Utilisation of Research in South Africa's Research Institutes

Leisl Joanne Bowers

Thesis presented in partial fulfilment of the requirements for the degree of Master of Philosophy at the University of Stellenbosch

Supervisor: Prof. Johann Mouton

University of Stellenbosch

December 2004

Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Leisl Joanne Bowers

24 November 2004

Abstract

The overarching aim of this study is to analyse what researchers in South African higher education institutes and science councils mean by the term 'utilisation'. In specific terms, this aim is interpreted as determining what researchers mean when they indicate that their research findings are being utilised. The data used to conduct this analysis is taken from a national survey conducted to establish the extent to which research findings in South Africa are utilised. The Centre for Interdisciplinary Studies – now called the Centre for Research on Science and Technology – conducted the survey for the National Advisory Committee on Innovation (NACI). This study for NACI involved a questionnaire survey of research being conducted with universities, technikons and science councils, and a telephone survey of a sample of research and development managers in 116 companies. As a researcher in the Centre, I played an active role in this two-fold survey component of the research process. Besides coding the questionnaire for the NACI survey, for the purposes of my study I did additional coding of the questionnaire data. This involved coding 1052 responses to an open-ended question using a software package. After exporting this data to Microsoft Excel, I further coded the data into one of three categories: Mode 1, Mode 2 and a combination of Mode 1 and Mode 2. This 'new variable' created, formed part of the quantitative analysis since it was correlated with the following variables: the 'trigger' or 'driver' behind the research; the expected outcome of the project or study; the scientific field of the project; the project's or the study's science culture; the source of funding of the study, the modes of dissemination of the results and the intended beneficiary(ies) of the research.

Results of the qualitative analyses reveal a profile for projects exhibiting features of Mode 1, Mode 2 or a combination of Mode 1 and Mode 2 knowledge utilisation. With Mode 1 we see that research was likely to be utilised within the discipline, was conducted for the benefit of the researcher's peers and it expanded on existing knowledge – all indicating that Mode 1 knowledge utilisation is predominantly associated with fundamental research. With Mode 2 we see that research was produced primarily for its use value and included the user's interests – indicating that Mode 2 knowledge utilisation is predominantly applied, commissioned and/or strategic.

Projects that exhibited both features of Mode 1 and Mode 2 were both indicative of fundamental and applied research. Besides the quantitative analyses also showing the same result mentioned above, it was also discovered that the majority of the projects exhibited features of Mode 2, with one third of the projects exhibiting features of Mode 1 and a small proportion of projects as comprising both modes of utilisation. This was a very interesting finding because it is no longer just speculation that a shift is occurring to more applied, strategic research. The analysis revealed that this shift is a reality. The correlations of mode of utility with the seven other variables produced a range of results that expanded on the features of Mode 1 and Mode 2 type of knowledge production and verified that each mode had qualities unique to itself.

My recommendations to researchers in South African research institutes concerns conducting the type of research which will be more relevant to the needs of South African society at large. To funding bodies and programmes of South Africa, the suggestion is to become more informed about the dissemination and intended utilisation strategies that they fund.

Opsomming

Die doel van hierdie studie is om 'n analise te doen van die begrip "navorsingsbenutting", soos verstaan deur navorsers binne die publieke Suid Afrikaanse navorsing- en ontwikkelingsektor. Data wat verkry is van 'n landswye ondersoek na die aanwending van navorsingsuitsette binne die publieke sektor, soos onderneem deur die Sentrum vir Interdissiplinêre Studies, is geanaliseer. As 'n lid van die navorsingspan wat die studie onderneem het, was ek aktief betrokke by die proses wat onder meer 'n vraelys-ondersoek ingesluit het na navorsingsprojekte wat in swang is aan S.A. universiteite, tegnikons en wetenskapsrade. Vir die doel van die studie het ek 1052 response wat die resultaat was van 'n oop vraag in die vraelys in drie kategorieë gekodeer naamlik Modus 1, Modus 2 asook Modus 3, 'n kombinasie-kategorie met die benaming "modus van aanwending".

Die kwalitatiewe analise het getoon dat in die geval van modus 1, die navorsing mees waarskynlik binne die dissipline en tot die voordeel van die navorser se eweknieë aangewend sal word en dat dit in die meeste gevalle 'n uitbreiding van bestaande kennis behels – 'n aanduiding dat modus 1 navorsing hoofsaaklik verbind kan word met fundamentele navorsing. In die geval van modus 2 blyk dit dat navorsing primêr berus op die utiliteit- of aanwendingswaarde daarvan. Dit vertoon 'n noue verband met die gebruiker se behoefte of belangstelling en is hoofsaaklik toegepaste, kontrak of strategiese navorsing. Projekte wat aspekte van beide modi 1 en 2 vertoon, het tegelykertyd gedui op fundamentele en toegepaste navorsing.

Die kwantitatiewe analise het aangedui dat die meerderheid projekte eienskappe van modus 2 vertoon het, met 'n derde van die projekte wat eienskappe van modus 1 vertoon het. 'n Klein hoeveelheid projekte het aspekte van beide modi 1 en 2 vertoon. Hierdie analise het aangetoon dat 'n verkuiwing inderdaad plaasgevind het vanaf fundamentele na meer toegepaste en strategiese navorsing. Die korrelasie van die modus van aanwending met sewe ander veranderlikes, het 'n reeks resultate tot gevolg gehad wat die eienskappe van modi 1 en 2 verder uitgebrei het. Dit het ook bygedra tot die bevestiging van die spesifieke eienskap van elke modus en unieke aspekte van elke modus aangetoon.

Aanbevelings word ten slotte gedoen met die oog op 'n keuse vir meer relevante navorsing binne die publieke sektor gemeet aan die kriteria van die navorsingsbehoeftes van die breër Suid Afrikaanse gemeenskap. Aanbevelings m.b.t. disseminasie en navorsingsaanwendingstrategieë van navorsing wat deur befondsingsliggame befonds word, word ook gemaak.

Acknowledgements

I wish to extend my profound gratitude to the following people who contributed towards the completion of my thesis: my parents and brothers for their support and encouragement over the years; my one and only sister, Simone, for always being there when I needed any form of help; Professor Johann Mouton for his supervision and for all the training and experience that I received over the past three years in the Centre for Research on Science and Technology; Nelius for his advice and insights with regard to the statistical analysis of the thesis; my friends, especially Darryn, for his support when I wrote this paper; Marthie van Niekerk for her assistance in the practicalities of putting my thesis together; and most importantly, Our Heavenly Father, for giving me the strength to persevere.

For my parents

Table of Contents

List of Tables

List of Figures

ACRONYMS	
ADARG	Alcohol and Drug Abuse Research Group
ARC	Agricultural Research Council
CENIS	Centre for Interdisciplinary Studies
CETT	Contingency Effectiveness model of Technology Transfer
CHAID	Chi-squared Automatic Interaction Detector
CREST	Centre for Research on Science and Technology
CSIR	Council for Scientific and Industrial Research
DIT	Durban Institute of Technology
HDI	Historically Disadvantaged Institution
KZN	Kwa-Zulu Natal
LPCAT	Learning Potential Computerised Adaptive Test
MINTEK	Mineral Technology Council
MRC	Medical Research Council
NACI	National Advisory Council on Innovation
NRDS	National Research and Development Strategy
NRF	National Research Foundation
NSI	National System of Innovation
R&D	Research and Development
S&T	Science and Technology
SAMSA	South African Maritime Association
SANDF	South African National Defence Force
SANPAD	South Africa Netherlands Research Programme on Alternatives in Development
SANRDS	South Africa's National Research and Development Strategy
SASOL	
SIMRAC	Safety in Mines Research Advisory Committee
SIRC	Seafarer International Research Centre
TETA	Transport, Education and Training Authority
THRIP	Technology and Human Resources for Industry Programme
UNISA	University of South Africa
WfW	Work for Water

Chapter 1
Introduction

1.   Background to the study

1.1   The 'Old' South African Research versus the 'New' South African Research

In South Africa's National Research and Development Strategy (SANRDS 2002:19), it is reported: "Between 1990 and 1994, the strong missions for technology developed by the National Party government (e.g. military dominance in the subcontinent, energy self-sufficiency, etc.) were systematically reduced, with the result that the percentage of the South African gross national product spent on research and development declined from 1,1% in 1990 to its current level of about 0,7%". By 1994 the areas of high investment that sustained critical mass were gone and what remained was the basic platform of competence in manufacturing technology, agriculture, mining and minerals research and fundamental sciences at the universities. Since the abolishment of Apartheid, there has been evidence that "...the private sector, with the exception of SASOL and some innovative small firms, is disinvesting from research and development (R&D) at an alarming rate" (SANRDS 2002:19).

Under the post-1994 rule, areas of national spending has been reduced in certain areas and increased in other areas, with the overall aim of developing a future for all South Africans and not just for a single minority group. At the same time as the government was making these changes, other changes were occurring in the private sector that had a detrimental effect on the country's R&D investment. To address issues such as these, the White Paper on Science and Technology was formulated and adopted in 1996.

1.2   The White Paper on Science and Technology

The White Paper on Science and Technology adopted the National System of Innovation (NSI) as a policy framework for science and technology (S&T) in South Africa and the South African Cabinet approved this policy in 1996. The adoption of the policy was in recognition of the move away from a "science push" framework to an

1

"innovation pull" model – a policy that had already been developed by the Organisation for Economic Cooperation and Development, and within industrialised nations of the world (SANRDS 2002:19).

The new S&T strategies have been embedded within the NSI. The following quote clearly expresses the objective the government believes this System will achieve:

> In such a System, institutions such as universities, technikons, science councils, private sector research laboratories and market intelligence divisions would cooperate in a nationally optimal way towards solving problems, whether these occur in industry, agriculture, defence or basic research. (Minister of Arts, Culture, Science and Technology – White Paper on Science and Technology, September 1996.)

Thus, with the NSI, the government intended to encourage interaction and cooperation between different sectors of the country with the aim of addressing national problems, with emphasis being placed on research being directed by industry, agriculture, defence, etc. and not directed by research institutes.

1.3   A 'social contract'

S&T policies – also in South Africa – articulate and attempt to shape a particular relationship between the state and scientific institutions. The above introduction shows how the South African government – through its White Paper on S&T and the NRDS – are trying to shape and steer scientific institutions within the national system of innovation in the direction of meeting new national goals. They are, in fact, attempting to form a new 'social contract' between the South African state and the new South African society.

In a recent article by Ben Martin (2003), entitled: *The changing social contract for science and the evolution of the university*, he outlines the history of the changing relationship between university science, on the one hand, and the state/government, on the other.

Martin's history begins with the Humboldt 'social contract', which spread from Germany to many other countries in the nineteenth and twentieth centuries. It was based on the

assumption that research and teaching had to be conducted within the same institution and governments would provide general institutional funding for both teaching and research, leaving the university free to determine the allocation of resources across disciplines. Similarly, academics were free to engage in research and were free to choose their research topics (Martin, 2003).

More recently we saw, the dominance of a new 'social contract' – which lasted from about 1945 to the end of the 1980s. This contract, initiated by the work of Vannevar Bush, stated that if government funded basic research, the results would be benefits in terms of wealth, health, and national security – a type of a "science push" model of innovation (Martin, 2003:9). However, it was not predictable when or what forms these benefits would assume. This implied a high level of autonomy for science; that decisions on which areas of science should be funded should be left to scientists.

At the end of the 1980s another shift occurred when governments were faced with increasing competition and tighter financial constraints and thus expected that, in return for public funds, scientists and universities should address the needs of the "user" in the economy and society (Martin, 2003:12). Martin (2003) refers in this regard to another formulation of this shift – i.e. as a shift in knowledge production from Mode 1 to Mode 2, as explained by Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow in their 1994 publication entitled: *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. The argument of Gibbons *et al.* is that Mode 1 involves the production of new knowledge primarily within individual disciplines and academic institutions, e.g. universities. Since societal accountability in this mode is limited, it follows that scientists are able to choose the problems on which to work. Mode 2 involves transdisciplinary research, where knowledge is produced with the users' needs having a direct influence early in the research process, where research is carried out at an increasing number of institutions and where the boundaries between traditional sectors and between science and society are indistinguishable (Martin 2003). (Both modes will be explained in greater detail in Chapter 4). Although the implication is that Mode 2 is new, Gibbons *et al.* fall short of presenting much evidence to support this (Weingart 1997; Martin 2003).

Martin (2003:13) argues that it is better to characterise this as "...a shift in the balance between the already existing forms of Mode 1 and Mode 2 ... [author's comment: and towards the end of the 20th century] we may merely be returning to a balance between the two modes exhibited in earlier eras". In other words, Martin presents an argument that looks at a longer-term historical perspective that shows that this 'new' social contract is actually "...a shift back towards a social contract closer to the one in effect for much of the period before the second half of the 20th century" (Martin 2003:7). In explaining the aforementioned argument, Martin (2003) says that after World War II, although Mode 1 was the more prominent form of knowledge production in most universities there was still much Mode 2 knowledge production taking place. Research was still closely linked to meeting the needs of society in the defence, energy, agriculture, health and space sectors and was conducted in different "varieties" and "species" of universities, including "technical universities", institutes of science and technology, technical "high schools", etc. (Martin 2003:14-15).

Johnston *et al.* (1993, in Martin, 2003) and Schimank and Winnes (2000, cited in Martin, 2003) report that for many, an essential feature of universities is that they must combine teaching and research; however, this does not always. Evidence shows that it is justifiable and 'dangerous' not to combine teaching and learning. However, there are a number of counterexamples of leading research-only institutions (e.g. Max Planck institutes) and of leading teaching only institutes (e.g. the United States 'liberal arts' colleges), thus showing that it is not essential that undergraduate scientific research should always be combined in higher education institutions or that good quality undergraduate teaching does not depend on the existence of research (Martin 2003:17-18).

Under the revised social contract a third function of the university – contributing to the economy – has become more prominent than the two traditional functions of teaching and research. The academic ideology regarding this third function is that it may "...damage both teaching – through an overemphasis on short-term specific skill needs as opposed to a broader education – and also research – because of an overemphasis on short-term applied research to the detriment of long-term basic research" (Martin 2003:18). There is little convincing historical evidence that an emphasis on helping to meet the needs of society and the economy necessarily results in adverse long-term

consequences for universities or scientific communities. Also, it is not just in the 20th century that the three functions have coexisted within universities. Etzkowitz (1997, cited in Martin, 2003) explains that towards the end of the 19th century the third function was even more pronounced than it is today.

Martin (2003) concludes with a number of significant points regarding the current social contract. First, since 1990, science and universities have become more closely linked to societal needs as was the prevailing situation in the late 19th century. Second, while there may be more Mode 2 research today than during the period from 1945 to the late 1980s, the level is not necessarily greater than a century earlier. A third point is that the social contract for science is changing, but once again, only compared with the period from 1945 to the late 1980s. Fourthly, in response to the question as to whether universities, in their current form within the current social contract, are under threat from new entrants – it is evident that universities have managed to adapt to the changing environment and thus either survive or take on new or modified forms. A fifth point is that there is not a great threat to the separation of research and teaching in universities, since most universities might remain multifunctional, some may focus primarily on undergraduate education, others more on the third function of the university, and thereby becoming entrepreneurial universities. An important factor is the decreasing time lag between the creation and use of knowledge which may result in the combining of "classical and technical" universities into "entrepreneurial universities" where the "...functions of knowledge creation, knowledge transfer and knowledge exploitation – that is, the integration of the three functions of teaching, research and contributing to the economy" are combined (Martin 2003:24). The last point is that the university will become more central in the knowledge society as the economy and society become more reliant on knowledge, and will become responsible for generating not only intellectual but also economic and social capital.

The social contract puts in perspective the road that South Africa should be travelling towards attaining its national goals. The new contract also demonstrates the important roles that the government, research institutes – including universities and technikons – play within the economy and society in meeting the new national goals. Most importantly, the new contract emphasises the differential roles that Mode 1 and Mode 2 knowledge production play under such a framework.

1.4   Closing the 'innovation chasm'

The National Research and Development Strategy for South Africa identified a number of critical factors. One of these, which are of particular relevance to research findings and my study, is that a gap exists between the producers of knowledge and the users of that knowledge (SANDRS 2002:35). As early as the 1970s this gap was referred to by Weiss (1977) as the great divide and by Caplan (1979) as the two-communities gap.

It is therefore not surprising that the National Advisory Council on Innovation (NACI) decided in 2002 to conduct a national survey to establish the extent to which research findings in South Africa are utilised as well as the key influencing factors and dynamics involved in the process, so that evidence-based strategies may be developed to increase the utilisation of research findings. Research on similar topics has been done in developed countries such as the United States of America, Canada and the United Kingdom. However, no comparable study has yet been conducted in South Africa.

Centre for Interdisciplinary Studies (CENIS) – now Centre for Research on Science and Technology (CREST) – was contracted to conduct two studies: a questionnaire survey of research conducted within universities, technikons and science councils; and a telephone survey of a sample of R&D managers in 116 companies. As a researcher at CENIS (CREST), I took an active part in both components of the process. With the telephone survey component my work was primarily administrative. With the questionnaire survey component, I started at the beginning. This involved editing the survey questionnaire, collecting the email addresses of the sampling frame, and continuing with editing the survey data and coding the open-ended survey questions on utilisation.

Over and above the coding of the questionnaire for the NACI survey, I did additional coding of the questionnaire data for the purposes of this study. I elaborate on these issues in the following sections.

2.   Main aim of the study

The main aim of this thesis was to conduct a finer and more in-depth analysis of what researchers in South African higher education institutes and science councils mean by the term 'utilisation'. More specifically, the aim was to determine what researchers mean when they indicate that their research findings are being utilised. Was their utilisation predominantly indicative of Mode 1, Mode 2, or a combination of both modes? This was to be achieved by analysing, in conjunction with other questions, Question 23 of the questionnaire, which read *Please describe how the research has been utilised/implemented/applied by the intended beneficiaries. (Give concrete examples).* The more detailed analyses of the responses to this question were subsequently correlated with a range of other responses to questions in the survey. These included:

- Research motive of the study
- Expected outcome or value of the research project
- Scientific field of the research
- The project's or the study's science culture
- Source of funding
- Intended beneficiary(ies) of the research, and
- Modes of disseminating the research findings.

3.   Procedure followed

The NACI study comprised two main components: A questionnaire survey of research being conducted with universities, technikons and science councils, and a telephone survey of a sample of R&D managers in 116 companies. In this section I will focus on the questionnaire component, as the data generated here is applicable to my 'finer-analysis'.

Approximately 8000 questionnaires were distributed to university and technikon researchers, with a further 2859 sent to science councils. To ensure that utilisation of research findings or results would have materialised by the time the survey was conducted (in October 2002) it was decided to focus on completed projects (projects started between 1997 and 1998). Respondents were asked to report on either stand-alone research or a project within a longer-term research programme. The respondent had to be the primary/principal investigator or project leader on the project. The total

7

number of 2058 completed questionnaires constituted a response rate of approximately 20%.

Utilising a multivariate exploratory technique – Chi-squared Automatic Interaction Detector (CHAID) – we subsequently investigated which of the various project-related features listed on the previous page, correlated most strongly with the expected effective utilisation of the project. The analyses revealed different patterns for the science council and higher education sectors.

4.   Thesis outline

Chapter 2 presents the literature reviewed for the study. Three main sections are included: A discussion of the term 'utilisation' (including the interchangeable terms and distinctions of utilisation); a discussion of models of knowledge utilisation and the presentation of a 'Network' model – which promotes effective knowledge utilisation. This 'Network' model was already suggested in the final synthesis report on the NACI utilisation study by Mouton and Bailey (2002) and is based on the combination of two of the models proposed by Landry *et al.* (2001): the dissemination model and the interaction model.

The research design and methodology that was followed in conducting this study are discussed in Chapter 3. The survey design is described in detail and the questionnaire is examined. The development of the sampling frame described and the method of coding the data are also described. Problems encountered during the collection of the data are also discussed.

