
○ Exposure to extreme amounts of cigarette smoke to see if cancers result.
○ Exposure to a wide range of products intended for use on humans, from
drugs to shampoos, to check for adverse reactions.
○ Use of healthy animals to test new surgical procedures (e.g. heart trans-
plants).

Those people against research harming animals (called anti-vivisectionists) main-
tain that animals have rights too, and such experimentation constitutes unacceptable
cruelty to animals. Further, even when such experimentation may be thought neces-
sary, the living conditions of the animals and the experimentation methods are often
unnecessarily cruel. The world has enough shampoos, cosmetics and the like already;
and so there is no need to continually rub new products into animals’ eyes to see the
effect.

All this might be appealing reasoning, but people who support such research ask
‘Would you like things to be tested on humans first rather than animals?’. If you answer
yes to this question, then would you be happy for your mother to be the ‘guinea-pig’
when a new drug is first tried?

For an in-depth discussion of this controversy you might contrast the views of Fox86
with those of Lan89.

15.1.3 Dubious results

A particularly vexing question is what to do with the results of morally unacceptable
research. In the early 1940’s, Nazi ‘scientists’ performed ghastly human experimenta-
tion on prisoners which produced data regarding such things as castration, sterilisation,
pain thresholds and operations without anaesthetic (Ast85). Clearly the research was
ethically unacceptable, but given that it has been done, and that the methods used were
otherwise scientifically correct, should not the resulting data be used? You decide!

15.2 INTELLECTUAL HONESTY

Apart from considering the ethics of the research topics and of the research methods
used, a researcher is expected to be ethically correct in a number of other ways. Fore-
most on this list is that the researcher is honest: honest about the methods, honest
about the results and honest about who did the work.
Plagiarism is the unacknowledged use of the work of someone else, where the researcher claims credit for work that he has not done. Careful referencing (see Chapter 13) should ensure that you do not plagiarise by accident—remember, it can’t be plagiarism if you acknowledge where you got the information from. Plagiarism might be a tempting way to avoid hard work—but, when discovered and proven, it will mean the end of your scientific career and, in cases of Masters and Doctoral students, will lead not only to the retraction of the degree but also to expulsion.

Good scientists accept the results they get, for they are interested in knowledge. Occasionally bad scientists falsify results, for they are interested in fame or in ‘proving’ a particular point of view. Many of these frauds are irritating but do not affect the world at large; however, some of these frauds have set scientific advancement back many years. One famous fraud was the Piltdown Man (Wei80). In 1912 Charles Dawson announced the discovery of a skull with a mixture of human and ape features. This provided scholars with the sought-after ‘missing link’ in human evolution. It was only in 1953 that tests proved that the parts of the skull were only a few hundred years old and the skull was an elaborate forgery. The missing link was again missing, and scientists had to rethink their results.

One reassuring aspect is that the nature of scientific enquiry ensures that fraud will always be found out when later results reveal inconsistencies.

A researcher has the obligation to expose scientific fraud wherever it is found.

Closely aligned with falsifying results is the selective choice of data. This happens when a researcher doesn’t present all the data captured, but only that which supports their preferred hypothesis. Often this is not done as a deliberate fraud; rather, the researcher on seeing unexpected data, reasons on the lines of: ‘Oh, that can’t be. There must have been something wrong with my equipment/experiment/subject. Better omit that data from my reporting.’. This is unacceptable and could, in fact, lead to very important data being ignored. If there is a genuine concern about the validity of data, it is acceptable to omit it from consideration if and only if you state in your reporting that you have done so, and give the reasons why. If space constraints allow, such data could also be presented in raw form (i.e. actual results rather than summaries) in an appendix to your report.

15.3 INTELLECTUAL PROPERTY RIGHTS

We have already observed that copying other’s people writing without acknowledgement is plagiarism, and cannot be defended. The same issues are involved in using pirated software and copying pictures and sound clips, but there are many who argue that piracy
is acceptable. What we would like to consider here is your intellectual property rights: who owns the results of your work?