Chapter 4 is devoted to a discussion of what researchers mean when referring to 'research utilisation'. The chapter begins with a brief outline of the notions of 'Mode 1' and 'Mode 2' knowledge utilisation as put forward by Gibbons *et al.* (1994). In the second section of this chapter I apply the distinctions between Mode 1 and Mode 2 forms of utilisation to the responses to Question 23. This qualitative analysis reveals the very rich detail and wide range of meanings attributed to research utilisation, also across a large variety of scientific fields.

In Chapter 5, we return to the structured responses of the survey. However, in this analysis, I correlate the newly post-coded classifications of modes of research utilisation with a number of standard variables:

- The project leader's key motive or motives that 'drove' the research projects being described
- The principal investigator's identification of the expected outcome or value of the research that he or she was engaged in
- The scientific field in which the project fell
- The source of funding as reported by the project leader
- The method of dissemination as indicated by the respondent
- The respondent's indication of whom the main intended beneficiaries of the research were (more than one option could be selected).

The main results of the research findings are discussed in Chapter 6. With the statistical analysis of the projects that were recoded into Mode 1, Mode 2 and a combination of Modes 1 and 2, a majority of projects were found to exhibit features of Mode 2; one third of projects exhibited features of Mode 1 type of utilisation and a small proportion of projects comprised both modes of utilisation. Cross-tabulating the newly created 'mode of utilisation' variable with variables relating to research motive and expected outcome or value of the project, it was found that projects identified by the researcher as typical of fundamental research portrayed features of Mode 1 and projects identified by the researcher as typical of applied research exhibited Mode 2 features. It was also found that the modes of knowledge production and modes of utilisation varied by scientific field, source of funding, who the intended beneficiaries were and by whom the dissemination of the results was driven. Lastly, recommendations are proposed based on the conclusions drawn.

Chapter 2
Literature Review

1.   Introduction

To determine what South African researchers mean by the term 'utilisation', I commence with a discussion of this term. This discussion will include some of the different uses of the term of 'utilisation' and distinctions between different types of utilisation. The third section of this chapter can be subdivided into two parts, the first of which will cover five models of research utilisation, whereas the second part is devoted to a discussion of the Interaction and Dissemination model of Réjean Landry, Nabil Amara and Moktar Lamari (2001). In the final section of the chapter, a combination of the models proposed by Landry *et al.* (2001), the Dissemination model and the Interaction model, are integrated and discussed under the heading of the 'Network' model of knowledge utilisation.

2.   The term 'utilisation'

What does one mean when one speaks about the 'utilisation' of research? When can one claim with some confidence that research has been utilised? Can one argue that if someone undertakes research and the results from such research are used in other research studies or projects or put into action in solving problems that the research has been utilised? Does utilisation occur immediately or only after some time has elapsed? Does utilisation occur all at once or is it a gradual process? Does utilisation include understanding of the knowledge or is direct application necessary?

On closer inspection of these questions it is clear that the terms 'utilised' and 'used' are used interchangeably. Reviewing the literature on the topic of research utilisation, I have found little consensus on the definition of these terms. As Dunn (1983:121) states: "The variability of competing conceptions seems virtually endless". Weiss (1977 & 1979, cited in Lester & Wilds, 1990), also points out that sometimes the literature fails to adequately define what is meant by the term (utilisation).

In an attempt to obtain some clarity, I will first discuss some of the interchangeable uses of the term and thereafter some of the distinctions made in debates about research utilisation will be discussed.

2.1 The interchangeable usage of the term 'utilisation'

Various terms are found in the literature on research or knowledge utilisation, including words such as 'uptake', 'adoption', 'diffusion', 'innovation adoption', or 'impact'.

Arie Rip (2002:3), when referring to strategic research and its "uptake", explains that: "...a distance is created between ongoing research and the eventual uptake of its results by emphasising expectations, the production of a "...base of knowledge, and the provision of a background to problem solving rather than offering solutions".

Beyer and Trice (1982:597) define "adoption" as occurring when "...decision makers in user systems use research results or prescriptions derived from them to decide what to do".

Hall, Loucks, Newlove and Rutherford (1975:52) define "innovation adoption" as a "...process rather than a decision-point – a process that each innovation user experiences individually".

According to Patton, Grimes, Guthrie, Brennan, French, and Blyth (1977, cited in Booth, 1990:81) research "impact" is the "...immediate and concrete effect on specific decisions and program activities resulting directly from evaluative research findings".

Knott and Wildavsky (1980:542) mention that some use social engineering theory to define "utilisation" as "...the immediate and direct impact of a major research project on a policy", while others use Weiss's enlightenment theory to define utilisation as having more to do with a "...long-term process in which the accumulated results of research over time enlighten policy".

Beyer and Trice (1982: 597) define "use" as occurring when "...members of user systems act to implement decisions based on research results and prescriptions".

Booth (1990:81) defines "utilisation" as "...the direct application of research to a pending decision in such a way that it makes a difference to what happens".

Huberman (1994:21) defines "use" as the "...levels of understanding, knowledge and/or of everyday practice that have been affected – or not, depending on the valence on the variable in question".

From the above definitions alone, one can see that there are a wide variety of terms associated with 'utilisation' and with an equivalent assortment of definitions. It is also clear, from these definitions, that there are more than just terminological differences at work here. The definitions as put forward by Rip (2002), Hall *et al.* (1975), Beyer and Trice (1982) and Booth (1990) refer to something other than the definitions presented by Knott and Wildavsky (1980), Patton *et al.* (1977, cited in Booth, 1990) and Huberman (1994). In the former set of definitions, terms such as 'uptake', 'adoption', 'implementation' and 'application' all refer to some 'action' or 'decision' taken by the user, i.e. that someone must take-up, adopt, implement or apply the findings of research as part of the process of utilisation. On the other hand, the latter set of definitions, which include terms such as 'impact' and 'effect', refer specifically to the effects or outcomes of such utilisation and the possible benefits or significance to those who do use research.

In this study, for simplification, the only two terms that will be used are 'utilised' and 'used' and variations thereof.

2.2   Forms of 'utilisation'

There are different forms of 'utilisation'. For example, research can have 'epistemic utility' or 'non-epistemic utility'; research utilisation can be 'direct' and 'unmediated' or it can be 'indirect' and 'mediated' by certain actors. In this section, these different forms of utilisation will be defined and discussed.

Based on a literature review conducted by Mouton and Bailey (2002:5), a distinction is made between "epistemic forms of utilisation" and "non-epistemic forms of utilisation". Epistemic or knowledge-related forms of utilisation of science refer to, for example, instances where other scientists use a scientist's findings to inform his/her own

research (Mouton & Bailey, 2002). Non-epistemic forms of utilisation refer to any non-knowledge use to which scientific research is put, e.g. in instances where research leads to economic growth, commercial gain, social utility or political value/benefit.

Mouton and Bailey (2002) also argue that research utilisation can be understood as being either direct or immediate or indirect or mediated. Direct or immediate use implies that research is used immediately, such as when research leads to the development of a new model, process or technology or to inform decision-making. In such cases there is a direct link between the dissemination of the research findings and resulting decisions or applications. Indirect or mediated use of research implies that research is disseminated in various ways, but the research results are not taken up immediately and might remain un-used for some time, until much later when applied or used.

Another distinction found in the literature is between conceptual and instrumental use of research. In a study done by Caplan, Morrison and Stambaugh (1975, cited in Caplan, 1979) interviews were conducted with 204 top-level executives in positions to influence policy regarding their use of social science knowledge in matters relating to policy. In this study, instrumental use (about 90% of the cases reported by respondents) is "…associated with the day-to-day policy issues of limited significance … and possibly as many as one-half of these applications involved administrative policy issues pertaining to bureaucratic management and efficiency rather than substantive public policy issues" (Caplan, 1979:462). Thus, research results used by these executives were used to make decisions that were considered to be at a 'micro-level'. It was also found that three-quarters of this research was commissioned under contract by the users or produced by the staff of the users, and that the users ordered the research for a particular purpose (Caplan, 1979).

From this same study, Caplan *et al.* (1975, cited in Caplan, 1979:464) defined conceptual use (about 10% of the cases reported by respondents) as involving "…important policy matters which affect the nation as a whole". On this level, "…scientific (hard) and extra-scientific (soft) knowledge … [are] combined conceptually" to deal with problems at a "macro-level" to "meta-level" (Caplan, 1979:463-464). In the examples given by the respondents in this study it was clear

13

that when dealing with matters of national importance decisions taken by government were attributed to research produced by the social sciences. However, the respondents were rarely able to cite specific sources of knowledge, especially since the source could be anything other than governmental sources, ranging from professional journals to the radio (Caplan, 1979).

Caplan *et al.* (1975, cited in Caplan 1979) define 'use' or 'utilisation' in the social sciences as occurring when the user is familiar with relevant research and attempts to apply that research to some relevant issue. Weiss (1977) argues that the usefulness of social science research to policy makers is determined by whether or not the research makes an intrinsic contribution to the work of an agency and whether or not officials say they would be likely to take that research into account in decision making. Regarding the use of research in policy making, Booth (1990:81) defines utilisation as the "...direct application of research to a pending decision in such a way that it makes a difference to what happens".

Pelz (1978, cited in Beyer and Trice, 1982:598) distinguishes between three types of use: "instrumental use" which involves using research results in "specific direct ways"; "conceptual use" which involves using research results for "general enlightenment" and though the results do influence actions, this occurs in less specific and direct ways than in instrumental use; and "symbolic use" involves "...using research results to legitimate and sustain predetermined positions".

In the same vein we find Weiss refers to the idea of "knowledge creep". Weiss (1980:381) aptly describes the process whereby research influences policy as it provides "...a background of empirical generalizations and ideas that *creep* into policy deliberations". On social science research informing public policy, Weiss (1980) found that the instrumental use of research was a relatively rare occurrence (Beyer & Trice, 1982) though research studies assume that when policy makers use research, it is done in instrumental ways (Booth, 1990). Conceptual use and the idea of indirect use, on the other hand, are central to Weiss' 'Enlightenment model' of research, and she argues that conceptual use is more common than instrumental use (Weiss, 1991). The enlightenment model refers to the way research knowledge enters the 'policy arena':

...it is not the findings of a single study nor even of a body of related studies that directly affect policy. Rather it is the concepts and theoretical perspectives that social science research has engendered that permeate the policy-making process (Weiss, 1979:429).

Weiss specifically uses the word 'enlightenment' since:

The imagery is that of social science generalisations and orientations percolating through informed publics and coming to shape the way in which people think about social issues. Social science research diffuses circuitously through manifold channels – professional journals, the mass media, conversations with colleagues – and over time the variables it deals with and the generalisations it offers provide decision makers with ways of making sense out of a complex world (Weiss, 1979:429).

Thus, because of the way research knowledge enlightens or broadens the existing knowledge base and over time reshapes the way in which people think, rarely will policy makers be able to cite the findings of a specific study that influenced their decisions (Weiss, 1979).

Beyer and Trice (1982) define instrumental use in terms of immediate use, where there is a definite link between the product of research and the resulting decision. This form of research utilisation could be in the form of the development or improvement of a technology, informing policy or decision-making, or in solving problems.

Landry *et al.* (2001) define instrumental use as referring to cases where knowledge induces users to make decisions that they would otherwise not have made. They define conceptual use as referring to cases where knowledge provides new ideas, theories and hypotheses that lead to new interpretations about issues and facts surrounding the decision-making contexts without inducing change in decisions.

Another important factor to note about research utilisation is that there are "intended" and "unintended" users of research (Mouton & Bailey, 2002:6). When research is disseminated, it does not imply that the scientist had necessarily targeted a specific person or group. As it stands, anyone who finds the research useful can use or apply

or adapt the research, as he or she deems necessary, which is especially true for the epistemic utility of research (Mouton & Bailey, 2002). On the other hand, often research is conducted with specific users in mind, as in cases where research is commissioned or contracted to address the specific concerns or problems of a particular user-group.

The distinctions discussed above are combined and highlighted in Table 2.1. This table clearly illustrates a basic principle about research utilisation, viz. the direct relationship between modes of knowledge production and knowledge utilisation. The presentation of the different conceptual distinctions should be regarded as a continuum and should not be interpreted as boxes into which research utilisation should fit regarding users or uses. At the one end of the continuum, research utilisation is immediate, and at the other end, research slowly infiltrates knowledge and other social systems in complex ways. As stated by Mouton and Bailey (2002:7): "The transfer of sophisticated technologies from the producer to the ultimate end-user is a complex process which involves overcoming many obstacles (financial, legal, social, cultural, institutional) as well as the involvement of multiple stakeholders".

Table 2. 1   Conceptual distinctions of 'utilisation'

		Epistemic utility	**Non-epistemic utility**
Direct or immediate utilisation	Intended users	Applied research	Technological development, project development, commissioned research
	Unintended users	Basic fundamental research ('blue sky') Immediate scientific uptake	Immediate social and political uptake, e.g. Gibbons *et al.* (1994) thesis's uptake in SA higher education policy documents
Indirect or mediated use	Intended users		Technology imitation
	Unintended users	Basic strategic research: Medium- to long-term scientific uptake	Knowledge creep: Diffusion into society/economy

3.   Models of knowledge utilisation

Another issue that is pertinent to this study concerns the specific dynamics of the utilisation process. How does research utilisation occur and what are the key variables in this process? To answer this question, I will discuss five prominent models of knowledge utilisation that have been put forward over the past three decades. Following this overview, I will then focus on a recent discussion (the Interaction and Dissemination model) by Landry *et al.* (2001) in which they present an interesting meta-framework for understanding different models of research utilisation. The five models of knowledge utilisation are:

- The Two-Communities theory of Norman Caplan (1979).
- The three models of policy research of Carol Weiss (1991), where she identifies policy as influenced by three forms of research: (1) research as data (2) research as ideas and (3) research as argumentation.
- The Triple Helix model of Henry Etzkowitz and Loet Leydesdorff (1996).
- The three policy paradigms of Barry Bozeman (1994), where he shows how debates about technology transfer in the United States are tied directly to technology policy debates and paradigms. He distinguishes between three such paradigms (the market failure paradigm, the mission paradigm and the cooperative technology paradigm) and shows how the notion of 'technology transfer' means different things in each.
- The Contingency Effectiveness model of Technology Transfer (CETT) of Barry Bozeman (2000).

3.1   The 'Two-Communities' theory

Although the 1970s and 1980s witnessed a remarkable surge in the volume of policy analysis, according to Webber (1987) governmental decision makers were not making much use of such research. Weiss argues: "...knowledge, at least the sub-category of knowledge that derives from systematic research and analysis, is not "utilised" in direct and instrumental fashion in the formulation of policy. Instead, research knowledge usually affects the development and modification of policy in diffuse ways" (Weiss, 1980:381).

The Two-Communities theory is associated with the work of Caplan (1979). He explains the non-utilisation of policy research in terms of the relationship between the

policy maker and the policy-making system. According to Booth (1988, cited in Neilson, 2001:4), the Two Communities hypothesis explains "...the under-utilisation of research by depicting social scientists and policy makers as living in separate worlds. The differences make for wide divergences in expectations, in perceptions of mutual impact as well as difficulties in achieving satisfactory and constructive relationships". Authors who hold this view argue, "...social scientists and policy makers live in separate worlds with different and often conflicting values, different reward systems and different languages. The social scientist is concerned with "pure" science and esoteric issues. By contrast, government policy-makers are action-orientated, practical persons, concerned with obvious and immediate issues" (Caplan, 1979:459).

According to Booth (1988, cited in Neilson 2001:5), the rift between social scientists and policy makers with respect to the differences in their epistemological frameworks has been explained by the Two Communities theory, where: "...[t]he inclination for scholars to see knowledge as deriving from theory and method is mirrored by an inclination among policymakers to see knowledge as coming from experience and common sense" (Booth, 1988, quoted in Nielson, 2001: 5). Booth argues that even when it comes to incentives, the two communities differ from each other:

> [the] structure of incentives within the academic community has also driven a wedge between social scientists and policymakers. These incentives attach greater weight to knowledge-building as against policy-forming research; to authoritativeness rather than usefulness; to the pursuit of rigor as against relevance; to the values of scientific independence as against the virtues of policy involvement; and to understanding rather than action (cited in Neilson, 2001: 5).

Frenk (1992:1398) agrees that this gap is the result of the differences between researchers and decision makers and he emphasises that it is due to the "...relative value each group places on excellence and relevance". Frenk (1992) argues that excellence is the rigorous observance of a series of research rules that gives objectivity to results and, as such, is emphasised by scientists because it constitutes the basis for progress within a discipline. On the other hand, relevance to decision making is the ability of research to take on problems that require solutions.

Frenk (1992) illustrates these differences between the two communities regarding their priorities, values, language, means of communication, perceptions about the nature of the end-products of research, etc., as also mentioned above by Caplan (1979), Weiss (1980), and Booth (1988, cited in Neilson 2001), with the following examples: decision makers' perceptions of problems may not coincide with those of the researchers; the researcher is mostly concerned with communicating results in a defined manner, where scientific language is esoteric and communication occurs through specialised publications. On the other hand, results for the decision maker need to be in a comprehensible language and easily accessible; and the final product for the researcher within the scientific community is usually a published article whereas for the decision-maker, research continues until it influences a decision.

The Two Communities theory originated from a study conducted in the early 1970s by Caplan *et al.* (1975, cited in Caplan, 1979). According to the theory a gap exists between social scientists and policy makers with regard to the differences in values, language, reward systems, and social and professional affiliations that are to be found in these two social groups. The theory states that it is not the policy-makers' lack of interest in social science information that leads to the lack of utilisation, rather it is the lack of interaction between social scientists and policy makers that is a major reason for non-use of the information (Caplan *et al.*, 1975, cited in Caplan, 1979). The gap can be bridged through personal relationships since the gap is seen as a "…communication failure or a lack of organised effort to systematically introduce social science knowledge in usable form into the policy-making process at the key points where it will most likely be used" (Caplan, 1979:460). However, one system or method for bridging this gap cannot be generalised to suit every problem, but is rather determined by the nature of the problem.

3.2   Weiss's three models of research

In her article *Policy research as advocacy: Pro and con*, Weiss (1991) discusses how the results of policy research enter the policy environment and influence policy decisions, by examining the influences of three forms of policy research on policy: research as data, research as ideas and research as arguments.

3.2.1 Research as data

Research as data refers to the use of research specifically for the data generated from the research. Within this category the assumption is that the user of the research is striving to do a competent job, that there is not much conflict of goals, that the researcher's data are compatible with the needs of the user and that the user has sufficient sophistication with the data to apply the data to the problem effectively (Weiss, 1991). Thus, research used in the form of data is a technocratic view in the sense that its specific use is primarily for a technical purpose. It follows that the influence of research as data on major issues is relatively infrequent except within the field of economics, where economics consistently puts data to technical use (Weiss, 1991).

Research as data is more likely to influence public policy firstly, when a situation of consensus exists concerning values and goals. Here research can pinpoint the problem and clarify the parameters of the problem (Weiss, 1991). Secondly, research as data is more likely to influence public policy when two or three alternatives are sharply posed. For example, data can be successful in determining the difference when research is designed to test a number of alternatives. Thirdly, research as data will more likely be influential in rapidly changing situations. As explained by Steinbruner (1974, cited in Weiss, 1991:3), "...when nobody knows what the situation is, data are likely to be heard, particularly if they signal that present conditions are outside the zone of acceptability"; data are more likely to be used as a backdrop than as guidance for action. Lastly, research as data will more likely be influential when decision makers are analytically sophisticated, since using research requires knowledge of research techniques to assess the quality and limitations of the data so as to ensure that the data are valid to the situation (Weiss, 1991:3).

3.2.2 Research as ideas

Examples of researchers Weiss (1991:2) cites as supportive of the statement "...it was taken for granted that what policymakers wanted was just what researchers were best qualified to supply – data, findings, research conclusions. The problem was that when social scientists went out to study the effects of research on government decisions, they found little impact" are Caplan (1977), Bulmer (1978), Alkin *et al.* (1979),

20

Deitchman (1976), Dockrell (1982), Knorr (1977), Rich (1977), Leff (1985) and Walker (1987).

The model of research as ideas does however have a more "humanistic flavour" than research as data (Weiss, 1991:3). This is because researchers' formulations of problems do not necessarily match up with the immediate needs of decision makers, and decision makers may remember selectively those ideas that they like, especially since research as ideas flows into the policy arena through a variety of uncoordinated sources. This image of users selectively recalling ideas which appeal to them depending on the policy at hand is explained clearly in the following quote of Weiss (1991:2):

> The telling characteristic of research as ideas is that the actual findings of the study have disappeared and become transmuted into a simple 'story'. Ideas are filed away higgledy-piggledy in people's minds and may emerge when new equations arise.

A user might not remember the source of a particular piece of research but the user will call on this research when needed, though not to effect 'authoritative action', but as new insight into the process, altering the way that people conceptualised issues and framed problems, and changing people's perceptions.

It is not clear how much effect research as ideas has on specific policy choices, nor is it clear how important research is as a source of ideas. However, research as ideas is more likely to be influential when, firstly, it is used at the early stages of policy discussion, i.e. before decision makers have already taken a certain position and there is no longer room for reconsideration of the issue. Secondly, research as ideas is more likely to be influential when existing policy is in disarray and all are in desperate search of a way out of the situation. Thirdly, research as ideas is more likely to be influential when uncertainty is high and, fourthly, in decentralized policy arenas, where decisions are made by many separate bodies, since a simple idea will have more success than detailed data (Weiss, 1991).

3.2.3 Research as arguments

Research as arguments takes "...an advocacy position. Not only are some of the data lost, as with research as ideas, but also the data are selectively lost" (Weiss, 1991:2). The sole purpose of selectively choosing from the findings which are to be used is to weaken the power of the argument of the opponent and to make one's own argument more persuasive; thus research as arguments will only be used if and when it advances the decision-maker's case (Weiss, 1991).

Decision-makers who use research as arguments have the advantage that it saves them time and work, since they do not have to figure out the implications of the research. Secondly, the argument relates the research explicitly to the issue(s) at hand. Lastly, with the integration of argument and evidence a watertight package exists for use in bureaucratic or legislative negotiations (Weiss, 1991).

According to Weiss (1991:3), research enters the policy arena as arguments primarily through the organised activities of partisans since the citation of research evidence often appears to be an effective tactic for gaining attention for a position, particularly when partisans try to go public with their case. Research will thus serve as evidence, give the case legitimacy and sometimes even 'heightened visibility'.

Research as arguments is more likely to influence policy making, firstly when conflict is high, since it will be used to substantiate and provide support for that side's position within the conflict situation. Secondly, research as arguments is more likely to be influential in legislatures, because in legislature, argumentation is the prevailing mode and research that supports argumentation will be welcome. Lastly, it is influential after decisions have been made, because in order to bring along the organisations and individuals, who will carry out decisions, there is an ongoing need for legitimisation, and research can help fulfil this need (Weiss, 1991).

From the above discussion we see how the results of policy research enter the policy environment and influence policy decisions through: research as data (used primarily for technical purposes); research as ideas (where the 'gist' of the study is used and the source of the study forgotten); and as argumentation (where the findings are selectively chosen to advance the decision-maker's case). We also note that Weiss

22

claims that research has a greater impact than the traditional report (as an output of a policy study) when it becomes part of advocacy for a preferred position. A similar point was suggested by the 'Two-Communities' theory, which states that for the decision maker, research continues until it influences a decision.

3.3   The Triple Helix model

A second influential model of knowledge utilisation is the so-called Triple Helix model of Etzkowitz and Leydesdorff. According to these authors, during the 1990s, nations that were newly industrialised, de-industrialised and re-industrialised were all mutually interested in promoting knowledge-based economic and social developments and subsequently formulated innovation strategies based on the deliberate elaboration of academic-industry relations through reflexive S&T policies. Etzkowitz *et al.* (1995, cited in Etzkowitz *et al.*, 1996) proposed to 'model' this afore-mentioned knowledge infrastructure of the global system as a Triple Helix of university-industry-government relations.

In the year after the university-industry-government relations was named the 'Triple Helix', a workshop was held in Amsterdam in January 1996 to discuss this three-component relationship. A comment made there by Judith Sutz of the University of Montevideo, Uruguay, summed up the situation in which educational institutions around the world find themselves:

> The increasing demand for funds from universities and research institutes gets a similar response worldwide: support yourselves! That is to say, connect yourselves with industries and the government; offer your knowledge and your capacity to generate new knowledge and charge for it. Only in this way will you be able to extend your laboratories, hire young people, and increase your salaries (Etzkowitz & Leydesdorff, 1996:282).

Etzkowitz and Leydesdorff (1996) argue that historically the systematic interaction between markets and science can be traced back to the early 19th century. Marx himself viewed it as "...a source of industrial growth, transcending simple combinations of land, labour and capital" (Marx 1953, cited in Etzkowitz & Leydesdorff, 1996:280). Etzkowitz and Leydesdorff (2001) explained the role of university-industry- government relations in knowledge utilisation using the Triple Helix model as follows:

A transformation in the functions of university, industry, and government is taking place as each institution can assume the role of the other. Under certain circumstances, the university can take the role of industry, helping to form new firms in incubator facilities. Government can take the role of industry, helping to support these new developments through funding programs and changes in the regulatory environment. Industry can take the role of university in developing training and research, often at the same high level as universities (Etzkowitz & Leydesdorff, 2001:2).

This quote assumes that, historically, universities had the sole academic mission to educate and research, and that industry was the passive receptor of this research. Now however, there are no clear boundaries between universities, government and industry, regarding their functions and roles. Today universities add entrepreneurial functions to their mission with the aid of government. As Mansfield (1991) writes "[t]he growing role of the university in the new economy goes well beyond providing industry and the state apparatuses with trained personnel and engaging in research that provides a knowledge base for industry to draw upon" (Etzkowitz & Leydesdorff, 2001:2).

Lissenburg and Harding (2000, cited in Etzkowitz *et al.*, 2001:2) also support the existence of such a three-component relationship when they state: "The Triple Helix of university, industry, and government is exemplified in new organisational mechanisms that promote innovation and new business formation".

In many countries throughout the world, university, industry and government are becoming less isolated from each other as each institution increasingly assumes the role of the other. For example, Leydesdorff (2000, cited in Etzkowitz & Leydesdorff, 2001) mentions that in Europe a paradoxical situation was created when the unification process led to the enhancement of the regional and transnational levels of governance simultaneously, with different effects in the various member states. Gibbons *et al.* (1994) uses the example of the first, second and third worlds that originally had distinctly different institutional arrangements, but are now moving in a common direction that seeks a balance between competition and cooperation. Gibbons *et al.* (1994:133) also state that in these developing countries "[s]cientific, technological and

educational activities could not be regarded as concerns only for scientists, engineers and educators".

While companies sought R&D outside of their companies due to the growing pressure of making themselves more internationally competitive, universities have become more important to industry as providers of R&D (Etzkowitz & Leydesdorff, 1997).

An increase in the interaction between the universities, industries and government has, within each sphere, led to: 1) the creation of new structures, for example centres in universities, or strategic alliances among companies, and 2) the creation of integrating mechanisms in the form of networks, for example, academic, industrial and governmental researchers (Etzkowitz *et al.*, 1996).

The globalisation of this Triple Helix is the result of the interconnection of the place of knowledge production and the users and is magnified by the rapid growth of industry-university centres (Etzkowitz & Leydesdorff, 2001). In these centres, both industry and academic researchers jointly determine the priorities. A second result, leading to the Triple Helix, is the technological and communications paradigm that has led to more extensive communication between organisations, e.g. the effects of technology such as the computer, Internet, etc. A third result is the emergence of networks and multi-media modes of coordination. With the progression of time, these developments led to shifts in the political-economic relationships among university, industry, and government in such a way that these institutions moved closer to each other.

This model is based on the idea of a network relationship between the university, industry and government that forms the Triple Helix. In addition, whereas the initial contact between university, government and industry was one of a vertical and linear nature, a transformation occurred in these communications that led to a more lateral and less linear relationship – one of a more "...expanding network system of interactive spirals" (Etzkowitz & Leydesdorff, 2001:1). The Triple Helix model of Etzkowitz and Leydesdorff emphasises that the utilisation of research occurs through processes of interaction within new networks of collaboration between academia, industry and government.

3.4   Bozeman's three policy paradigms

Before discussing Bozeman's technology policy paradigms, it is necessary to discuss the notion of 'technology transfer' as a form of research utilisation. Bozeman (2000) himself points to the fact that the terms 'technology transfer' and 'knowledge transfer' are often used interchangeably. In Section 2.2 of this chapter I discussed epistemic and non-epistemic forms of utilisation. 'Epistemic' or 'knowledge' outputs include all forms of new knowledge: new theories, interpretations, insights, models, hypotheses, conjectures, facts, data, as well as instrumentation; whereas 'non-epistemic' outputs or 'knowledge' applications include all forms of application and technology that flow from the research process: process and product technologies and artefacts, social science applications, etc. Thus, simply stated, technological innovation (through technology transfer) is one form of research output – non-epistemic output.

In the United States in the early 1980s most of the research on technology transfer focused on domestic technology transfer, as opposed to the period prior to 1980 when research focused on cross-national technology transfer. As a result, during the 1980s and early 1990s many changes in public policy relating to technology transfer occurred. Bozeman discusses three competing paradigms – the market failure paradigm, the mission paradigm and the cooperative paradigm – to describe and organise the history of the technology policies in the United States during this period (Bozeman, 2000).

3.4.1 Market failure technology policy paradigm

According to Bozeman, the market failure paradigm is based on the familiar premise that "...the free market is the most efficient allocator of goods and service ... and an unfettered market will lead to optimal rates of science production, technical change and economic growth" (Bozeman, 2000:632). In this paradigm, the role of government in science and technology policy should be to remove barriers to the free market through intellectual property policies, free trade agreements, neutral impact taxation, and limited regulation of enterprise. If that is the role of the government within this paradigm, then universities, who were seen to be practical in orientation and emphasising engineering and technical craft, had a main role as educators and providers of public domain research. Basically, universities evolved into the chief source of basic research and the market failure paradigm suggests that this is the way it should be.

3.4.2 Mission policy paradigm

According to Bozeman, the mission paradigm is based on the premise that "...government should perform R&D in service of well-specified missions in which there is a national interest not easily served by private R&D" (Bozeman, 2000:632). Thus, because private R&D would find it less easy to perform research in certain areas in which there is a national interest, for example in defence and national security-related R&D, government should step in and carry out research in these areas. According to Chiang (1991), besides defining this role of the government in R&D, the paradigm also recognises the unique ability of government to foster technology development and innovation.

In this paradigm, the emphasis is placed on two facts: 1) that the government has a unique position to positively influence the development of technology and innovation, and 2) that the government can also take part in R&D, and thus R&D is not the sole responsibility of universities. Thus in a way, this paradigm assumes that the roles of government and university are interchangeable.

3.4.3 Cooperative technology policy paradigm

The cooperative technology policy paradigm, as presented by Bozeman, sees an active role for government and universities in technology development and transfer, where the government's role can include the supply of applied research and technology to industry or as a developer of policies affecting industrial technology development and innovation (Bozeman, 2000). Bozeman (2000:632) cites both Larsen and Wigand (1987) and Wigand and Frankwick (1989), as reporting, "...the cooperative technology paradigm is an umbrella term for a set of values emphasizing cooperation among sectors [author's comment: industry, government, and university]". The role of universities and government laboratories is central within this paradigm and is based on the simple logic that:

> ...universities and government labs make, industry takes ... many policies involve co-production of technology and various forms of collaboration between industry and either government or universities. But the central point of cooperative technology policies is clear: putting universities and governments laboratories to

greater use as progenitors of technology and applied science (Bozeman, 2000:633).

In this paradigm, cooperation among industry, government and universities is emphasised. However, a linear relationship from the quote "…universities and government labs make, industry takes" is hinted at (Bozeman, 2000:663).

From these paradigms, one can see how notions of and approaches to technology transfer or knowledge transfer have changed over time, starting with the market failure technology policy paradigm, which suggests that universities are the chief source of basic research, then came the mission technology paradigm, most influential in the post-World War II period, which emphasises the importance of the government's role in R&D and assumes that the role of the government and that of the university are interchangeable and, lastly, the cooperative technology policy paradigm, during the 1980s and late 1990s, which emphasises cooperation among industry, government and universities. The last paradigm, more so than the other two paradigms, encourages technology or knowledge transfer since it introduces the idea of interaction between industry, government and universities and, as such, is consistent with the Triple Helix model.

3.5   The Contingency Effectiveness of Technology Transfer (CETT) model

Bozeman's aim was to develop a model that explains the effectiveness of domestic technology transfer from universities and government laboratories. The purpose of his article *Technology transfer and public policy: a review of research and theory* (2000) was to review and criticise the large volume of the most recent multidisciplinary literature on technology transfer using a Contingency Effectiveness model of Technology Transfer to organise the literature. He refers to his model as the "contingency effectiveness model" because its main point is that the effectiveness of technology transfer can be measured in different ways, "…including market impacts, political impacts, impacts on personnel involved and impacts on resources available for other purposes, and other scientific and technical objectives" (Bozeman, 2000:628).

After reviewing more recent lessons learnt about technology transfer and inter-sectoral cooperation, Bozeman proceeds to present and explain the outlines of the Contingency

Effectiveness Technology Transfer (CETT) model. The CETT model incorporates five dimensions: (1) characteristics of the transfer agent, (2) characteristics of the transfer media, (3) characteristics of the transfer object, (4) the demand environment, and (5) characteristics of the transfer recipient. In his own words: "... the model says that the impacts of technology transfer can be understood in terms of who is doing the transfer, how they are doing it, what is being transferred and to whom" (Bozeman, 2000:637). Table 2.2 below elaborates on the dimensions and provides examples of each.

Table 2.2   Dimensions of the CETT model

DIMENSION	FOCUS	EXAMPLES
Transfer agent	The institution or organization seeking to transfer the technology	Government agency, university, firm
Transfer medium	The vehicle, formal or informal, by which the technology is transferred	License, copyright, person-to-person, formal scientific literature
Transfer object	The content and form of what is transferred	Scientific knowledge, technological device, process, know-how and specific characteristics of each
Transfer recipient	The organisation or institution receiving the transfer object	Firm, agency, consumer, user group, institution and associated characteristics
Demand environment	Factors (market and non-market) pertaining to the need for the transferred object	Price for technology, substitutability, relation to technologies now in use, subsidy, market shelters

In the remainder of his review article, Bozeman discusses the main findings and lessons learnt from recent studies on each of these five dimensions. Only some of the most prominent conclusions that he draws are summarised below:

(1)   Characteristics of the transfer agent

In determining what is the institutional culture of the university that affects its ability to transfer technology, Etzkowitz (1994 & 1998, cited in Bozeman, 2000) focused on cultural changes within the new entrepreneurial university environment and shows a culture more conducive to industrially relevant work, whereas Lee (1996, cited in Bozeman, 2000) found much less enthusiasm amongst university faculties for business

partnerships. Slaughter and Rhoades (1996, cited in Bozeman, 2000) focused on the effects of the cooperative paradigm on the structure of academic work, including salary distributions by field and faculty research choices. They suggest that more divisions – especially between the humanities and the natural sciences/engineering – are appearing because of these. Bozeman and Coker (1992, cited in Bozeman, 2000:640) reports that they found that three types of effectiveness related to the transfer agent:

> Number of licenses related chiefly to the size of the lab; getting technologies out the door was best explained in terms of the missions of the laboratories and the composition of their R&D; market impact, measured in terms of commercialised technology, was best explained by research diversity and degree of commercial orientation of the lab.

(2)   Characteristics of the transfer medium

In a comprehensive study of transfer media, Roessner (1993, cited in Bozeman, 2000) found that the most important category of interaction is contract research, followed by cooperative research. Few firms valued licensing and more formal interactions. The verdict on science parks as a transfer medium remains ambiguous. In a recent study by Felsenstein (1994, as cited in Bozeman, 2000) it was found that location in a science park seems to provide no direct contribution to innovation but does confer status and prestige, and these indirectly promote technology transfer and information flows.

Not surprisingly, numerous studies increasingly recognise the role of human capital and training in technology transfer. Bozeman (2000) refers to work by, amongst others, Bessant and Rush (1995, cited in Bozeman, 2000) on consultants, the study of Hicks (1993, cited in Bozeman, 2000) on personnel exchange and secondment, and his own work (Bozeman *et al.*, 1995 cited in Bozeman, 2000) on informal relations among bench-level scientists.

(3)   Characteristics of the transfer object

Grant and Gregory (1997, cited in Bozeman, 2000) have analysed the transfer of 'tacit knowledge' – an area that is receiving new attention – and found that the extent of transfer of tacit knowledge often has a major impact on the effectiveness of manufacturing technology transfer.

An issue that has also received much attention is the extent to which transfer objects achieve commercialisation and what their rate of commercial success is. Bozeman (2000) mentions various studies in the United States (Roessner, 1993; Bozeman *et al.*, 1995; Geisler & Clements, 1995, cited in Bozeman, 2000) that have in fact shown that a minority of interactions are motivated by the prospect of directly realised commercial products. In addition, relatively few projects actually result in the company's commercialisation of technology transferred to the company.

As far as successful commercialisation is concerned, Bozeman (2000) refers to his study in 1997; he found that projects are more likely to lead to a commercialised product if they are initiated by either the company's R&D manager or by top managers in the company. Interestingly enough, Rogers and Bozeman (1997, cited in Bozeman, 2000), in a study of 219 federal laboratory-industry partnerships, found that projects which involved basic research had higher costs but also a greater likelihood of yielding a commercial technology projects.

(4)   Characteristics of the demand environment

It is often assumed that the demand for technology is either market-push or market-pull. However, as Dalpe *et al.* (1992, cited in Bozeman, 2000) showed, the role of the public sector as the first user of technological innovations is equally important.

Bozeman refers to a study of technology transfer in the biomedical industry conducted by Azzone and Maccarrone (1997, cited in Bozeman, 2000), where it was found that the critical demands for technologies and technical competencies is a major factor in determining market impact success.

(5)   Characteristics of the transfer recipient

According to Kingsley and Farmer (1997, cited in Bozeman, 2000), studies that have compared business and non-profit or government technology recipients have consistently found significant differences in processes, barriers to effectiveness, and also in understandings of what counts as effectiveness.

There is evidence that the cooperative technology policy paradigm is taking hold – at least in the United States. Bozeman (2000) reports that in a study that involved interviewing companies' research directors and chief technical officers about sources of external technical knowledge, Roessner and Wise (1994, cited in Bozeman, 2000) found that universities fared better than federal laboratories or other firms. However, with respect to sources of technical knowledge for new products and production processes, respondents rated in-house R&D as most important, with universities and government agencies being ranked well below such sources as customers, competitors, suppliers and consultants.

In conclusion, the terms 'technology transfer' and 'knowledge transfer' are often used loosely and interchangeably in the literature. This was followed by a discussion of the three paradigms identified by Bozeman to describe and organise the history of the technology policies in the United States – the market failure paradigm, the mission paradigm and the cooperative paradigm. From the discussion of these paradigms, we see how the notion of 'technology transfer' means different things in each. Through my discussion of the CETT model five dimensions, present in all knowledge transfer or utilisation processes, were identified: the transfer agent, the transfer medium, the transfer object, the transfer recipient and the demand environment, and that the ultimate effectiveness of knowledge transfer or utilisation depends on the peculiar interplay of each of these. Emphasis is placed on the fact that Bozeman points out that despite hundreds of research studies on technology transfer carried out in recent decades, many topics are still neglected. Although we have learnt much, we still know very little about many aspects of the technology transfer process. I quote Bozeman in full:

> We still know almost nothing about technology transfer politics, including distributional outcomes of technology-based economic development. We have little understanding of many critical impacts, such as developments in scientific and technical human capital, occurring over long time periods. We know little about the impact of technology transfer activities on institutions, their designs and their full range of capabilities. (Bozeman, 2000:650).