Our experiences suggest that South African tertiary institutions have a poorly defined policy on intellectual property rights. In particular, who owns work done by students. We would like to suggest the following policy. Copyright of theses, research, etc., performed as a student should remain with the author, but the institution is given a royalty-free license for internal educational purposes. You may wish to check with the research office at your institution. If you do research explicitly for a company, and are paid for it, then it is reasonable that the company owns your research.

Discussion questions and exercises

1. Given that a particular society has moral qualms about abortion, should tissue from aborted foetuses be used in medical research in that society?

2. Genetic engineering has now reached a stage where it is possible to ‘design’ features into plants and animals. There is a proposal to develop a new type of cow which has no legs but produces vast quantities of milk. Is there an ethical question involved? What do you think?

3. While most people agree that Watson’s experiments on conditioning in children would not be accepted by a Research Ethics Committee today, there are no qualms about using his results. Is this reasonable?
16 The History and Philosophy of Research

People have searched for answers to questions since the beginning of known civilisation. Why this continual search? The reasons are hotly debated by philosophers, see (Kea86), but many attribute this search for knowledge to the notion that knowledge empowers. Bacon wrote that ‘There is a most intimate connection and almost an identity between the ways of human power and human knowledge...’ (Far53). Such empowerment is present in all aspects of our lives—the skilled technician, the graduate, the company which knows how to produce a superior product, the country which knows how to create wealth, and so on.

In this chapter we look at how the search for knowledge has developed through history, paying particular attention to the ongoing debate regarding what knowledge is and how it may be reliably obtained. As current scientific research across the world is rooted in a line of development traceable back to the Ancient Greeks, we begin with them.

16.1 GREEK THOUGHT AND THE ORIGINS OF RESEARCH

The ancient Greeks from about 600 B.C.E. (Before the Christian Era) contributed significantly to how humankind searches for knowledge. This Greek thought provided the roots of current day science and research.

The Greek civilisation was itself the product of earlier thought. Written language in particular had been developed earlier by the ancient Egyptians and Babylonians. It is known that by 3000 B.C.E. both cultures possessed written logographic languages (Gro95). The possession of a language consisting of symbols, rather than mere pictures, meant that any knowledge acquired could be passed down from generation to generation, rather than having to be ‘re-learnt’. There is dispute as to the nature of further contributions by the Egyptians and Babylonians. Some maintain that their contribution to human knowledge was in the form of ‘rules of thumb’ regarding agriculture, mathematics, astronomy and medicine, motivated purely by practical necessity (see Rus91 and Far53). Others suggest that they did show original and abstract thought (Far53).

While other early civilisations made similar advances, it is unclear to what extent these influenced ancient Greek thought and therefore modern views on research.
16.1.1 Pre-Socratics

Western Philosophy began with Thales (585 B.C.E.) (Rus91). From the point of view of the history of research, his importance is that he asked a question (All66). The question itself, along the lines of ‘What is the source of all things?’, and his answer ‘The source of all things is water’, are not important. However, his question sparked a debate amongst his contemporaries that was dialectical in character: a question was followed by an answer, which was in turn questioned. Some of the attempts to answer this question relied on mysticism and religion. However, as early as Heraclitus (c.480 B.C.E.), there was an attempt to observe nature in order to come up with a common-sense approach, rather than to rely on the deities as the answer (Far53). With Pythagoras (c. 550 B.C.E.), hailed as the founder of modern science (Fle84), one sees the beginnings of speculative hypotheses and deduction. Atomists such as Democritus (5th Century B.C.E.) also attempted a more scientific and rationalistic approach to the question of the nature of things.

16.1.2 Socrates, Plato and Aristotle

Socrates (c.470-399 B.C.E.), known primarily through the writings of his pupil Plato (c.428-348 B.C.E.) (Rus91), developed what became known as the Socratic Method—in this method, the dialectical process of question and answer is used in order to arrive at knowledge. Plato was idealistic in his approach to the question of reality. He saw reality as consisting not in the material world, but in ideas (the forms of things). Plato’s pupil Aristotle (384-322 B.C.E.), on the other hand, was realistic in his approach. For Aristotle, reality consisted in material, individual things and he placed great emphasis on the role of observation in acquiring knowledge. The first attempts at categorisation can also be seen in Aristotle’s work (Rus91). Aristotle’s Categories were classes that described different ‘modes of being’, e.g. substance, relation, quantity, quality. Aristotle’s most significant contribution is his formulation of the syllogism (a form of argument in which, if something is stated, something else is logically true) (Fle84). The creation of the syllogism led to deductive logic.