3.6   Landry's framework of the history of research utilisation approaches

In a recent review of research utilisation in the social sciences, Landry *et al.* (2001:334-335) classify models of knowledge utilisation into four broad categories: a 'Science push model', a 'Demand pull model', a 'Dissemination model' and an 'Interaction model'. All these models support the importance of research results in policy making, but there are differences between them regarding the main determinants of knowledge utilisation.

3.6.1 Science push model

The foundation of the Science push model is based on the following premise "…supply of advances in research findings as the major determinant of knowledge utilisation" (Landry *et al.*, 2001:334). This model identifies the researcher as the source for directing research and the users as being mere receptacles of the results of research. From this we can see that utilisation follows a linear sequence, from the supply of research by producers to utilisation by users. Within this framework, prior studies considered many dimensions of research results influencing utilisation. These dimensions include content attributes, types of research, and research domains and disciplines (Landry *et al.*, 2001).

RESEARCHER → Directs → RESEARCH → Received by → USER
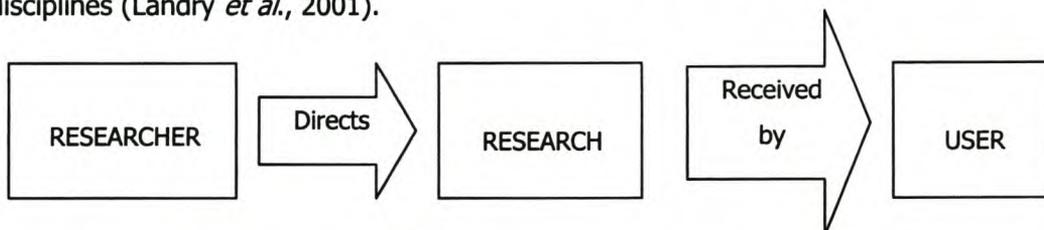
Figure 2. 1   Knowledge utilisation in the science push model (a linear relationship)

Figure 2.1 represents knowledge utilisation as a linear relationship between the researcher and the user. The researcher, who is the producer and director of research, determines the utilisation of knowledge; while the user receives this research in a passive manner with the user making no contribution to what is researched by the researcher.

There are two main critiques that have been raised against the Science push model. The one critique argues that a context has to exist in which someone assumes responsibility for the transfer of knowledge otherwise knowledge transfer will not be an automatic occurrence. The second critique, according to Lomas (1990, cited in Landry *et al.*, 2001), is that raw research information is not usable knowledge since there is a process of transferring it to usable policy making. To elaborate on these two critiques, the most likely person to take responsibility for transferring the knowledge to potential users is the producer of the knowledge and the knowledge transfer will occur through using various forms of dissemination mechanisms that should be part of the research process.

Bozeman's market failure policy paradigm can be equated with this Science push model, because, as already reported in Section 3.4.1 of this chapter, in this paradigm universities are seen as the main source of basic research. Stated differently, universities (producers) 'push' the research out to industry (users), which implies a linear sequence, as identified by the Science push model.

3.6.2 Demand pull model

Rich (1979:15) states that "[t]he notion of adapting knowledge to the needs of society dates back to the Greeks and is a theme running through much of western thought". For centuries, it has been accepted that knowledge has to meet the needs of society, thus the research that was conducted was to meet with the requirements of society. The Demand pull model of Landry *et al.* (2001) argues along a similar vein, namely that the use of knowledge is increased when researchers focus their projects on the needs of users as opposed to focussing them on the advancement of scholarly knowledge only. With the Demand pull model, the users, in contrast, are the main source of ideas for directing research. Knowledge utilisation in this model is explained only by the needs of the users (Landry *et al.*, 2001). This model also follows a linear sequence since it starts with the users identifying the research problem to which the knowledge producers respond.
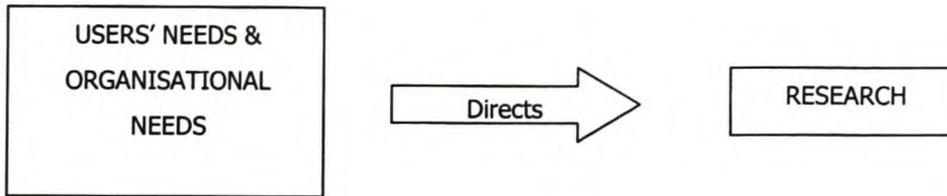
Figure 2. 2   Knowledge utilisation in the demand-pull model (a linear relationship)

Figure 2.2 also emphasises the linear relationship between the researchers and the users, but in this case it is the users and their needs (which include the organisational needs and interests) that are the main determinants and shapers of the research.

A shortcoming of the model is that it fails to consider that even "...research geared to solve problems may be ignored or pushed aside by the potential users because it may be in conflict with the organisational [author's note: and other] interests of the users" (Landry *et al.*, 2001:335). The model thus takes it for granted that organisational structures, rules and norms are essential determinants of knowledge utilisation. For this reason, according to the model, the major cause of under-utilisation of research is identified as the political interests of the users, which are more than likely to be in conflict with the research findings (Landry *et al.*, 2001).

There are three main critiques advanced against the Demand pull model. The first criticism is that it focuses largely on the instrumental use of research and thus ignores the fact that different types of knowledge lead to different uses of that knowledge (Cf. my discussion of the differences between instrumental, conceptual and symbolic use in Section 2.2 of this chapter). The second critique is that it places too much emphasis on the sole interests of the users. The third critique concerns the fact that the model omits the interaction between the producers and the users of the research findings (Landry *et al.*, 2001).

3.6.3 Dissemination model

The first critique of the Science push model, that the transfer of knowledge to users is not automatic in a context where no one assumes responsibility for its transfer, led to

the development of a variant of the Science push model – the Dissemination model. According to the Dissemination model, a step should be added to the research activities of researchers to develop dissemination mechanisms to identify useful knowledge and transfer it to probable users, since dissemination only occurs when a potential user becomes aware of the research results (Landry *et al.*, 2001). The model explains knowledge utilisation according to the dissemination effort and emphasises that the reception of knowledge does not imply use of this same knowledge.

Webber (1987:615) states, "...it is not likely that decision makers will extensively use policy information if left to their own inclinations". Thus for research to be used, it seems that the responsibility of dissemination automatically lies with the researcher. For example, Frenk (1992:1400) mentions that obstacles to communication between user and researcher can be reduced with the use of "bibliographic revisions" and "progress reports", to aid decision making even before the project is completed; "academic papers" for scientific colleagues; "executive syntheses" for decision makers; and "seminars", where together decision-makers and researchers discuss results. May (1975, cited in Frenk, 1992:1400) even suggests the training of "translators" who, while offering an interface between user and researcher, can also consider each one's needs, values and priorities. All these are examples of dissemination strategies that are primarily the responsibility of the researcher.
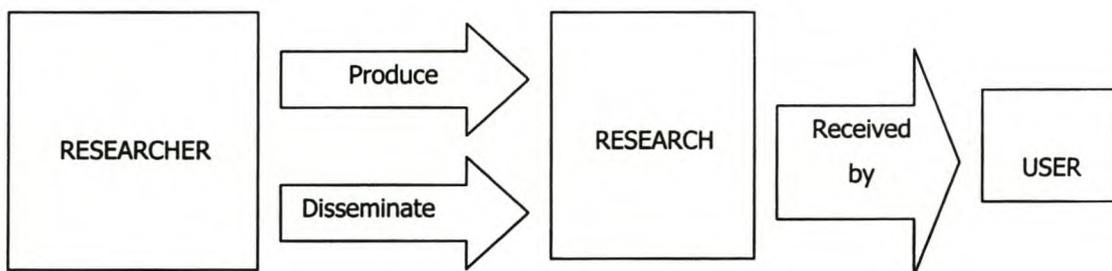
Figure 2. 3   Knowledge utilisation in the dissemination model (a linear relationship)

Figure 2.3 also shows that knowledge utilisation follows a linear relationship between the researcher and the user. Once again we see that the researcher produces and

disseminates the research and the user is the passive recipient of the research, since the user does not have a say in what is researched nor in what is disseminated or how.

Huberman (1987), Oh and Rich (1996), and Lomas (1997, cited in Landry *et al.*, 2001) have attributed the main problem in under-utilisation of research findings to the lack of interaction between researcher and user. Huberman (1987:27) emphasises that interaction may not just bring about the dissemination of the research in the form of new information, knowledge or instruments to the user, but it may have a similar effect on researchers in the form of "...surfacing new lines of inquiry, new constructs or potentially flawed design and instrumentation". The main critique of this model is that potential users are neither involved in the selection of the transferable information nor in the production of the research results (Landry *et al.*, 2001).

3.6.4 Interaction model

Since the mere reception of knowledge by a potential user does not imply that this knowledge will be used, as implied by the Science push and Dissemination models, in this section we turn our attention to the Interaction model. This model suggests that knowledge utilisation depends on various interactions occurring between researcher and user – rather than on linear sequences – and these interactions start with the needs of researchers or the needs of the user (Landry *et al.*, 2001). On this point Weiss (1979: 428) says that the process from research to decision does not have a linear order but rather a "disorderly set of interconnections" and "back-and-forthness". Rothman (1980) and Webber (1983, cited in Lester & Wilds, 1990) recommend that improving the interaction and communication between users and researchers will lead to an increase in use. The World Health Organisation (1986, cited in Frenk, 1992) also mentions interaction between users and researchers as a key to improving the quality of decisions made.

Two ideas are suggested by this Interacton model: (1) a difference between the culture of science and the culture of users leads to lack of communication between them and thus to low levels of knowledge utilisation, and (2) the more sustained and intense the interaction between researchers and users, the more likely utilisation will occur. This model also argues that utilisation varies according to research and scientific

disciplines, the needs and organisational interests of users, and differences in dissemination and linkage mechanisms (Landry *et al.*, 2001).
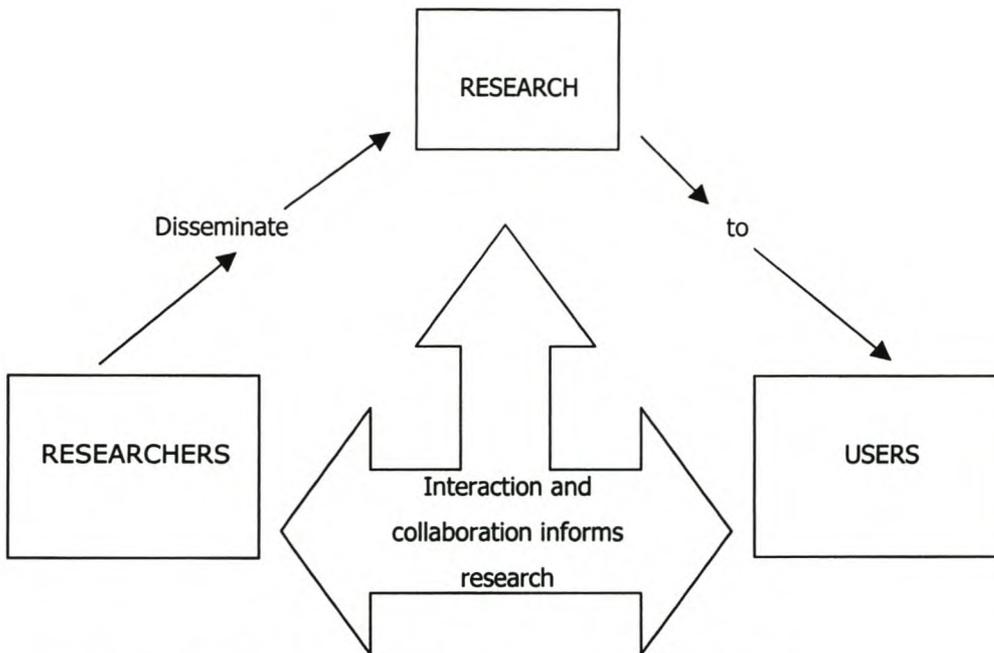
Figure 2. 4   Knowledge utilisation in the interaction model

Figure 2.4 shows that knowledge utilisation occurs through many different interactions between the researcher and the user. Researchers and users collaborate and interact with each other and this interaction informs research to such a point that the needs of both the researcher and the user are met through the research. We also see that it is the producer's responsibility to disseminate the research to the user.

3.6.5 Determinants of research utilisation according to Landry *et al.*

After classifying the literature pertaining to knowledge utilisation under the above-mentioned models, Landry *et al.* (2001) then proceeds to address the question of what are the determinants of utilisation of social science research knowledge. To answer this question they used a survey to assess dissemination, use and the impact of research on users.

Their survey results showed, first, that social science research results are more extensively used than commonly assumed. Furthermore, the results of the disciplinary

social sciences (economics, political science, sociology and anthropology) are used less than the professional social sciences (industrial relations and social science). This difference was explained by using regression models that showed that the determinants of knowledge utilisation included in the Science push, Science pull and Dissemination models are not good predictors of knowledge utilisation whereas the determinants associated with the Interaction model provide the best predictors of knowledge utilisation in the social sciences.

It was also found that the types of research methods used to produce research are neither a good predictor nor a powerful intervention force to promote utilisation of social science research results; and research projects that focused on users' needs were not more likely to lead to utilisation than the projects that focused on the advancement of scholarly knowledge.

A good predictor of utilisation in all social sciences (except anthropology and social work) is dissemination efforts by the researchers. By creating incentives that target dissemination, an increase in knowledge utilisation could result. The researchers' context, especially their scientific credibility, created by a greater number of publications, influences the utilisation of knowledge in all social sciences (except industrial relations and social work). Mechanisms linking the researchers (political science, anthropology and social work) and the users are also good predictors of utilisation.

Research projects based on internal university funding were less likely to lead to use than projects based on funding from sources external to universities. This result suggests that universities that support research projects with their internal funds should have low expectations with respect to the utilisation of the results of such projects.

The most important finding of Landry *et al.* (2001) is that knowledge utilisation depends much more heavily on factors related to the behaviour of the researchers and users' context than on the attributes of the research products.

From the above-mentioned findings of Landry *et al.* (2001) it is interesting to note that the popular preconceived idea that there will be greater use of research if the research focused on users' needs exclusively was refuted by this study. It is also interesting to note that they found that knowledge utilisation depends more heavily on the behaviour of researchers and users of research than on the research product. Other points to highlight from the above findings are the facts that the Interaction model provides the best explanation of success in knowledge utilisation, as do the number of publications and intensity of mechanisms linking the researchers and users.

3.6.6 Linkage mechanisms

Huberman (1987:596) state that "...the degree of linkage influences directly the dissemination effort: its intensity, the quality of its execution, the sophistication". Huberman and Thurler (1991, cited in Landry *et al.*, 2001) devised an interesting set of indicators of mechanisms linking researchers and users; it includes informal personal contacts, participation in committees, and transmission of reports to non-academic organisations. Following from the interaction model, mechanisms linking the researchers and the users have also been shown to be good predictors of knowledge utilisation. Once again, the more resources the researcher invests in mechanisms linking the researcher and the user, the higher the use of social science research.

4.   A 'Network' model

Based on a combination of two of the models proposed by Landry *et al.* (2001), the Dissemination model and the Interaction model, I would like to propose a 'Network' model, as already suggested in the final synthesis report on the NACI utilisation study by Mouton and Bailey (2002). Because this 'Network' model is a combination of the Dissemination and the Interaction models, it promotes effective knowledge utilisation.

As can be seen from the results of the study done by Landry *et al.* (2001) in Section 3.6.5, dissemination efforts by researchers, whether improving the method of dissemination, increasing the occurrence of dissemination or increasing the cost of dissemination, represent a good predictor of knowledge utilisation in all of the social sciences bar two disciplines. Thus when researchers adapt their products to make reports more readable, easier to understand and more appealing and to make conclusions and recommendations more specific and operational, then an increase in

40

utilisation should occur. Also, besides improving the specific dissemination method, when a researcher increases dissemination then an increase in utilisation is also likely to occur. Thus, when researchers hold meetings to discuss their projects with users and disseminate results to users, the more likely it is that utilisation will follow. Thus it follows that when researchers invest resources to adapt their products to facilitate their use by users, the use of social science knowledge will increase (Landry *et al.* 2001).

From the various ways of disseminating research it is obvious that in order to disseminate research findings effectively, interaction between the user and the researcher is imperative. Thus we can see how the two models of Dissemination and Interaction go hand-in-hand.

Results of the study by Landry *et al.* (2001) have indicated that the determinants of knowledge utilisation included in the Interaction model were the best indicators of knowledge utilisation in the social sciences. This is obvious, as the Interaction model integrates all the features of the Science push and Demand pull models (Landry *et al.* 2001). In addition, the Interaction model explains utilisation through a new factor – the linkage mechanism. Landry *et al.* incorporate this mechanism, introduced by Huberman and Thurler (1991, cited in Landry *et al.*, 2001), in the study as one of the factors that determine utilisation.

From the description of the Two Communities theory, in Section 3.1 of this chapter, a term – and a derivative thereof – that constantly surfaces and resurfaces is 'relation' and 'relationship'. This reinforces the point highlighted from the findings of Landry *et al.* (2001), namely that knowledge utilisation depends more heavily on the researchers and users of research behaviour than on the research product. This point can be extended to include the idea of the Network model.

In an earlier section in this chapter, Section 3.3, in the discussion of the Triple Helix model of Etzkowitz *et al.* (2001), the idea that the utilisation of research occurs through processes of interaction is also supported. The Triple Helix model is based on the idea of a network relationship between university, industry and government – forming the Triple Helix, and it is through these interactions that the utilisation of research occurs. In the quote of Etzkowitz *et al.* (2001:1), in referring to the lateral

41

university-industry-government relationship as an "expanding network system of interactive spirals", we can clearly see the significance of the notion of networking.

The discussion of Bozeman's model of technology transfer is another example of the Network model of technology transfer, as indicated by the comprehensive incorporation of (1) the characteristics of the transfer agent; (2) the characteristics of the transfer media, (3) the characteristics of the transfer object, (4) the demand environment, and (5) the characteristics of the transfer recipient.

5.   Conclusion

The review of different models of research utilisation as presented in this chapter has revealed the wide variety of terms associated with 'utilisation' (Hall, Loucks, Newlove & Rutherford, 1975; Patton, Grimes, Guthrie, Brennan, French & Blyth, 1977, cited in Booth, 1990; Beyer & Trice, 1982; Huberman, 1994; Booth, 1990; Arie Rip, 2002).

When looking at the five models of research utilisation, we can see that some form of Interaction or Dissemination is encouraged between users and producers in most models. With the Two Communities theory, it was argued that the producers and users are in separate camps and that it is only through bridging this gap and encouraging interaction between the two communities that knowledge utilisation can be achieved. With Weiss's three models of research: research as data, research as ideas and research as arguments, we can see that there are three different ways in which research can be used, with the emphasis on research as advocacy. To achieve this, interaction between the user and the producer is required. The Triple Helix, as with the Two Communities theory, also places much emphasis on interactions and relations between university, government and industry. With Bozeman's cooperative technology paradigm, cooperation and interaction among industry, government and universities is emphasised. With Bozeman's Contingency Effectiveness model of Technology Transfer, much emphasis is placed on the transfer of technology; in other words, dissemination is stressed as a requirement for effective knowledge transfer. With Landry's four models, the two most effective models for knowledge utilisation are the Dissemination model and the Interaction model (the Interaction model more so). The positives and strengths of the six models discussed – especially those models emphasising interaction and dissemination – together form the Network model. Separately, these

models encouraging dissemination and interaction are not as effective for knowledge utilisation as they are when combined. Thus in the Network model, the emphasis is placed on the relationship between the researchers and users and the intensity of the linkage mechanism. The model specifies that dissemination, interactions and collaborations between researchers and users will increase the likelihood of utilisation and that linkage mechanisms will dictate the degree of knowledge utilisation.

Chapter 3
Research Design and Methodology

---

1.   Introduction

In Chapter 1 I discussed the origin of the data used to conduct my study. Data were taken from the NACI survey, which was conducted by CREST in 2002. In this chapter I discuss, in more detail, the background to the survey instrument – including the aim of the research, focus of the study, unit of analysis, time dimension and validity of choice of primary research design – and the research method employed to carry out the survey.

2.   Background to the survey instrument

According to Babbie and Mouton (2001), the choice of research design is determined largely by how the aim of the research has been formulated, the focus of the study, the unit of analysis and the time dimension.

2.1   Aim of the research

The aim of the research conducted for NACI was to establish the extent of the utilisation of publicly-funded research findings as well as to identify the factors associated with more or less effective utilisation of research knowledge in higher education institutions and science councils in South Africa. Research on similar topics has been done in developed countries such as the United States of America, Canada and the United Kingdom. However, no comparable study has yet been conducted in South Africa.

The specific research aim of my study is to perform a finer and more in-depth analysis of what researchers, based at South African education institutes and science councils, mean by the term 'utilisation'.

More specifically the objectives of my study are as follows:

- Putting in perspective the changing research process in South Africa and other industrialised countries of the world – including the United States, the European Union and the United Kingdom.

- Examining and discussing of the term 'utilisation' – including the different uses of the term and different types of utilisation.

- Discussing the different models of knowledge utilisation.

- Presenting and analysing the thesis on knowledge production of Gibbon *et al.* (1994) where two modes of utilisation were introduced – Mode 1 and Mode 2 (To these two modes of Bozeman, I added a third category that is a combination of the features of Mode 1 and Mode 2).

- Offering a qualitative analysis of the responses to the open-ended question on how their research was utilised by intended beneficiaries.

- Presenting a quantitative analysis of a comparison of Mode 1, Mode 2 and a combination of Mode 1 and 2 knowledge utilisation with the following variables:

  - The project leader's key motive or motives that 'drove' the research projects being described

  - The principal investigator's identification of the expected outcome or value of the research that he or she was engaged in

  - The scientific field in which the project fell

  - The source of funding as reported by the project leader

  - The method of dissemination as indicated by the respondent

  - The respondent's indication of whom the main intended beneficiaries of their research were (more than one option could be selected).

2.2   Focus of the study

My study focuses primarily on the recently completed research projects of researchers in public R&D institutions. Respondents were asked to provide information on a project that could either be a stand-alone research study or a project within a longer-term research programme. The project had to have been completed in the last five years (completion is taken to mean that results or findings have been generated, and/or that the project had been reported on), and the respondent had to be the primary/principal investigator or project leader.

2.3   The unit of analysis

In this study, data were collected from researchers at all major research and development institutions across all scientific fields and on the projects of these researchers. The unit of analysis was the project and the process by which research knowledge was utilised.

2.4   The time dimension

To ensure that only completed projects – where utilisation of research products could already have materialised – were included in the study; the time frame selected in which the projects were to have started was 1997 to 1998. The data collection and analysis for the research design was done in 2002 and 2003.

2.5   Validity of choice of primary research design

A key objective of the analysis was to establish whether there is a significant association between the dependent variable (i.e. mode of research utilisation) and different independent variables (e.g. types of dissemination, scientific field, source of funding, etc.). This analysis was based on previous research and especially the work of Landry and Bozeman discussed previously (Section 3.4 and 3.6 respectively).

External validity depends on the extent to which the results of the research are applicable to all the subjects in the population. In the survey, I used information about project funding to determine the extent to which the sample of completed questionnaires actually reflects the variety of projects in the higher education and science council sectors. This was done as follows:

> For any project an exact funding amount was calculated by using the interval mid-point as estimate. This gives a total funding of R791.6 million, based on 1 681 projects. If we replace the missing values for each sector by its modal funding (the value with the highest frequency), the total project funding amounts to R799.2 million (R535.5 million for science councils and R263.7 million for higher education). However, this covers all projects in their total duration, which may be more than 30 years in some cases. Also, not all the projects have the same years in common (e.g. some started in 1995 but ended in 1999, whereas others started in 2001 and are still ongoing). The year that the majority of projects (N = 1 148 or

64% of total) have in common is 2000. Thus, if we want to obtain an estimate of our coverage of projects in terms of its share of public R&D expenditure it would be best to use 2000 as reference year (Mouton, Bailey & Boshoff, 2002:24).

Table 3.1 shows that for the NACI study, the sample of projects, in terms of funding for 2000, covers about 20% of all public R&D expenditure in the higher education and science council sectors.

Table 3. 1   Project funding for 2000 as a percentage of total R&D expenditure (R millions)

Sector	Project funding for 2000	Total R&D expenditure for 2000	Project as % of total R&D
Science councils (N = 350)	371.0	1 770.0	21%
Higher education (N = 798)	202.3	1 100.0	18%
Total (N = 1 148)	573.3	2 870.0	20%

Source: Mouton, Bailey & Boshoff (2003:25, Table 2.4)

Note: The figures for total R&D expenditure are taken from Boshoff and Mouton (2003)

3.   Research methodology

3.1   The web-based survey system

A web-based survey approach was developed to collect the data, using the email addresses of research staff at universities, technikons and science councils as sampling frame. In Sections 3.1.1 to 3.1.4 below, the procedures used to obtain email addresses from the sampling institutions, as well as the development and implementation of the web-based system, are discussed.

3.1.1 Development of a sampling frame

The higher education sector. Given the national scope of the survey, and the need to obtain as high a submission rate as possible, it was essential to negotiate the support of the heads of the participating institutions. For universities and technikons it took the

form of a personal email, addressed to the Rector or Director of Research, explaining the background and aim of the study. Approval was also sought to send the survey under their names, and an electronic file of research/academic staff (C1-staff) was requested. It was further explained that each person in the file would be sent a covering letter via email, together with a hyperlink to the survey questionnaire, which could then be completed on-line. Nine universities and nine technikons provided us with an electronic list of their C1-staff.

The science council sector. Appointments were scheduled with the CEOs and/or senior management personnel of six R&D performing science councils. Prof Mouton, who facilitated the meetings, used the opportunity to negotiate their assistance, as well as requesting the names and email addresses of research staff. All science councils complied with the request although it had to be followed up with both telephone calls and email reminders.

3.1.2 Development and implementation of the web-based system

The survey was set up on an Internet host located at the University of Stellenbosch. The first step was to import the electronic lists of staff into the web-based system's database. In doing so, each individual was automatically assigned a unique user code, making it possible to track responses (and possible technical problems) by respondent. User codes thus served the dual purpose of keeping track of individuals, as well as providing authenticated access to the questionnaire. Moreover, it made it possible to transparently provide access to the correct version of the questionnaire (i.e. the higher education sector version or the science council version), and access to a choice of language (Afrikaans/English) for staff at traditionally Afrikaans institutions.

Once the staff list of an institution had been imported, and the covering letters finalised, the letters were emailed to the respondents. Each letter was personalised and contained a unique URL (web address) that gave access to the questionnaire for that person. Email recipients accessed the questionnaire by clicking on the link in their email software. When the correct URL was entered, the respondent went directly to the questionnaire. The respondent then completed the questionnaire in his/her web browser and clicked on a 'submit' button at the end of the questionnaire. If submitted

successfully, the server captured the user's response and the user was thanked for his/her effort. The server also captured the following:

- The exact time that an email was sent to each respondent
- Whether it was delivered successfully[1]
- The time that the questionnaire was accessed and
- The time that the questionnaire was returned.

The emailing of covering letters and hyperlinks took place at various stages during September and October 2002. Reminders were posted towards the end of October 2002 to users from whom no replies had been received.

3.1.3 Evaluation of the web-based system

Generally, the system worked seamlessly, but there were isolated cases of difficulty. A relatively small number of users complained that they were unable to access the questionnaire, which might have been network-related (e.g. network congestion). Similarly, some respondents' computers had errors or faulty set-up. In all of these cases, there was nothing we could do besides asking respondents to try again or to use an alternative computer and/or Internet access provider.

One problem related to our system concerned the requirement of an active user code. An active code enabled a user to log in to the system and to complete one questionnaire only, after which the code was no longer active. Some users, however, found that the computer had submitted the questionnaire before completion. These users were therefore prevented from going back and completing the questionnaire. In such cases, the incomplete questionnaires had to be manually deleted in order to reactivate the user codes.

At one institution, the Mineral Technology Council (Mintek), a more serious problem occurred. For a reason as yet undetermined, respondents from Mintek experienced errors when attempting to access and/or return the questionnaire. Since completed

---

[1] The assumption was made that if the mail system did not return an error, the message was delivered successfully. This does not imply that the person had actually read the message, only that the address is very likely to be valid – similar to regular mail.

questionnaires were becoming lost as a result, it was eventually decided to shut down access to the system for Mintek users. They were provided with the alternative of a MS Word version of the questionnaire.

3.1.4 Alternative for tertiary institutions that did not provide a list of staff

A number of universities and technikons did not provide CREST with a list of their C1-staff, but opted to distribute the covering letter internally. An alternative to the system described above therefore had to be developed, since it was no longer possible to link information in a respondent database to invitations or to responses. A special link was provided that facilitated open access (i.e. without a user code) to the questionnaire. Most of the advantages of being able to track respondents were lost in this way for some institutions, but it had the advantage of giving freer access to the questionnaire.

3.1.5 Ethical considerations during data collection

To account for ethical considerations, participation by the researchers in the survey was voluntary; confidentiality was assured. With reporting of the quantitative data, information was presented in aggregated format only and with qualitative data, individual responses were reported anonymously.

3.2   Measuring instrument

3.2.1 Questionnaires

The email survey was constructed during July and August 2002. Two questionnaires, designed to serve as the measuring instrument, were generated. One version was for the higher education sector and the other version for the science council sector. The reason for having the two versions was because the two questionnaires differed from each other with regard to question 18 and question 23 (see Appendixes A and B). With question 18, the range of possible funding that the higher education sector could receive was smaller than that of the science councils; for example, the range for the higher education sector started at *less than R50 000* and the science council's started at "less than R250 000". With question 23, the sources of funding differed; for example, the science councils could receive funding from parliament, government, industry, etc. and the higher education sector could receive funding from the science councils, government, their own source for funds, etc. Access to a choice of language

(Afrikaans/English) for staff at traditionally Afrikaans institutions was also given (see Appendix C). This was done to accommodate more respondents.

The questionnaire was divided into two sections. Section A covered a short biographical section requesting information on an individual level (title, name, position, age, gender, etc). Section B covered a longer section with a project as the unit of inquiry and included aspects of both knowledge production (research domain, collaboration etc.) and knowledge utilisation (intended beneficiaries, modes of dissemination etc.). The following broad themes were covered:

- What was the researcher's motive(s) for doing the research
- What was the expected outcome or value of the research project
- What triggered the researcher to do the research
- What was the scientific field in which the research fell
- What sources of funding did the researcher receive
- Who were the intended beneficiaries of the research
- What modes of dissemination did the researcher use to distribute the results.

To answer the questionnaire, the respondents had to select any research project according to the following criteria:

- The project was completed within the last five years (completion is taken to mean that the results or findings had been generated, and/or that the project had been reported on)
- The researcher was the primary/principal investigator or project leader on the project
- The researcher devoted significant research time and resources to the project.

Additionally, the project either had to be a stand-alone research study or a project within a longer-term research programme.

A first draft of the instrument was distributed to all members of the larger consortium who collaborated on the NACI project, and piloted with a few researchers in the higher education and science council sector. After the questionnaire was altered on the basis of feedback and discussions, the questionnaire was then loaded onto the web server.

3.2.2 Questionnaire submission rates

Tables 3.2 to 3.4 summarise the questionnaire return rate by institution.

Table 3.2   Questionnaires returned by universities

University	Emails sent	Emails delivered	Reminders sent	Accessed questionnaire	Returned questionnaire	Accessed/ Delivered	Returned/ Delivered
Cape Town[1]	447	244	0	40	17	16%	7%
Durban Westville	Unknown	Unknown	--	1	1	--	--
Fort Hare							
Free State	441	427	355	144	124	34%	29%
Medunsa							
Natal	756	741	639	305	176	41%	24%
North (QwaQwa)	196	117	118	13	6	11%	5%
North-West							
Port Elizabeth	Unknown	Unknown	--	36	16	--	--
Potchefstroom	516	495	399	200	133	40%	27%
Pretoria	Unknown	Unknown	--	391	135	--	--
Rand Afrikaans	368	351	288	135	85	38%	24%
Rhodes	305	274	215	128	96	47%	35%
South Africa[1]	1273	1230	0	98	61	8%	5%
Stellenbosch	769	748	625	312	214	42%	29%
Transkei							
Venda							
Vista	549	460	423	148	87	32%	19%
Western Cape	Unknown	Unknown	--	37	9	--	--
Witwatersrand	Unknown	Unknown	--	100	25	--	--
Zululand[2]	28	28	25	12	7	43%	25%
Total (Known)[3]	5648	5115	3087	1535	1006	30%	20%
Total (All)	--	--	--	2100	1192	--	--

Source: Mouton, Bailey & Boshoff (2003:12, Table 1.1)

Blank cells that are merged mean that the university was not surveyed.
"Unknown" means that the university distributed the emails.
[1] No list of C1-staff provided. Email addresses from SA Knowledgebase were used.
[2] Emails only sent to the Faculty of Science.
[3] Universities where the number of emails sent/delivered is known.

Table 3. 3   Questionnaires returned by technikons

Technikon	Emails sent	Emails delivered	Reminders sent	Accessed questionnaire	Returned questionnaire	Accessed/ Delivered	Returned/ Delivered
Border	160	158	0	42	20	27%	13%
Cape	Unknown	Unknown	--	1	0	--	--
Dbn Inst of Tech	49	45	41	16	10	36%	22%
Eastern Cape							
Free State	Unknown	Unknown	--	3	1	--	--
Mangosuthu	54	54	52	9	4	17%	7%
North. Gauteng	252	242	223	77	32	32%	13%
North-West							
Peninsula	224	199	183	56	25	28%	13%
Pretoria							
Port Elizabeth	278	259	205	128	76	49%	29%
South Africa	93	80	63	41	28	51%	35%
Vaal Triangle	63	60	61	39	24	65%	38%
Witwatersrand	164	163	149	41	21	25%	13%
Total (Known)[1]	1337	1260	977	449	240	36%	19%
Total (All)	--	--	--	453	241	--	--

Source: Mouton, Bailey & Boshoff (2003:13, Table 1.2)

Blank cells that are merged mean that the technikon was not surveyed.

"Unknown" means that the technikon distributed the emails.

[1] Technikons where the number of emails sent/delivered is known.

Table 3. 4   Questionnaires returned by science councils

Institution	Emails sent	Emails delivered	Reminders sent	Accessed questionnaire	Returned questionnaire	Accessed/ Delivered	Returned/ Delivered
ARC	872	773	669	351	206	45%	27%
CSIR	1185	1185	1023	552	273	47%	23%
Geoscience	139	139	122	82	51	59%	37%
HSRC	111	92	74	42	25	46%	27%
Mintek[1]	202	166	0	95	25	57%	15%
MRC	336	185	161	105	43	57%	23%
SAAO	14	14	13	7	2	50%	14%
Total	2859	2554	2062	1234	625	48%	24%

Source: Mouton, Bailey & Boshoff (2003:14, Table 1.3)

[1] Completed questionnaires for Mintek were captured manually onto the system.

A total of 2 058 questionnaires were received.

3.3   Analysis of data

This section gives a short description of the data analysis. A more detailed coverage is presented in Chapters 4 and 5.

3.3.1 Analysis of qualitative data

A few questions of the questionnaire were open-ended and thus needed to be coded. Of these open-ended questions, one question in particular was relevant to both the NACI survey and to my study. This question was question 23 – which required the respondent to describe how the research of his/her project was utilised/implemented/applied by the intended beneficiaries. The respondent also had to give concrete examples.

For the NACI survey, the method of coding required each answer to be analysed on three different levels. The first level was specific to each particular project, the second level was more general and could apply to any number of projects, and the last level

served as an umbrella description that categorised the utilisation of the project's research under one of approximately seven descriptions.

For my study, question 23 was coded using a software package called ATLAS/ti. With this package I was able to qualitatively analyse (manage, extract, compare, explore, and reassemble) the large bodies of textual data of the email questionnaire survey. The coded data from this package could also be exported to Microsoft Excel, where question 23 was further coded. This generated a 'new variable' with three categories: Mode 1, Mode 2 and a combination of Mode 1 and Mode 2.

3.3.2 Analysis of quantitative data

After the data was coded in Microsoft Excel, it was exported to the statistical software package SPSS (Statistical Package for the Social Sciences) where I subsequently cross-tabulated the 'new variable' with the following variables:

- The 'trigger' or driver behind the research
- The expected outcome of the project or study
- The scientific field of the project
- The project's or the study's science culture
- The source of funding of the study
- The modes of dissemination of the results, and
- The intended beneficiary(ies) of the research.

The analysis was largely descriptive in nature. The reason inferential statistical procedures were not used is because, in the questionnaire, a respondent could have ticked more than one option, e.g., Figure 5.3 of Chapter 5. Therefore, the lack of a tick implies either a missing value or a *no* response, and the cross-tabulation of mode of utility with any of the options will generate a 2x3 contingency table (*yes* and *no/missing* by *Mode 1*, *Mode 2* and *Modes 1 & 2*). The figures and tables in Chapter 5 only present the distribution of mode of utility responses for *yes* responses. The application of a Chi-square test of significance to any of these 2x3 tables will in fact involve a comparison of the utility responses for the *yes* category against those of the *no/missing* category. Since the options are not mutually exclusive and a *no/missing* response on any option could involve the presence of other options, the interpretation of the results of Chi-square does not seem be that straightforward. Hence, no Chi-square tests were performed.

4.   Conclusion

Using a web-based data-collection instrument is something of a novelty in South Africa. However, it was possible to fully utilise this method because the population of interest all had access to email. It was also a matter of the respondent clicking on an Internet link to access the questionnaire and then clicking on the 'send' button after completing the questionnaire. The greater effort was setting up the web-based system, which in itself probably required less effort than an interview survey or a postal survey. All in all, this process required less effort than would have been required had it necessitated interviewing, or posting and receiving 2058 questionnaires. By using a web-based survey system, the questionnaires received from the respondents were in an electronic format and thus migrating the data to the statistical packages that were used to analyse and correlate the different variables that data was made easier, and was less time consuming.

A final question that might need addressing is whether one can – through a self-reporting questionnaire – get a valid picture of the extent of research utilisation. In this regard the data speaks for itself – as will be seen in the following chapters (Chapter 4 and Chapter 5). The fact that the qualitative post-coding and data-analysis supports the quantitative picture that has emerged through the survey – the mere fact that respondents wrote quite detailed comments to the open-ended questions – demonstrates this.