16.1.3 Post-Socratics

Other schools of thought followed on from Plato and Aristotle. Hedonism (the idea that happiness is the proper goal of human actions) led to the belief that the pursuit of knowledge should concern itself only with what was practically useful. These views are clearly expressed in the ideas of the Cyrenaics and the Epicureans (4th century B.C.E.)
The idea that no sure knowledge can be found, makes an early appearance in the theories of the Sceptics (c280-80BCE) (Rus91). The nowadays contentious issue of a moral basis for enquiry after knowledge appears strongly in the thought of the Sceptics (although this moral basis can be seen to varying degrees in the thought of Socrates, Plato and Aristotle).

From 300 B.C.E. to 400 A.C.E. (After the Christian Era), although there were developments along existing lines of thought, no new ways of thinking developed in Greek thought. The Greeks were, however, becoming increasingly exposed to Eastern thought (Zoroastrian dualism, Buddhism, etc.), as a result of Alexander the Great’s conquests.

With the decline of the Graeco-Roman civilisation from approximately 400 A.C.E. onwards, the only significant advances in science and scientific thought for some 800 years were those made by the Arabs in fields such as astronomy and algebra.

16.2 DEVELOPMENT OF MODERN SCIENTIFIC THOUGHT

It is only around the 13th century that one sees a resurgence of new developments in thought. This revival of intellectual thought was made possible by the combined contributions of the Monastic orders of the Christian Church which provided the structures for a revival of learning (schools), and the Arabs, who had preserved ancient Greek knowledge in libraries and also maintained the idea of education (Rus91, Gro95).

It was then that Thomas Aquinas (c.1225) made the works of Aristotle known to the West. William of Occam (c.1290) contributed by insisting that the pursuit of knowledge could occur without metaphysics or theology playing a role. This break from the Church contributed to an intellectual climate that made possible the significant advances in thought that followed. Occam was also responsible for the idea that, when given a number of possible explanations for a phenomenon, the simplest one should be chosen. This is known in modern science as ‘Occam’s razor’.

16.2.1 Renaissance of science

The rise of modern science begins with Copernicus (1473-1543). By introducing mathematical reasoning into cosmology, he came up with the theory that the earth revolves around the sun; and the earth was not, as had been previously thought, the centre of the universe. Kepler (1571-1630) refined Copernicus’ thought and devised the three planetary laws of motion.
Galileo (1564-1642), sometimes called the founder of modern mechanics, refined the techniques of experimentation and observation. Consequently, he discovered the law of falling bodies and the law of inertia, and also published many new discoveries concerning his telescopic observations. Galileo argued for the separation of theology and science. Newton (1642-1727), in addition to formalising the three laws of motion, discovered the law of universal gravitation and contributed to the theory of light.

The theories of these four men (Copernicus, Kepler, Galileo and Newton) form the foundation of our modern scientific theories. It was Francis Bacon (1561-1626) who identified, formalised and developed the method of thought that these four men were using, namely inductive logic. Until the 15th century, intellectual thought had been largely bound to deductive logic.

16.2.2 Descartes, Locke and Kant

Descartes (1596-1650) is said to be the founder of modern philosophy. He was unhappy with the way philosophical thought was conducted and wanted to achieve the same degree of certainty in philosophy as was being achieved in the natural sciences. To this end he created his ‘method of doubt’: everything that is not absolutely certain is rejected and what remains is simply ‘I think therefore I am’ (Cogito ergo sum). From this our knowledge is then rebuilt according to logical principles. Descartes philosophy was hence highly rationalistic.

Locke (1632-1704) was the founder of empiricism. He claimed that all knowledge, with the possible exception of mathematics and logic, is derived from experience. At best, our general truths concerning the world can only be highly probable and not certain (Fle84). Locke stressed the importance of the senses in obtaining knowledge, while Descartes stressed the importance of reason in obtaining knowledge.