Chapter 4
Qualitative data analysis

1.   Introduction

The focus in this chapter is on elaborating on the meaning of 'research utilisation'. How do the results of research projects get optimally utilised? This is not a straightforward matter to address since projects are open-ended enterprises with no rigid boundaries. This means that it is difficult to indicate whether the research findings have been utilised, by whom, over what period of time, and to what effect. The difficulty in establishing whether research findings have been utilised was also pointed out by Vergragt (1988) after he conducted a study at one of the big five multinational chemical/pharmaceutical corporations in the Netherlands. His primary objective was to map, in retrospect, the 'social shaping' of two technological products (alpha-olefins and telometric fatty acids; flame-retardant nylon) at this pharmaceutical corporation's research laboratory in Arnhem. Vergragt (1988:482) explains that the concept of "social shaping" refers to the possibility that, in the early stages of the innovation process, choices – influenced by economic and political interests of the parties involved – can be made between alternatives. What Vergragt (1988:496) found was that, especially in established research units, a project consists of "research lines" – activities to which the existing product is subjected in order to reach the specific project goal – that may branch into two or more research lines, or merge with another research line, when needs or possibilities arise, and that projects such as these benefit from prior and parallel research activities, and that apart from its outputs, some of its findings may be taken up in the medium or the long term by another project. He went on to state that projects, therefore, are rarely isolated activities, starting 'out of the blue' at one particular point and wrapping up completely at another point and that, in general, this makes it difficult to measure one particular, isolated project's outcomes, and more so immediately after the conclusion of the project. As pointed out by Larédo *et al.* (2002:68), projects are only temporarily discreet entities within the "Project Plus" – the 'space' filled with related needs and interests, which the funded project responds to, and which legitimate a continuation of research along the lines of the (previously concluded) project.

In this chapter, I discuss what researchers mean by 'utilisation' through a qualitative analysis of an open-ended question of the questionnaire (See Appendixes A and B). This qualitative analysis involved a two-fold coding of the open-ended question. The question was first coded using the qualitative methods as mentioned in Section 3.3.1 of Chapter 3 and then the question was coded either as "Mode 1" or "Mode 2" knowledge utilisation (or a combination thereof) following the distinction put forward by Gibbons *et al.* (1994), as already mentioned in Chapter 1. In the next section this Mode 1 and Mode 2 knowledge utilisation is discussed in more detail, followed by details of the distinctions between these two modes. In the final section examples of Mode 1, Mode 2 and a combination of Modes 1 and 2 that illustrate their distinctions or characteristics are given.

2.   Mode 1 and Mode 2 knowledge production

In a now influential publication, Gibbons *et al.* (1994) argue that changes in the modes of knowledge production are occurring across scientific fields. According to Gibbons *et al.* (1994:2), the "…new mode of knowledge grew out of the existing one". Thus the new mode does not replace the existing mode; the two are different from each other in every respect. Gibbons *et al.* (1994) refer to the existing, traditional form of knowledge production as 'Mode 1' and the 'new mode' of knowledge production as 'Mode 2'. Mode 2 knowledge production involves the emergence of new, global trends in the production, organisation and dissemination of knowledge. In modern-day society, knowledge is being produced in a variety of social settings, it is no longer concentrated in a few institutions, and it involves many different types of individuals and organisations in different interactions and relations (Gibbons *et al.*, 1994).

Gibbons *et al.* (1994) state that many argue that one can equate the meaning of Mode 1 with the meaning of 'traditional academic' science. Further, Mode 1 is governed by cognitive and social norms that determine what are "…significant problems, who shall be allowed to practice science and what constitutes good science" (Gibbons *et al.*, 1994: 3). In other words, these norms distinguish between scientific and non-scientific forms of practice.

In Mode 2, research problems are "not set within a disciplinary framework", but are transdisciplinary; the research is conducted in "non-hierarchical, heterogeneously

organised forms which are essentially transient", due to many parties being involved in the entire production process – it is said to be "socially accountable" and knowledge production is more reflexive (Gibbons *et al.*, 1994: vii). As a result of these changes from Mode 1 to Mode 2, additional quality control criteria are added.

3.   Distinctions between Mode 1 and Mode 2

The Gibbons thesis (1994) identifies five shifts that form the core of the distinction between the Mode 1 and Mode 2 knowledge production distinctions. These are:

- Discipline-based problem-solving context versus application problem-solving context
- Disciplinary cognitive context versus transdisciplinary social and economic context
- Heterogeneity and organisational diversity in the forms of knowledge production
- New forms of social accountability and reflexivity
- New measures and criteria of quality control.

3.1   Discipline problem-solving context versus application problem-solving context

In Mode 1 research is done within a particular disciplinary context "...defined in relation to the cognitive and social norms that govern basic research or academic science" (Gibbons *et al.*, 1994: 76). In comparison, in Mode 2 research is performed within a specific context of application. That is, Mode 2 research is produced chiefly for the user and where the user's interests are included in the research process. Contracted research is an example of such a Mode 2 distinction since, in such a case; the aims of the research prioritise the contractor's needs and interests (Gibbons *et al.*, 1994).

3.2   Disciplinarity versus transdisciplinarity

Research within Mode 1 contributes to disciplinary knowledge, and is "...developed first and then applied to that context later" (Gibbons *et al.*, 1994: 5). In Mode 1 the research results are communicated through institutional channels, e.g. professional journals, conferences, etc. In Mode 2 the results are disseminated through the production process to the participants of the research and "...as the original practitioners move to new problem contexts" (Gibbons *et al.*, 1994: 5). Mode 2

transdisciplinary knowledge is dynamic since a particular solution can offer the cognitive site for further research. An example of transdisciplinarity in the humanities is classical world studies which once mainly concerned archaeologists, philologists, historians and specialists in Greek and Latin literature. Now, however, the "...insights of anthropology and the techniques of science" (idem: 101) are changing it. An example of transdisciplinarity in the natural sciences is a research project on Viticulture conducted at the Agricultural Research Council (ARC), as indicated in the quote below. The project's results formed the basis for further research, as indicated by the researcher's report on the utilisation of the findings:

> The technology from this and previous research on the same subject is now implemented in the South African Wine Industry and in other countries (e.g. Chile, Switzerland, Uruguay, Spain, Australia, etc.) as a standard canopy management program for the control of vegetative growth, and the improvement of disease control, grape composition and wine quality. A leaf-thinning machine has been developed and patented based on results obtained from this research. It is manufactured in SA and is already running in South Africa, Chile, Switzerland and Australia.

3.3   Heterogeneity and Organisational diversity

The heterogeneous nature of Mode 2 is defined by the diverse skills and experiences required of the research team members. Mode 2 is typified by temporary teams and networks, which are not strictly institutionalised, but exist only for the duration of the project.

Gibbons *et al.* (1994) maintain that organisational diversity is expressed in three ways. Firstly, the inclusion of government and industrial laboratories and research centres, think-tanks, consultancies, and civil society organisations has led to an increase in the potential number of 'sites of knowledge production' besides that of universities and colleges. Diverse patterns exist for funding these kinds of partnerships and new organisational forms. Secondly, Mode 2 knowledge is facilitated by the diverse ways (social, organisational, electronic and informal forms) in which these sites are linked by communication networks. Thirdly, research activity at these sites has become more and more specialised (of fields, areas) to form sub-fields from which new knowledge is

produced. "Over time, knowledge production moves increasingly away from traditional disciplinary activity into new societal contexts" (Gibbons *et al.* 1994:6).

3.4   Social accountability and reflexivity

New forms of social accountability are reflected in the increased participation of different interest groups in the research process. It filters through to the entire knowledge production process "...not only in interpretation and diffusion of results but also in the definition of the problem and the setting of research priorities" (Gibbons *et al.*, 1994: 7). This consideration of the "...impact of the research is built in from the start [and] forms part of the context of application" (Gibbons *et al.*, 1994:7). Gibbons *et al.* (1994) link the need for greater accountability to the need to be reflexive of other standpoints and it is this acknowledgement of other standpoints that makes the research process itself more reflexive. Examples of disciplines to which reflexivity has given rise, since their intellectual energy comes from perpetual inquiring of the past by the present, are the humanities, history, literature and philosophy.

3.5   Quality control

In Mode 1, the primary criterion for judging the quality of disciplinary research has always been peer review. In Mode 2, research quality is determined by additional criteria (socio-economic and political criteria) which the social players involved in the context of application bring to the review process. This broader set of criteria, and the increased participation in the review process, functions in two ways. First, it raises questions not traditionally deemed important in disciplinary research (e.g. the competitiveness of the solution in the market, cost effectiveness, social acceptability). Second, the broadening of criteria provokes disagreements about what constitutes "good science" (Gibbons *et al.*, 1994: 8). For example, scientific and technological knowledge production systems began the process of quality control with educating and selecting students and then, through their recruitment into the scientific community and to its "elites" through peer review (Gibbons *et al.*, 1994: 8). Then later as the market expanded and became more dependent on external funding, this process was enhanced by more bureaucratic forms of quality control measures implemented by committees, commissions, etc.

4. Forms of knowledge utilisation: analysing the NACI dataset

As already mentioned in Section 3.3.1 of Chapter 3, the open-ended responses to Question 23 in the survey were post-coded according to the distinctions of Mode 1 and Mode 2 mentioned above. Thus each project that was reported on (a total sample of 1052 projects) received a code of *1*, indicating that the project exhibited some features of Mode 1; received a code of *2*, indicating that the project portrayed some features of Mode 2; and a code of *3*, indicating that the project exhibited a combination of features of Mode 1 and Mode 2. My analysis of the responses revealed a variety and richness in detail that added to an understanding of forms of utilisation. In the remainder of this chapter I will provide illustrative examples of these open-ended comments.

4.1 Mode 1

The distinctions of Mode 1 and Mode 2 knowledge <u>production</u>, mentioned in Section 3 above, were extended to distinctions of Mode 1 and Mode 2 knowledge <u>utilisation</u>. I argue that Mode 1 modes of utilisation are primarily aimed at 'epistemic' forms of utility – the use of research to contribute to the body of knowledge and (by others) to improve (their) knowledge. Research that would be classified as typically Mode 1 knowledge utilisation would exhibit the following features:

- Research is used to advance or improve existing knowledge and understanding
- Others scientists benefit or use the research to advance their research or to improve their understanding, as indicated through e.g. citations, invitations to conferences, workshops, open days, etc.
- Development of skills and competencies
- Training of students
- The main beneficiaries of this mode of utilisation are other academics, scientists, scientists-in-training, or the like.

In the rest of this section, I will illustrate how these features were manifested in the open-ended comments with some examples. What should be noted in each example is that although the quotes have been selected to illustrate a specific distinction, the quotes also illustrate some of the other characteristics of Mode 1 knowledge utilisation.

The following four quotes, from four different fields, were selected because they illustrate how research is used to advance existing knowledge and understanding.

In the Library and Information Department at the Durban Institute of Technology (DIT) a study on the Development of the SALIT (South African Literature) Database was conducted, entitled *Investigation of the research possibilities of an organised database of electronic texts in South African literature*. The researcher described the utilisation of the findings in the following manner:

> The bibliographic segment of the database is available to scholars via the Internet. Additional content is the basis of a print encyclopaedia yet to be published. The project has also led to a further South African literature information gateway.

In another study a researcher in the Pathology Department at the University of Pretoria worked on a project entitled *The Pathology and Pathogenesis of Canine Cerebral Babesiosis* and described the aims of the project as "Gross, histopathological and ultrastructural investigation of the pathology of cerebral lesions in canine babesiosis. Comparison of brain capillary parasitemias and central/peripheral blood smear parasitemias to investigate the process of sequestration of parasitised erythrocytes in cerebral capillaries". The researcher described the utilisation of the research results as:

> Improving the knowledge base on the mechanisms involved in the development of cerebral pathology in canine babesiosis is of use to veterinarians both in Southern Africa and world-wide: Cerebral babesiosis is not recorded outside of Africa although piroplasmosis (various species) occurs in dogs all over the world. South African colleagues find the material useful in terms of enhancing treatment success as a consequence of better understanding of the disease mechanisms. A colleague from South America was able to establish that he had cases of Diminazine toxicity and not cerebral babesiosis, based on findings from my work. The comparison between human cerebral malaria and canine cerebral babesiosis is not sufficiently close or predictably inducible to make a canine model of cerebral malaria practical. However, much light has been shed on the similarities and differences between the two diseases.

A study on the *Optical characterization of semiconducting, hard materials, alloys and diamonds* in the Physics Department at the University of Port Elizabeth, the description

63

of the study was reported as follows "Reflectance Fourier Transform Infrared Spectroscopy is used, together with computer curve fitting procedures, to obtain as many as possible dielectric, physical and optical parameters of materials investigated". According to the author, the research was useful in the following ways:

- Knowledge gained was used to improve growth conditions of new semi-conducting materials developed in the Department
- Students gained degrees
- Knowledge base in the field of optical characterization was broadened.

In a study on *The influence of infection history on the immunopathology of unrelated infections* at the University of Stellenbosch, the project objectives were formulated as "Die ondersoek van die invloede van infeksies op die immuunsisteem en spesifiek die veranderde presentasie van daaropvolgende infeksies: die meganismes van sulke interaksies in ondersoek". The researcher described the utilisation of the study as:

> Die werk gee ondersteuning aan die konsep dat infeksies vroeg in die lewe van 'n individu 'n positiewe uitwerking op die ontwikkeling van die immuunsisteem kan uitoefen. Dit vorm deel van die literatuur wat die oordrewe fokus op uitskakeling van alle infeksies en voorkoming van blootstelling aan alle kieme teenstaan.

The following four responses illustrate Mode 1 utilisation where other scientists benefit or use the research to advance their research or to improve their understanding, as indicated mainly through citations. Being cited and recognised by one's peers in turn often leads to invitations to conferences and workshops.

The first study was a narratological approach to the Gospel according to John and was conducted at the University of the Free State. The principle investigator described the project as "Theories on the way in which narrative texts should be analysed (i.e. narratology) and are used to explain the Gospel according to John". In describing the utilisation of the project, the researcher reported that "the results were published in two academic books overseas (United States and Europe) and these books received good reviews. Both books are regularly quoted by other scholars working in the same field".

The second study was conducted by a researcher in the School of Anatomical Sciences at the University of the Witwatersrand, entitled *Factors affecting the differentiation of embryonic gut and pancreatic endocrine cells. Also Factors affecting implantation.* In the description of the project the following was reported:

- We have tried to determine what factors cause proliferation and differentiation of pancreatic endocrine cells in order to increase insulin cell proportions for diabetic patients.

- We have used super-ovulation to attempt to investigate factors that control implantation of blastocysts.

Utilisation was reported as follows: "information in published papers has been utilised by other researchers in the field".

The third study, entitled *Structure and function of a Lepidoptera assemblage associated with fungus galls on Acacia karoo: implications for environmental monitoring*, was described as:

> Variability in characteristics of this moth assemblage was examined across geographic (regional) and urban gradients. Amongst the more theoretical objectives, the aim was to identify the impact of regional climatic turnover and disturbance related to urbanisation on the system (i.e. moths, fungus and tree). This was then used to further understand, and as basis for developing a bioindication system for, the impact of regional climate change and the impact of urbanisation on biodiversity.

The research results were recognised by other scholars:

> It has been reasonably well cited by other researchers in the field. It formed the basis for a major conceptual advance in the field of bioindication. These concepts have been included in the recent Encyclopaedia of Environmetrics, and I have been invited to present them at international fora.

The final study in this set of examples is a project entitled *Die Griekse vertaling van die Ou Testament.* The researcher described the project as follows "Die boek Spreuke in die Septuaginta was tot onlangs 'n braak navorsingsarea. Ek was in die gelukkig posisie dat ek die situasie kon verander. Ek het aan verskeie aspekte van die vertalingseenheid

65

gewerk en die resultate internasionaal laat toets". According to him the research was put to use as follows:

> Ek het nuwe perspektiewe kon open tov verskeie aspekte van die Septuaginta-navorsing. My standpunt oor die beperkte invloed van die Hellenisme in hierdie Griekse vertaling word tans algemeen in spesialiste kringe aanvaar. Dit word, bv. in die nuutste internasionale handboek oor die Septuaginta positief aangehaal. Verder is ek pas uitgenooi om die oorsigartikel vir die Septuaginta vir die volgende uitgawe van die internasionaal erkende Duitse Ensiklopedie, RGG (Religion in Gegenwart und Geschichte) te skryf.

Another form of Mode 1 utilisation is where research involves the development of skills and competencies related to scholarship.

In the Biochemistry Department of the University of Natal, a researcher conducted a study on *Immunomodulation in Malaria* and described the project as "Using monocytes as a model to determine alterations in receptor expression in response to antimalarial drugs". According to the researcher, the study was useful in the following ways:

- Publications cited

- Methodology utilised

- Students gained employment in a range of fields both related to the research field (postgraduate studies) or unrelated (business).

The second study in this set of examples was conducted at the Rand Afrikaanse University in the Department of Geology, entitled *Southern Africa's coal deposits*. It was described as "Investigating the sedimentological and geological origin of Southern Africa' Permian coal, to establish its distribution and quality characteristics relative to its geological setting". The research results were used in the following manner:

> Several postgraduate students who undertook coal research projects under my supervision successfully completed their theses and now are employed in the coal industry sector. I also generated many journal articles and congress proceedings, locally and abroad, and these widely publicised my research findings.

Below are three quotes selected to illustrate the training of students as a characteristic of Mode 2 knowledge utilisation.

In a study on the *Modern Day Impact of Religious Legal Systems in South Africa* at Potchefstroom University, the aims are described as "Die invloed van nie-erkenning van Godsdienstige regstels (bv. Hindoereg, Islamitiesereg en Joodsereg) in die nuwe grondwetlike bedeling van SA". The researcher reported utilisation of the project findings as: "Publikasie van boek oor regspluralisme - word voorgeskryf by sekere Universiteite. Ontwikkeling van nuwe kursusse in die vooruitsig by Universiteite wat nog nie vantevore die kursus aangebied het nie".

In another study concerning *Trends in medical education in South*, the principle investigator described the project as "Bepalings is gedoen t.o.v. die nuutste tendense wat huidig in Suid-Afrika besig is om die opleiding van geneeshere te beïnvloed in die lig van veranderde onderwys- en gesondheidswetgeing" and reported the form of utilisation as: "Nuwe leerplanne vir mediese opleidingsprogramme is en word tans opgestel aan die hand van resultate wat uit hierdie navorsing voortgevloei het. Die nuwe 5 jaar mediese program aan die UV is 'n sprekende voorbeeld hiervan". The researcher identified lecturers, students and academic general practitioners as the beneficiaries of this research.

A researcher in the Psychology Department at Vista University worked on a project entitled *Perceptions of psychology students from a historically black South African university of circumstances impacting on their lives*. The project was described as "The identification of factors impacting on the successful studies of black university students at an historically disadvantaged institution (HDI). Students' perceptions of obstacles and helpful factors in their experiences of study were explored. Personal experiences relating to cultural challenges were explored. Personal biographical information was obtained". The utilisation of the research was reported as:

> Students were made more aware of the application of psychology to their own lives (short term). The results were integrated into a new revised curriculum in psychology programmes at Vista University. The programme is considered one of the most progressive and successfully transformed in the country. The research

has sparked further interest within the Department in terms of transformation in psychology application and teaching.

In a project entitled *Luminescence Properties of Platinum Complexes,* the utilisation of the research results are described as:

> Students have been trained in a range of important techniques. To date on this project 2 PhDs have graduated and a third submits his PhD next month (November 2002). Of the three, two have employment with the de Beers DRL while the third works for South African Tioxide - all have benefited from the skills and theory training the project offered.

The six quotes below were selected to illustrate Mode 1 knowledge utilisation as changing behaviour, attitude or values.

The first quote concerns a study conducted in the Biomedical Science Department at Port Elizabeth Technikon on the *Biological activities of traditional medicine in the Eastern Cape* and is described as "Antimicrobial and antifungal activities were determined for traditional medicines and medicinal plants in the Eastern Cape used to treat various infections". The research resulted in traditional healers using more sterile techniques than before.

In another study, entitled *The maintenance, evaluation and upgrading of indigenous sanga cattle* the researcher reported the aim of the project was "To counteract the misconception that indigenous cattle breeds are inferior and with little improvement potential". The form of utilisation of the project findings was determined as:

> The value of indigenous breeds is generally recognised by both commercial and emerging farmers. The nguni is now recognised as a breed with more than 150 seed stock producers

In a study that centred on *The role of women in the decision making structure of the Church* and which was conducted in the Communication Department at Border Technikon the findings/results led to the following:

> There has been an acceptance of responsibility in the area of decision by women in the congregation. Also, an acceptance by men that women have what it takes and,

as such, a decision by the male dominated session has been taken to include women in the ruling body of the congregation where the sample was taken.

Researchers at a centre for visual art worked on a project entitled *Zulu ceramics: Tradition and innovation*. The project was described as having the following aspects:

- Quantitative and qualitative survey of heritage collections of both historical and contemporary Zulu ceramics in museums of Kwa-Zulu Natal (KZN)
- Indigenous pottery utilisation in KZN: forms and functions.

The researcher described the utilisation of the findings in the following manner:

- Positively enhanced (altered) heritage reception to indigenous ceramics artefacts in national and international museums
- Drew national attention to a neglected area of material cultural production, and hence altered perceptions of Zulu ceramics.

The aims of a study on *Tuberkulose in 'n geselekteerde gemeenskap in die Wes-Kaap* were described as:

> Die kennis, houdings, persepsies en oortuigings van TB pasiënte en gemeenskapsleiers is vasgestel om beter pasiënt bywoning by klinieke te kry en om meer begrip vir die TB pasiënt te hê. Stigmatisering is nog 'n groot probleem, asook onkunde oor die siekte onder die pasiënte en leiers.

The form of utilisation was reported as:

> Gemeenskapsleiers se persepsie oor TB het verander nadat hulle die werklike feite gekry het. TB lyers self het goed gevoel en was meer gemotiveerd om bahandeling te neem, omdat daar begrip was vir hule siekte en meer tyd by die kliniek aan hulle spandeer is.

Yet another project investigated the portrayal of women on television and in the media. It was conducted in the Research Department at the Vaal Triangle Technikon. The principle investigator reported that the project aimed to study the image of gender in the media. The form of utilisation was reported as:

> The SABC has utilised women as announcers, presenters and newsreaders and implemented recommendations to have programmes for women audiences. The advertisements no longer portray the image of women as trivial.

All the abovementioned quotes and the quotes that follow illustrate that the main beneficiaries of Mode 1 type knowledge utilisation are other academics, scientists, scientists-in-training, etc.

In a study on the *Application of Chromosome Doubling for the Commercial Exploitation of our Indigenous Flora* was conducted and described as:

> The use of a chromosome doubling technique to develop indigenous plants which cannot be commercialised mainly due to size constraints, but also due to other constraints. Many of the induced autopolyploids are expected to have at least one of the following characteristics that would result in the improvement, or development of new economically important plants: larger tuber, rhizome or root size; increased fruit size; enhanced flower size.

The researcher described the utilisation of the study as:

> At this stage, the University Outreach Programme has been extremely successful to date and has encouraged a number of students to continue with postgraduate studies in the field of research. To date, at least 10 students are continuing with postgraduate research projects.

Rhodes University's Biochemistry Department housed a project entitled *Cell stress and chaperones.* The project was described as "Determination of the role of the tetratricopeptide repeat (TPR) motif domains in the co-chaperone protein, Hop. We showed that the TPR domains were critical in facilitating the role of Hop in binding to the major heat shock proteins, Hsp70 and Hsp90, thereby bringing Hsp70 and Hsp90 together for the maintenance of protein homeostasis in the cell". The researcher reported that "Publications resulting from this work have been cited in the research reports/publication of my scientific collaborators, i.e.: my publications enabled my collaborators to further their work. Two students have been trained and obtained their PhDs". The researcher identified colleagues in Molecular Biology and peers in Biochemistry as the beneficiaries of this research.

The project *THUSA: Transition and Health during Urbanization of Africans* was described as "Die monitering van die gevolge van verstedeliking, verwestering en modernisering op die fisieke en psigiese gesondheid (en risikofaktore vir siektes) van swart mense in die Noord-Wes Provinsie". The research results were used in the following manner:

> Ekself en my kollegas het ongeveer 10 D en 15 M-graad studente in die projek kon oplei, en tans het meer as 15 artikels in nasionale en internasionale joernale reeds oor die projek verskyn. Die akademiese belangegroep as teikengroep se belange is dus goed gedien. Om die resultate in Gesondheisbeleid in die Noord-Wes Provinsie opgeneem te kry (Bv. dat daar 'n siftingsprogram vir diabetes mellitus onder plattelandse swartes gedoen moet word) was nie suksesvol nie. Terugvoering na die proefpersone self en hulle families se uitkomstes is nie gemoniteer nie.

From these examples we see that projects exhibiting Mode 1 forms of knowledge utilisation predominantly related to research that occurred within the discipline, was conducted for the benefit of researcher's peers and expanded on existing knowledge. This indicated that the research of Mode 1 is mostly associated with fundamental research.

4.2   Mode 2

Examples of research that illustrate Mode 2 forms of knowledge utilisation are now given attention. The following is a list of some of the 'indicators' that can assist in identifying research utilisation as Mode 2:

- The most important feature of Mode 2 knowledge utilisation is that the research is driven by non-academics e.g. professionals, those in industry, the greater society, etc., suggesting that commissioned and contract research refers to Mode 2 knowledge utilisation
- Solving of technical, applied, environmental or social problems
- Research that informs decision-makers and/or policy
- Research that lead to changes in legislation
- Developing of new prototypes, products or technologies
- Improving existing products or technical designs.

Once again, it should be kept in mind that although the quotes that follow have been selected to illustrate a specific distinction, the quotes also illustrate some of the other characteristics of Mode 2 knowledge utilisation.

The first five quotes were selected to illustrate that Mode 2 knowledge utilisation is user-driven and therefore especially includes contracted research. To illustrate variety, these selected quotes vary with regard to discipline/field and institution.

The first example, a project entitled *Articulating Agency: A case study of the strategies used by the South African Transport and Allied Workers Union in servicing South African seafarers* was conducted under a Programme for Industrial, Organisational and Labour Studies was described as "Interrogating claims of capital being all powerful via its mobility and labour being agentless in influencing the processes of globalisation". The utility of the research was described as:

> The Seafarer International Research Centre (SIRC) has written and distributed a report of the findings of the research. The Transport, Education and Training Authority (TETA) has distributed the report to all stakeholders in the maritime industry, such as the union (SATAWU), the South African Maritime Association (SAMSA) and four South African shipping companies as well as the navy. We have been invited to contribute to a Department of Transport maritime policy document. The researcher identified peers in Labour studies and Industrial Sociology; colleagues in Economic and Maritime studies; and contractors – the National Research Foundation (NRF) and the SIRC as the beneficiaries of this research.

The next study, conducted in a zoology and entomology department, concerned the *Biological control of alien aquatic vegetation.* It was described as "Involving the identification, importation, host specificity screening, release and post-release monitoring of biological control agents for five aquatic weeds in South Africa. It also involves the integration of biological control with other traditional control methods, such as the use of herbicides". According to the researcher, the findings were used as follows:

> Biological control agents have now been released against all five of the declared aquatic weeds in South Africa. As these programmes have been successful, the Work for Water (WfW) alien clearing programme has reduced the amount of

herbicide and mechanical control needed to clear these weeds. In most cases the weed infestations can be left, as the biological control agents will effectively control them.

According to the researcher the contractor aiding WfW in their alien-clearing programme were the main beneficiaries of this research.

In determining the *Development of indigenous substrates for the cultivation of gourmet/medicinal mushroom species* a researcher in a biotechnology division described the project as the "Evaluation of conditions for spawn production, primordia formation, and fruiting body development" and the form of utilisation was reported as the "Registration of a patent". The contractor EON Corporation was identified as the beneficiary of this research.

The results of a study on *Resin Film Infusion*, concerning "The optimisation of the processing parameters of a dry resin film infusion process for FRP processing" in a mechanical engineering department were reported as follows: "Process was implemented by industry partner to produce a number of technology demonstrators and is used on a small scale in conjunction with pre-preg systems". The researcher identified the industry, Denel Group (a technology based company in South Africa), as the beneficiary of this research.

A researcher in a department of human kinetics and ergonomics worked on a study entitled *Physiological and perceptual responses of SANDF personnel to varying combinations of marching speed and backpack load*. The project was aimed at identifying 'optimal' combinations of marching speed and backpack load depending on whether a fast, short duration march is required, or whether a slower, longer duration march is needed. Results were based on physiological (VO2, VCO2, RER, FB, VT, VE and heart rate) and perceptual responses". The utilisation of the research results was reported as: "Speed and load combinations are being utilised by the SANDF for route marches depending on the needs of the march". The researcher identified other researchers in the field and the SANDF as the beneficiaries of this research.

Below are three quotes selected to illustrate that a feature of Mode 2 knowledge utilisation is often aimed at solving immediate technical, applied, environmental or social problems. The first two quotes are related to studies that were conducted at the Council for Scientific and Industrial Research (CSIR).

The first example concerns a study conducted by a logistics analyst in the Department of Transportek and involved *An integrated supply chain information system for fruit produce between South Africa and the Netherlands*. The researcher described the objectives of the project as:

- To assess the potential benefits and costs of investment in an integrated supply chain information system in order to improve the (electronic) exchange of logistics information as well as product quality information between chain parties

- To assess the feasibility of a fully functional system, small-scale pilots were carried out in 3 existing fresh fruit supply chains from SA to the Netherlands.

According to the researcher the findings/results led to the following:

> The fruit industry partners were involved in the project from the start. The project focused on developing solutions for the information exchange problems that they identified in their respective supply chains, e.g. an improved version of the resulting report was developed and this is now sent from the receiving port in the Netherlands to South Africa electronically.

The researcher identified the fruit export industry as the beneficiary of this research.

In the second study a researcher in the Department of Rock Engineering undertook a project entitled *Develop and implement preconditioning techniques to control face ejection rock bursts for safer mining in seismically hazardous areas* and described the project as follows "Development of practical, implementable and cost-effective preconditioning (rock burst control) techniques to minimise the incidence and effects of damaging seismic events on highly stressed stope faces in deep-level gold mining industry". The form of utilisation was reported as:

74

The project team also studied and published the recommended guidelines for the best implementation of developed preconditioning techniques. Since the completion of the research project the team has been helping mines implement the techniques. Currently, several mines have been implementing preconditioning in deep-level gold mine stopes. Accident rates were decreased while the productivity was significantly increased where the techniques were implemented properly.

The researcher identified researchers in mining, the mining industry (specifically regarding rock engineering and production), inspectors in the Department of Minerals and Energy, and the contractor Safety in Mines Research Advisory Committee (SIMRAC) as the beneficiaries of this research. SIMRAC has the principal objective of advising the Mine Health and Safety Council on the determination of the safety risk on mines, and the need for research into safety on mines based on the safety risk.

A third study, entitled *Health Workers for Change*, was described by the author as follows:

> Development of an innovative research method to investigate quality of care at primary care level, with a specific focus on gender issues. Research methodology developed in a research process in one clinic in South Africa. Method tested for acceptability and generalisability in a multi country study in Africa - four research sites (Mozambique, Zambia, Senegal and Uganda. Research method implemented and output evaluated in a longitudinal multi country study in 7 sites in five countries - Argentina, Nigeria, Ghana, Tanzania, and Kenya. Impact on provider client relations, on provider - provider relations and between levels of care were documented. Patients were interviewed to assess if the intervention had an impact on quality of care. Findings were that this intervention - Health Workers for Change - can improve quality of care and increase gender sensitivity if it is undertaken where the health system is sufficiently functional and where there is buy-in by line managers within the system. Simultaneous to this process was a large intervention project in three provinces in South Africa that also used Health Workers for Change.

According to the researcher, the findings were useful in the following ways:

> Method selected and implemented in a 4th Province in South Africa (Mpumalanga)

Method utilised by international NGOs

Method selected by an UN agency in India and implemented there

Method utilised by NGOs in other countries, e.g. India

Manual translated into Spanish and distributed by Pan American Health Organisation.

The researcher identified primary healthcare workers, nurses and doctors as the beneficiaries of this research.

Changing or informing legislation, as another distinguishing feature of Mode 2 knowledge utilisation, is illustrated below in the three selected projects.

In a project concerning computers and the law the researcher described the utilisation of the findings in the following manner: "Part of the research has been implemented in the new Act on Electronic Communications and Transaction, 25 of 2002, particularly the parts on electronic signatures and on computer crime".

A study on *Reform of the law of negotiable instruments* was conducted in a department of mercantile law and was described as "Investigating the payment systems of the banking industry". The form of utilisation was reported as an amendment in 2000 to The Bills of Exchange Act and the researcher identified the banking industry as the beneficiary of this research.

The three quotes below were selected to illustrate that one of the characteristics if Mode 2 knowledge utilisation is the development of new technology or a product.

The first is a study on *Phytophthora control of avocados using foliar sprays of phosphonic acid* and was conducted in a department of plant production and soil science. The project was described as the "Development of pH balanced foliar sprays of phosphonic acid for the systemic control of avocado root rot (Phytophthora cinnamomi)". The research results were used in the following manner:

Avocado growers internationally now utilize the technology to spray trees rather than inject them to control Phythophthora rootrot. This is a major cost saving to

them as it usually takes 2 weeks to inject 5 hectares whereas a foliar spray may be undertaken in 0.5 days, using a tractor

The researcher identified avocado growers as the beneficiaries of this research.

The second project, entitled *Variflex Beam Technology (Wiper Blades)*, was described as follows:

Process and equipment for manufacturing of a new wiper blade has been designed in this project. A pilot station for production of test samples was built. All specified requirements about mechanical properties and geometry of the product were achieved.

The researcher described the utility of the research as:

The technology has been patented, US 6,063,216. The equipment and process has been sold by Anglo American Corporation to the company Trico Products Corporation of New York, a company that specialises in windshield wiper systems and windshield wiper blades

The researcher identified the contractor Anglo American Corporation, a global leader in the mining and natural resource sectors, and Kolbenco, the largest manufacturer of pistons in South Africa, as the beneficiaries of this research.

In the third study *Development and Validation of the Learning Potential Computerised Adaptive Test (LPCAT)* conducted at a department of industrial and organisational psychology, the researcher described the project as "The development of a dynamic, computerised adaptive psychometric test for the measurement of learning potential, using item response theory methods". According to the researcher "the product of the research is a standardised and registered psychological test. This test is used by persons in industry as well as academics and government departments for assessment of individuals for training and development or for selection/placement".

The researcher identified test users and persons involved in psychometrics and all persons in industry and the government using assessment for selection as the beneficiaries of this research.

The quotes below illustrate improving product or technical design as a distinction of Mode 2 knowledge utilisation.

A researcher in the Measurement and Control Division at Mintek conducted a study on the development of an autotuner for the tuning of control loops in the minerals industry, which included finding a practical way of determining plant models online amidst process noise and disturbances and investigating what online controller design/tuning method will be best suited for the industry. The researcher described the utilisation of the findings in the following manner: "Used in the commissioning of our control systems on minerals processing plants, making the commissioning process easier and enhancing the product we supply the customer with".

A study on *Advanced Monitoring and Control Technology* was conducted in a faculty of electrical and mechanical engineering and the project was described as *"Through research and development, improve and enhance existing or new manufacturing processes/systems, current process: Friction Stir Welding and Glass Manufacturing Process".* The researcher described the utilisation of the findings as: Automated SPC system for quality control embedded networking system for down-time monitoring and control vision system for automated part recognition and classification.

A researcher in a forestry department worked on a project entitled *Commercial products from the wild* and described the project as: "Ontwikkeling en kommersialisering van natuurlike produkte, bv. wildevrugte, wat van bosbou-omgewings verkry word". The form of utilisation was reported as: "Verbeterde produkte is gemaak en beter bemark; volhoubare oesstelsels is in gebruik geneem; vernietiging van bewaarde soorte is verminder".

From the examples used to illustrate Mode 2 forms of research utilisation, we see that research was produced primarily for its use value and that it included the interests of the users. This means research of Mode 2 is predominantly applied, commissioned and/or strategic.

4.3   Combination of Mode 1 and Mode 2

In this section, examples of projects are given to illustrate research where there is a combination of Mode 1 and Mode 2 knowledge utilisation.

The quotes that follow illustrate research used by academics e.g. scholars, students, academics, etc. in combination with research used by non-academics e.g. professionals, those in industry, etc. – i.e. Mode 1 type combined with Mode 2 type knowledge utilisation. The first quote illustrates research used for student development and research used in industry as a form of reference. The second and third quotes also illustrate student training, but differ from the first quote in that they both refer to the development of a new product. In addition, the third quote illustrates use of the research by non-academics – scholars.

The first example is a project conducted by a consultant in a Department of Mining Technology, involved *A Handbook on Rock Engineering Practice for Tabular Hard Rock Mines*. In describing the project and its knowledge production, the consultant reported the following:

> The writing and editing of the book involved the collation, selection and interpretation of relevant research carried out over the past 20 years or so, into a text suitable for students, practicing rock engineers and mine managers. Used as a textbook at universities, technikons and for training of senior personnel on mines. The book is used for training of inexperienced rock engineers on mines and as a reference by practicing rock engineers when presented with out of the ordinary, practical problems. Used for training of mine inspectors in the Dept. of Minerals and Energy and also as a reference for inspectors in their day to day duties and for conducting accident inquiries."

In a physiological sciences department a researcher conducted a study on the *Immune system of athletes*. The project was described as involving studies that were mostly "longitudinal i.e. with multiple time points for assessment of changes in the immune system due to various interventions such as an ultra-endurance race; a season of match-play; high intensity training; nutritional supplementation. We quantified certain aspects of the immune system including some functional assays." Knowledge production was reported as follows:

79

A postdoctoral fellow was employed for 3 years. Results form a significant part of an ongoing PhD thesis (>50%) and 3 MPhil (Exercise Science) students worked on the project. The laboratory collaborated with academics from 2 other departments within the same university. Several abstracts and some publications have arisen from the research. A series of 3 nutritional supplements were designed, tested and the products launched by an industry partner. The project was a finalist in the THRIP awards system.

The study on *Bio-lipiedantigene in tuberkulose*, conducted in a biochemistry department, was described as: "Ontwikkeling van 'n serodiagnostiese toets vir tuberkulose. Ontdekking van ander moontlike toepassings van bio-lipiede in die tuberkulose-veld of ander siekte-toestande van die mens" and the utilisation of the project was reported as follows:

Die navorsingsprojek is aangewend om internasionale kollegas (België, Duitsland, Nederland) te motiveer tot samewerking. Hierdie het gelei tot buitelandse befondsing van die projek en die geleentheid vir vyf nagraadse studente (twee MSc en drie PhD) te skep om hul studies deels by oorsese universiteite op die projek te onderneem. Daar kon drie na-doktorale genote uit die buiteland (Nederland, België en Indië) op die projek gewerf word wat nuwe tegnologie na Suid Afrika gebring het en hoë graadse begeleiding aan studente verskaf het. Daar is drie internasionale patente vir die Suid Afrika farmaseutiese maatskappy geliasseer op die projek, wat aan hulle die eerste keuse bied om kommersialisering van enige produkte daaruit te lisensieer of te vervaardig. Reeds vier MSc-tesisse en een PhD-proefskrif is op die projek geproduseer, terwyl vyf verdere MSc-tesisse en twee PhD-proefskrifte na verwagting voor eind 2003 die lig sal sien op die projek. Daar het ook 14 Honneurs-studente op die projek gekwalifiseer, met nog vier in die vooruitsig voor eind 2003. Daar is reeds drie eweknie-beoordeelde publikasies in erkende wetenskapsjoernale geproduseer op die projek, met drie ander wat reeds ingedien is vir oorweging en twee verderes in gevorderde stadia van opskryf. Die projek is aangewend om skoolkinders uit onderwysbenadeelde gemeenskappe op te lei om TB/VIGS-bewuswordingsprogramme te skep wat uitgedra is na sewe skole in die UP-opvang-gebied.