Kant (1724-1804) made a strenuous attempt to reconcile various aspects of Descartes’ and Locke’s thought. Kant was extremely impressed with the advances made in the natural sciences. However such science was presenting a highly mechanistic and deterministic picture of the world. Kant was concerned that this, if accepted as the true picture of reality, would be a denial of the individual’s autonomy and freedom of will. He thus attempted, via a study of pure Reason, to find out how enquiry becomes scientific. His conclusion (very simplistically!) was that we make progress in the search for knowledge when our experiments and observations are guided by certain rational principles (Kan46).
16.2.3 Continental philosophy

Continental Philosophy follows on from Descartes. Hegel (1770-1831) developed the idea of the dialectic further: a process of argument in which there is an event (thesis) having a reaction (antithesis) which results in the best from both the action and reaction coming together (synthesis). With the development of phenomenology by Husserl (1859-1938) and Heidegger (1889-1976), there is a shift away from the attempt to find meaning in a ‘narrow scientific attitude’ (Kea86). Heidegger claimed that meaning was to be found in the fact that as humans we ‘exist’ in the world. This places emphasis on the role of the observer. Around this time, Einstein (1879-1955) formulated his theories of relativity, which were not only of tremendous importance for physics, but were also interesting from a philosophical viewpoint. Relativity implies that the observer is vitally important to the results.

Later continental philosophy (such as existentialism, critical theory and structuralism) led to a greater stress on the role of individual creativity in scientific thought. The rejection of a narrow scientific attitude has led to a broader, less prescriptive interpretation of the search for knowledge. A prime example of this is the multidisciplinary approach.

16.2.4 British philosophy

British philosophy developed from the empiricist ideas of Locke, with thinkers such as Berkeley (1685-1753) and Hume (1711-76). J.S. Mill (1806-73) founded utilitarianism, which is based on the theory that actions are judged on their consequences: an action which produces ‘good’ (happiness, usefulness, etc.) is to be desired. Logical positivism stressed the importance of empiricism as a method of enquiry. The logical positivists attempted to systematise the empirical method with the use of various logical procedures such as the ‘verifiability principle’. Popper (1902-) stressed that a single false result (‘falsifiability criterion’) could show a theory to be false, while no number of positive results could prove it to be true, but only added to our confidence in the theory.

16.2.5 The uncertainty of science

All of 20th century science has been influenced by the development of quantum mechanics. Heisenberg made a critical contribution to quantum theory by showing that the position and the momentum of sub-atomic particles cannot be simultaneously determined (Heisenberg’s ‘uncertainty principle’). Therefore, at a very basic level, and
hence at all higher levels, all phenomena must have a degree of uncertainty. This fundamental uncertainty has profound implications for all of science and research. (For an excellent detailed discussion of the role of certainty in science, see Cas93.)

16.3 RESEARCH TODAY

Most of the different ‘ways of thinking’ (speculation, observation, deduction, etc.) that people use today to acquire knowledge had made an appearance by the 4th Century A.C.E. The contributions of ancient civilisations are therefore vital: it is usually far more difficult to ‘invent’ something than it is to refine and develop it. However, it was only from about the 14th century onwards that these approaches were developed to the extent that rapid progress could be made by using them.

The 20th-century approach to research consists of a curious combination of the various approaches outlined above. Research must be rigorously and thoroughly carried out — there are definite rules that must be complied with in order to produce results that are valid (e.g. logical and statistical rules). While researchers are always attempting to establish some theory as a ‘fact’ about the universe, there is at the same time a reluctance to call such facts ‘truths’. There is a tendency amongst researchers to disbelieve that anything can be known to 100% certainty. The nature of both statistical techniques and quantum theory lends support to this viewpoint.

Researchers need to be aware that they are part of the research. While the researcher is expected to be objective, she will nevertheless influence the research in many ways. The researcher is an observer and hence views the experiment or research from a unique position. In addition, depending on what the researcher’s interests and background are, she will decide to research certain topics and not others, and to use one methodology of approaching a research problem rather than another.

Indeed there is a growing tendency in philosophy towards a more individualistic and less absolute approach. Rorty argues that we should not look for a ‘permanent framework for enquiry’ (Ror80). Rather we should ‘see knowing not as having an essence, to be described by scientists or philosophers, but rather as a right, by current standards, to believe,...’
17 Research and South Africa’s Needs

17.1 COUNTRY-SPECIFIC RESEARCH

Some argue that all research is good and research should be pursued for it’s own sake, free of intervention from government. On the other hand, some argue that the impact of the research on society should be considered, especially if society is footing the bill. A great deal of research at academic institutions is funded by the taxpayer, be it directly via government subsidies to the institutions or indirectly via government funding bodies such as the NRF and MRC. Why should the taxpayer pay for some academic indulging himself in researching a pet theory which has no significance for the country?

Some have argued that any research not geared towards solving specific problems in the country should not be supported, and that pure research in particular should be left to first-world countries ‘who can afford it’. But, the distinction between pure and applied research is, of course, a tenuous one, and today’s pure research can be, and often is, the basis of tomorrow’s vital applied research. In addition, if all nations took the position of ‘We’ll just research our own problems, let other research be somebody else’s problem’, we would very quickly find ourselves with no new theoretical results on which to base new practical systems.

The Science and Technology policy of South Africa’s Reconstruction and Development Programme (RDP) had clear guidelines on what scientific research at technikons and universities would be most appropriate for the country. In particular it stated that government should make such research ‘more responsive to the needs of the majority of our people for basic infrastructure, goods and service’ (ANC94). Nevertheless, in its section on higher education, it stated that ‘the higher education system represents a major resource for national development and contributes to the world-wide advance of knowledge’. Current government policy re-affirms the importance of South Africa playing its part in international and basic research. At the same time, national imperatives do mean that there will be increased focus on research relevant to the country, and government funding will reflect this.

17.2 WHAT ARE SOUTH AFRICA’S NEEDS?

The RDP contained five broad programmes: (a) meeting basic needs, (b) developing human resources, (c) building the economy, (d) democratising the state and society, and
(e) implementing the RDP. The following list, based on the RDP and the NRF focus areas (NRF01), gives some areas that are extremely relevant and in need of research.

- job provision/unemployment
- the land issue
- provision of low-cost quality housing
- water—provision, sanitation, conservation
- electrification of the country
- provision of telecommunications
- transport
- health provision
- social welfare
- accessible quality education
- rectifying gender and racial imbalances
- democratising society
- industrial policy
- describing, understanding and conserving our biodiversity resources
- understanding rural and urban development
- management and development of human resources
- information and communication technology
- the effects of globalisation on South Africa
18 Case Studies

Our first case study is in the field of chemical engineering applied to water purification (Swa93). It covers the experimental comparison of different filtering methods.

Our second case study is in the field of data communications (Mel89). It addresses a particular problem in practical communication systems which involve bouncing signals off meteor trails.

For our final case study, we look at an example from medicine involving the health of pregnant women (Qol95). The research looked at the numbers of women in South Africa who have specific diseases during pregnancy.

18.1 COMPARISON OF FILTRATION METHODS
(or Building a better muck-trap!)

Using common water supplies to yield drinking water requires filtration and purification. Given a mixture of liquids and solids, filters are often used to separate the two. In particular, microfilters are used to separate the finer (colloidal) particles from the suspension. The research was to compare two different methods of microfiltration.

18.1.1 The problem

Two common methods of microfiltration are crossflow microfiltration (CFMF) and dead-end mode microfiltration (DEMF). In both cases the goal is to take the suspension and separate the permeate (liquid) from the solids. The turbidity of the suspension is a measure of how ‘thick’ it is.

Traditionally, CFMF has been favoured when the main objective is to recover the permeate (from suspension with low turbidity), and DEMF has been favoured when the main objective is to recover solids (from a suspension with high turbidity). The objective of this project was to establish criteria for the choice between CFMF and DEMF.

18.1.2 Experimentation

The performance of both CFMF and DEMF was experimentally measured for synthetic suspensions over a wide range of input turbidities. Performance criteria included the
rate at which permeate is produced and the turbidity of the permeate.

18.1.3 Results and implications

It was found that, for low turbidities, typical of raw surface waters (such as rivers and streams), the performance of DEMF was similar to CFMF, provided the DEMF was precoated with a limestone suspension prior to the introduction of the input suspension. This has significant implications for the treatment of water to make it drinkable. CFMF requires a much larger pumping capacity and consumes much more energy than DEMF does. Thus DEMF is to be preferred where energy is scarce (such as rural communities). It is also possible to use DEMF without any pump at all by using ‘natural heads’—such as weirs across rivers—where the falling water provides the necessary pressure.

18.1.4 The write-up

The study was reported in a Masters thesis by A.F. Swart, entitled ‘Considerations in the Selection of an Operating Regime for Microfiltration’ (Swa93).

18.2 CLASSIFYING METEOR TRAIL REFLECTIONS

One branch of data communications is that of meteor-burst communication (MBC). Meteors burn up in the upper atmosphere and leave behind trails of ionisation. Electronic engineers have developed a method of using such trails as ‘cheap satellites’. They use the trails to reflect radio waves sent up from one point on the earth’s surface down to another point (up to about 2 000 km away). The fact that billions of these meteors collide with the earth’s atmosphere every day makes such communication far more practical than it may sound at first.

18.2.1 Research problem

Optimising data communications by MBC is complicated by the fact that trails vary in duration and size, so that signals reflected from different trails have different durations and signal strengths. The problem of determining what types of trails naturally occur is important for a number of reasons. First, knowing the proportions of the various types of trails is necessary if optimal fixed data rates are to be chosen. Second, if a
data rate that can change during the course of the trail is used, then information about the first part of the trail must be used to predict the strength and duration of the next part—an impossibility if there is no idea of what different entire trails look like.

18.2.2 Literature study

A literature study revealed that previous researchers had attempted to describe trails by looking at the trail reflections. They transmitted a radio signal that was reflected by the trail and the receiver measured the signal strength over time. Thus the classification was done on the basis of time and amplitude. Theoretical work had indicated that trails would be in one of two classes, underdense or overdense, with distinctive shapes (see Figure 11: the underdense trail is the smaller of the two curves). However, practical studies had found up to five different classes.

![Figure 11. Underdense and overdense trails.](image)

18.2.3 Researchers

A large team was involved in a cross-disciplinary effort funded by Salbu (Pty) Ltd. The research was based in the Department of Electronic Engineering at the University of Natal, Durban, but members of the Computer Science and Mathematics departments were also involved, as were Salbu’s research and development team.

18.2.4 Data collection

A team set up receiving stations in Arniston (Western Cape) and Durban to record meteor trail reflections from links to Pretoria (to compare links of different distances). Essential characteristics (including amplitude samples, background noise and start time) of some millions of reflections were eventually recorded and stored on computer disks. (This data forms the basis of several projects/papers.)
The data had to be ‘cleaned’ as occasional power surges and other sources of noise had corrupted some recordings. Recordings with clearly contradictory data were tagged as ‘unreasonable’ and this ‘noise’ was separated out.

18.2.5 Method

The first step was to transform the recordings into a form a human could deal with. A computer program was devised to graphically display time, amplitude and background noise.

A computer expert system was then designed where human experts could interact with the computer to define various classification rules to distinguish amongst different ‘shapes’ of trail reflections. These rules were based on ‘feature-detection’ computer routines (such as fitting lines and parabolas). An initial base of two rules (one to detect underdense trails, the other a ‘don’t know’ category) was used. The experts viewed all trail reflections in each classification separately. Anomalies and sub-families were detected, with existing rules being fine-tuned to remove anomalies and new rules introduced to make new categories for the sub-families. All trails were then reclassified according to the new rules, and the process repeated.

18.2.6 Results

The approach described above took several months before there was agreement that no significant subfamilies existed in any category, and that there were no outstanding anomalies. Twenty-seven distinct types of meteor trail reflections were identified, a far more detailed classification than had been previously achieved.

The reliability of the results was tested by running the classification system on a control group of trail reflections that had not been used in the classification process, including trails that had been recorded over other MBC links. The discovery that these trail reflections had similar proportions of the various categories, and that there were no visible anomalies, lent strong support to the hypothesis that these 27 categories did constitute a general classification system for meteor trail reflections.

18.2.7 The write-up

The results of the classification research were submitted to the journal Transactions of the SAIEE in September 1988, and published in the September 1989 issue. The title of the article was ‘The Classification of Meteor Trail Reflections by a Rule-Based
18.3 THE BENEFITS OF RE-SCREENING FOR DISEASES DURING PREGNANCY

18.3.1 The research problem

A pregnant woman’s first visit to a clinic is a major event. She is given a comprehensive medical check-up that includes tests for specific diseases that affect the mother’s health, that complicate the pregnancy, or that affect the health of the unborn child. This process is called screening.

For some of the diseases, action can be taken if they are detected in time. Another potential problem is the human immunodeficiency virus (HIV) which eventually causes AIDS. Though HIV/AIDS is at present uncurable, it is known that certain drugs may stop the transmission of the virus from the mother to the child (see NRF00). Hence, if the presence of the virus is detected, action can be taken to protect the unborn child.

However, some of these problems may develop only later in the pregnancy and thus not be detected at the initial screening. For example, there is a window of several months from the time of infection with the HIV virus until the time that it is detectable, or infection may occur after the first visit. So further visits during the pregnancy are desirable. This is known as re-screening.

In South Africa, re-screening is not always possible or affordable and consequently many mothers are not re-screened. The researchers set out to see what the potential benefits would be of re-screening mothers. This was motivated by the knowledge that certain infections are common in South Africa. Specifically they looked at the incidence of the sexually transmitted infections syphilis and HIV, and compared the results at the initial screening and at birth.

18.3.2 The researchers

The five researchers were from the Faculty of Medicine at the University of Natal. Three were lecturers there and two were registrars (physicians studying to be specialists) at the time of the research. The latter included the principal author D.C. Qolohle. The research required knowledge of several branches of medicine; thus the authors came from the departments of Obstetrics and Gynaecology, Medical Microbiology, and Virology.
18.3.3 Procedure

Having settled on the research question, the researchers designed the research. They chose a case-study approach. A random sample of mothers coming to be screened was selected and informed consent was obtained for serological testing (in which body fluids are analysed for components of the immune system such as antibodies). The test for syphilis were done on an individual basis with the results being told to the mothers-to-be and treatment administered. The test for HIV was done anonymously and only the total number of such cases was recorded.

Other information was also collected. This included the overall incidence of the infections, a comparison of the infection-rate in mothers who came to antenatal tests and those who were seen for the first time when the baby was born, and the incidence of the hepatitis B virus.

Other aspects of the design included the instruments and the data analysis tools that would be used. The researchers had to choose a serological test to use. Obviously the same test was used on all patients. For the statistics tests they chose a 5% level of significance.

18.3.4 Main results

In the initially screened group of 191 pregnant women, 13 tested positive for the HIV virus at the initial screening and 17 at the final screening. This increase of 4 yields a 95% confidence interval of 0.0–4.4. (The confidence intervals are explicitly given in the text of the journal article.) This 2.2% increase is claimed to be strong grounds for re-screening.

For syphilis, the overall infection rate was around 9.3%. Of the 329 women who were screened initially but found to be negative, 9 were found to be positive at delivery. This is 2.7%. The researchers obtained a 7.7% prevalence of HIV-positive women (95% confidence interval: 5.1–10.3). This was contrasted with previous studies of the KwaZulu-Natal area which had found 1.6% in 1990, 2.9% in 1991, and 4.8% in 1992. The data for the study was gathered in 1993. The trend was alarming indeed (and the prevalence has continued to rise) (see NRF00).

18.3.5 Write-up

The title of the article is: ‘Serological screening for sexually transmitted infections in pregnancy: is there any value in re-screening for HIV and syphilis at the time of
delivery?’

The paper starts with a brief abstract which is a series of short paragraphs under the headings Objective, Setting, Method, Results and Conclusion. Apart from the description of the actual data collected, there is also a discussion of related work both in South Africa and worldwide. Some of the patterns in the data seem strange to the authors and they point this out and suggest that further research is needed. The paper concludes with an acknowledgement of the financial support of the Medical Research Council.

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