The following quote illustrates academics and non-academics as beneficiaries of the research. Interest was created and decision-making was influenced.

In the Department of Alcohol and Drug Abuse Research Group (ADARG), at the Medical Research Council (MRC), a study was conducted on *Substance Abuse Treatment Demand Indicators for Cape Town (1997-2001)*. The project was described as "An exploratory study of trends in treatment demand indicators for substance abuse in Cape Town over a four-year period. This study also examines patterns of substance abuse treatment service utilisation and makes recommendations based on the findings for substance abuse treatment service planning and service delivery". The researcher described the utilisation of the findings as:

> Has stimulated debate on the development of minimum standards for substance abuse treatment facilities in South Africa. A document has been developed to this extent. Western Cape Drug Forum is currently debating results.

The quote below illustrates research findings used to advance or improve existing knowledge and to inform and influence decision-making.

In a biosystematics division, a study on *Taxonomy of the phytophagous species of Bruchophagus (Hymenoptera: Eurytomidae) associated with invasive Australian acacias in South Africa* was conducted and was described as "A biosystematic study to determine the identity, distribution and host plant ranges of the species of Bruchophagus that develop in the seeds of Australian acacias, as part of an ongoing search for suitable natural enemies to limit the invasiveness of these plants in South Africa." The utilisation of the research results was described as: "Based on the findings regarding the identity, distribution and host plant preference of these wasps, informed decisions have now been made as to whether it is feasible to import these natural enemies into South Africa for the biological control of invasive Australian acacias".

The quote below illustrates an example of Mode 1 and Mode 2 dissemination.

This study concerned the *Reproduction in the springbok Antidorcas marsupialis* and the researcher reported that the project involved "determining the seasonality of oestrous cycles and the influence of the ram in synchronising oestrus". In describing the utilisation of the project the researcher reported as follows:

The research has been published in one leading international scientific journal and a second paper is appearing in another journal in October 2002. The research has been reported to game ranchers at the Arid Zone Ecology Forum in the Karoo and this is continuing at farmers' days. Lectures to undergraduate and postgraduate veterinary students.

This project exhibits features of Mode 1 utilisation. This is indicated by the fact that the research was disseminated by being published in journals and was reported at forums, and because the research results were used in lectures to veterinary students. There was no reported utilisation of the research outside of the academic environment.

The quote below illustrates an example of research used to inform further research (Mode 1) and research used to improve a product (Mode 2).

The researcher described the project *The identification of groundnut cultivars on biochemical level* as "The unique identification of groundnut genotypes using molecular biology techniques, mainly the AFLP technique and the correlation of generated genetic data with known pedigree and species data" and the form of utilisation was indicated as: "Different seed companies wanted to test their groundnut seed samples for purity and identity. Information generated was also used to plan future breeding projects at our institute."

This next quote illustrates an example of Mode 1 knowledge utilisation as the research being used for student training and by non-academics.

This was a comparative study on the *Organisational restructuring in South Africa and Australia* and was conducted with the purpose of obtaining empirical data about the reasons for and objectives of organisational downsizing as well as the effect of workforce reduction on "survivors" in the public and private sectors in South Africa and Australia. The form of utilisation was reported as follows:

> Die resultate is ingesluit by studiemateriaal vir derdejaar en nagraadse studente in
> die Bedryf- en Organisasiesielkunde. Van die resultate is gepubliseer in joernale
> wat primêr multi-dissiplinêr van aard is en deur persone in die Ekonomiese en

Bestuurswetenskappe gelees word. Konsultante het die resultate gebruik om hulle kliënte te adviseer rondom organisasie-verskraling.

The following quote illustrates student training and informing legislation.

The project title is *The relationship between law and morality with reference to the juridical institutionalisation of the same-sex family* and the researcher, in a law department, described the project as:

> An analysis of the dynamic interaction between law and morality, demonstrated by looking at the changes that our law has undergone from criminalisation of homosexual intercourse to decriminalisation and an active process towards achieving equality in accordance with the constitutionally entrenched right against discrimination on the basis of sexual orientation, e.g. recognition of social security benefits available to "spouses", immigration permits, pension fund rulings, adoption rights, etc. Hart-Devlin debate deconstructed and reconstructed.

The researcher reported that the utilisation of the findings was:

> Articles generated during the course of the research have been prescribed as part of the family law curriculum of University of South Africa (UNISA). Contributions to the field have been incorporated into LAWSA and quoted in major works on family law (e.g. by Sinclair & Heaton). Much debate has been stimulated both at national and international level, by means of conference papers, panel discussions and correspondence with peers in other countries.

This research led to articles being published, to these articles being included in the law curriculum of a university, to dissemination at conferences, to the work being quoted and to awareness being created within this field – all evidence of Mode 1 knowledge utilisation. Because the research contributions were included in LAWSA, utilisation outside of academia is implied and this indicates Mode 2 utilisation.

The quote below illustrates student training and solving of environmental problems.

This was a study on the *Impact of stocking rate, livestock type and livestock movement on sustainable utilisation of sourveld*. It was conducted in a grassland

science department. The description of the project was reported as "Quantifying impact of grazing animal type, numbers and movement on vigour and condition of sourveld with a view to developing ecologically and economically sustainable management strategies for livestock production", and the form of utilisation was reported as follows:

> Groups of farmers and individual farmers have implemented the resulting management strategies and recommendations with improvement in economic performance and improvement of resource conditions. Several provincial departments of agriculture have incorporated resultant recommendations into their farming guidelines. Principles emanating from the research have been incorporated in the relevant modules at several universities.

A researcher in a biology department worked on a project entitled *Control of Delinquent young elephant killing rhino in Pilanesberg National Park* and described the project as "Fifty white rhino were killed by orphan male elephants that were coming into musth, a state of heightened aggression. This is abnormal behaviour, which was attributed to the lack of a male hierarchy in the population. Adult male elephant were introduced to Pilanesberg National Park from Kruger Park to establish this hierarchy, suppress the musth in the young males, and thus prevent the killing of rhino". The author described the utilisation of the research as: "This solution has been implemented at Hluhluwe-Umfolozi Park, which is run by a different conservation agency, based on the results of this work. The work was published in Nature, which made it accessible to academics, and is being incorporated into texts."

This projects exhibits features of Mode 1 knowledge production as indicated by the fact that the research was incorporated in texts and that the results were published. Mode 2 utilisation occurred because the solution to the problem was implemented at a game park.

5.   Conclusion

In this chapter I focused on the meaning of 'research utilisation' as used by researchers in South African higher education institutions and science councils. In answer to the question: "What do researchers mean by 'utilisation'?" the qualitative analysis of the open-ended question revealed that researchers reported that their

projects displayed a wide range of modes of knowledge utilisation. Mode 1 forms of utilisation refer to research used to advance or improve existing knowledge and understanding; where other scientists and scholars benefited or used the research to advance their research or to improve their understanding; where the development of research skills and competencies resulted and where students were trained because of their research. Examples of Mode 2 research were displayed when researchers reported that their research was driven by non-academics e.g. professionals, those in industry, the greater society, etc. and thus their research was commissioned or contracted; that their research led to the solving of technical, applied, environmental or social problems; that their research informed decision-makers and/or policy; that their research led to changes in legislation; that the developing of new prototypes, products or technologies resulted and that their research resulted in improving existing products or technical designs. Researchers also reported utilisation of their research that exhibited features of both Mode 1 and Mode 2. In the next chapter, I will discuss the quantitative analysis utilising this new three-fold classification of 'modes of utilisation'.

Chapter 5
Quantitative data analysis

1.   Introduction

A conceptual framework linking knowledge production and knowledge utilisation informed the construction of the questionnaire used in the survey. The framework, proposed by Mouton and Bailey (2002: 52), takes as its point of departure the fact that scientific research or inquiry produces research outputs of two kinds: 'epistemic' or 'knowledge' outputs, that include all forms of new knowledge: new theories, interpretations, insights, models, hypotheses, conjectures, facts, data, as well as instrumentation; and 'non-epistemic' outputs or knowledge applications, that includes all forms of application and technology that flow from the research process. The latter includes process and product technologies and artefacts, as well as social science applications such as policies, programmes, interventions, tests, scenarios, strategies, plans, systems, and many more (Cf. Figure 5.1).

"Epistemic outputs (or 'new knowledge') in turn, can be divided into *codified* or *embedded* (or 'tacit') knowledge ... codified knowledge is knowledge that has been 'written up' and which is usually transmitted to a particular audience in a standard form such as a scientific presentation, paper, book, report, electronic communication and so on ... embedded knowledge refers to the knowledge (including skills, competencies) that is embedded in people" (Mouton and Bailey, 2002:52-53).

In their discussion, Mouton and Bailey (2002) also emphasise that different modes of knowledge production have different intended or unintended audiences (or target groups, beneficiaries, user groups) and this principle is expanded on in the framework by including the most important audiences of research: the scientific community, society, government and industry.

Mouton and Bailey (2002) place the focus in Figure 5.1 on the generic context of knowledge production and knowledge application or utilisation.
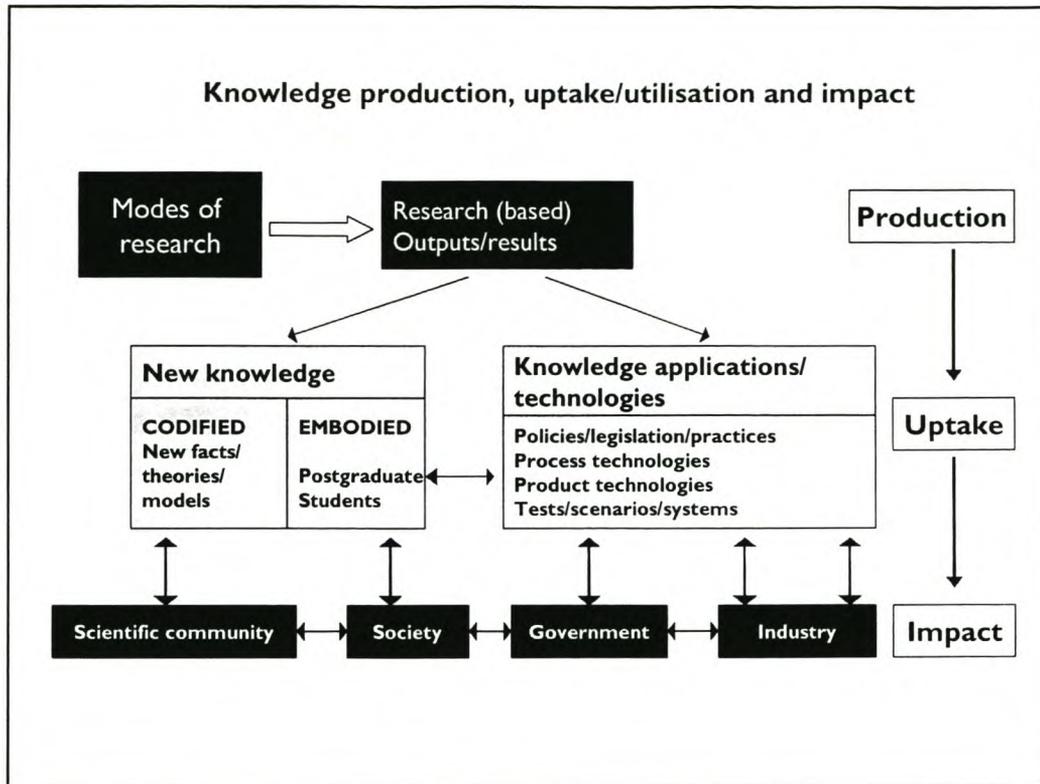
Figure 5.1   Conceptualising knowledge productions and utilisation

They emphasise the following basic precepts about the dynamics of knowledge production (research) and utilisation (technological development and utilisation):

- That R&D manifests itself differently in different scientific domains

- That research culminates both in epistemic and non-epistemic products

- That different 'audiences' or 'interest-groups' place different expectations and demands on the R&D process.

2.   Mode of utilisation

Out of the total of 2058 questionnaires that were received, 1803 respondents (88% of total) provided details about their research projects. In this study I have recoded 1052 according to type of utilisation. This recoding was based on open-ended responses of those projects where some form of utilisation was recognised by the project leader (as

discussed in the previous chapter). As is evident from Figure 5.2, the majority of projects were recoded as involving features of Mode 2 (nearly 60%), with one third of projects exhibiting features of Mode 1 type of utilisation. A small proportion of projects (7%) were recoded as comprising both modes of utilisation.
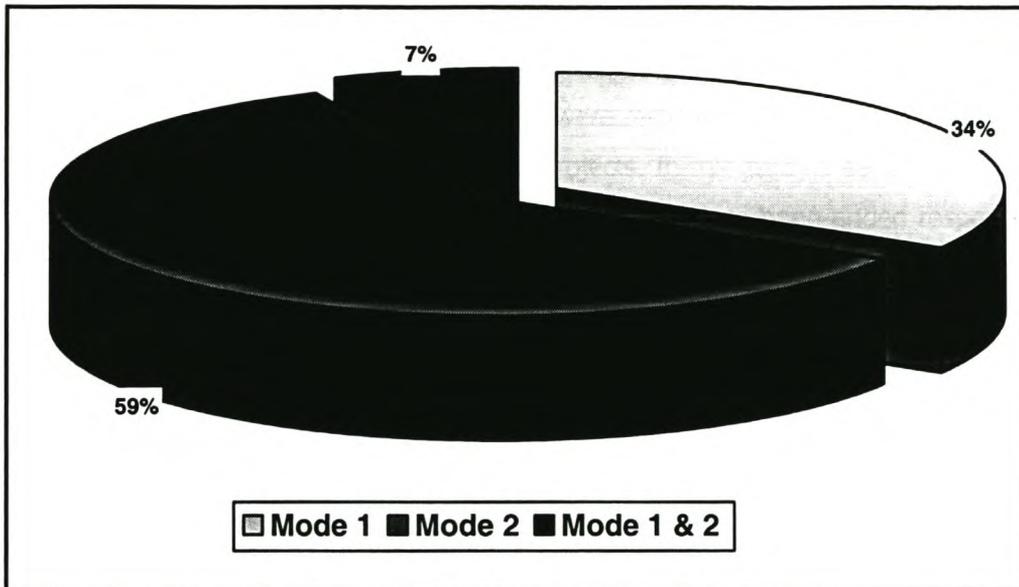
Figure 5.2   Type of utility

Note: N=1 803. Number of missing cases 751.
Source: Mouton, Bailey & Boshoff (2003)

Utilising this three-fold re-classification of 'mode of utilisation', I subsequently cross-tabulated the new variable with the following variables:

- The 'trigger' or driver behind the research
- The expected outcome of the project or study
- The scientific field of the project
- The project's or the study's science culture
- The source of funding of the study
- The modes of dissemination of the results
- The intended beneficiary of the research.

2.1 Mode of utilisation and trigger of research

In an attempt to measure the key motive or motives that 'drove' the research projects being described, the project leaders were asked to indicate what 'triggered' their research. The responses were not mutually exclusive because the respondent could choose between more than one option; in fact they were presented as a series of seven options. These 'triggers' ranged from motives that one would typically associate with fundamental research, such as *own curiosity, previous research by the investigator, being approached by other colleagues to collaborate with them* and *their own interpretation of the immediate environment* to 'triggers' that were more typically associated with applied and commissioned research – *an outside firm or company approaching the researcher*, and *responding to a tender*. Another trigger – *responding to a funding agency* – was dependent on which agency. In the South African context, however, where most funding agencies fund research in specific focus areas, such projects can often be described as being 'strategic research'.

Each of these seven triggers was cross-tabulated with the mode of utilisation. Figure 5.3 shows the distribution of mode of utility by research trigger, arranged in descending order of Mode 1 forms of utilisation.

As expected, in Figure 5.3, those research motives or 'triggers' associated with fundamental research (own curiosity, own previous research and own interpretation of the environment) correlate quite strongly with Mode 1 form of utilisation. Conversely, research triggered by external tenders and a request by an outside agency, is strongly correlated with Mode 2 form of utilisation.
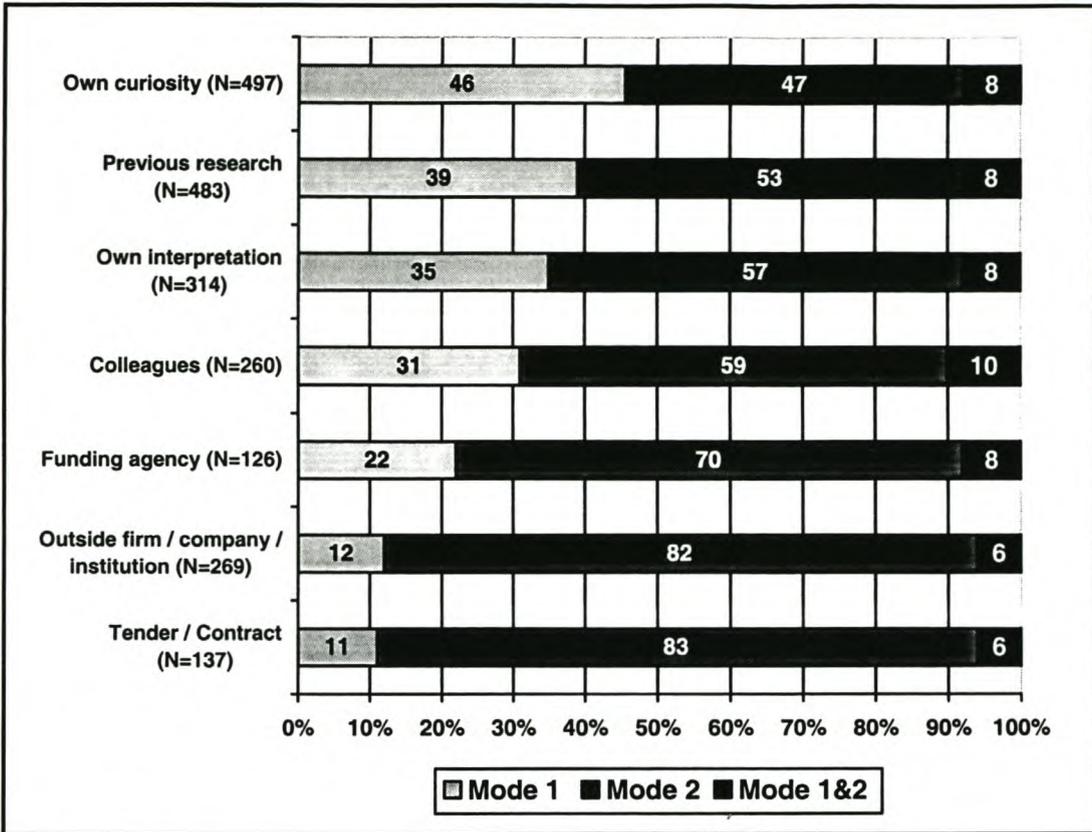
Figure 5.3   Type of utility by trigger of research

Note: N = 1 803. Number of missing cases 751.

Source: Mouton, Bailey & Boshoff (2003)

2.2   Mode of utilisation and expected outcome or value of research project

Another way of measuring the 'type of research' or 'mode of knowledge-production' was to ask the principal investigator to identify the expected outcome or value of the research that he or she was engaged in. Again, some of the expected outcomes would be regarded as typical of fundamental research, e.g. solving theoretical problems, and advancing or improving knowledge. Other outcomes are typical of applied research, e.g. solving applied problems, changing behaviour and informing decision-making. Finally, some outcomes are typically associated with technological innovation and experimental development, e.g. entrance into new markets, engineering a prototype and improving product or design. The expectation was that there would be a clear correlation between Mode 1 forms of utilisation and outcomes associated with

fundamental research. Conversely, it was expected that projects that have outcomes associated with applied studies and technological development would involve more Mode 2 forms of utilisation. The results in Figure 5.4 show that these expectations were borne out.
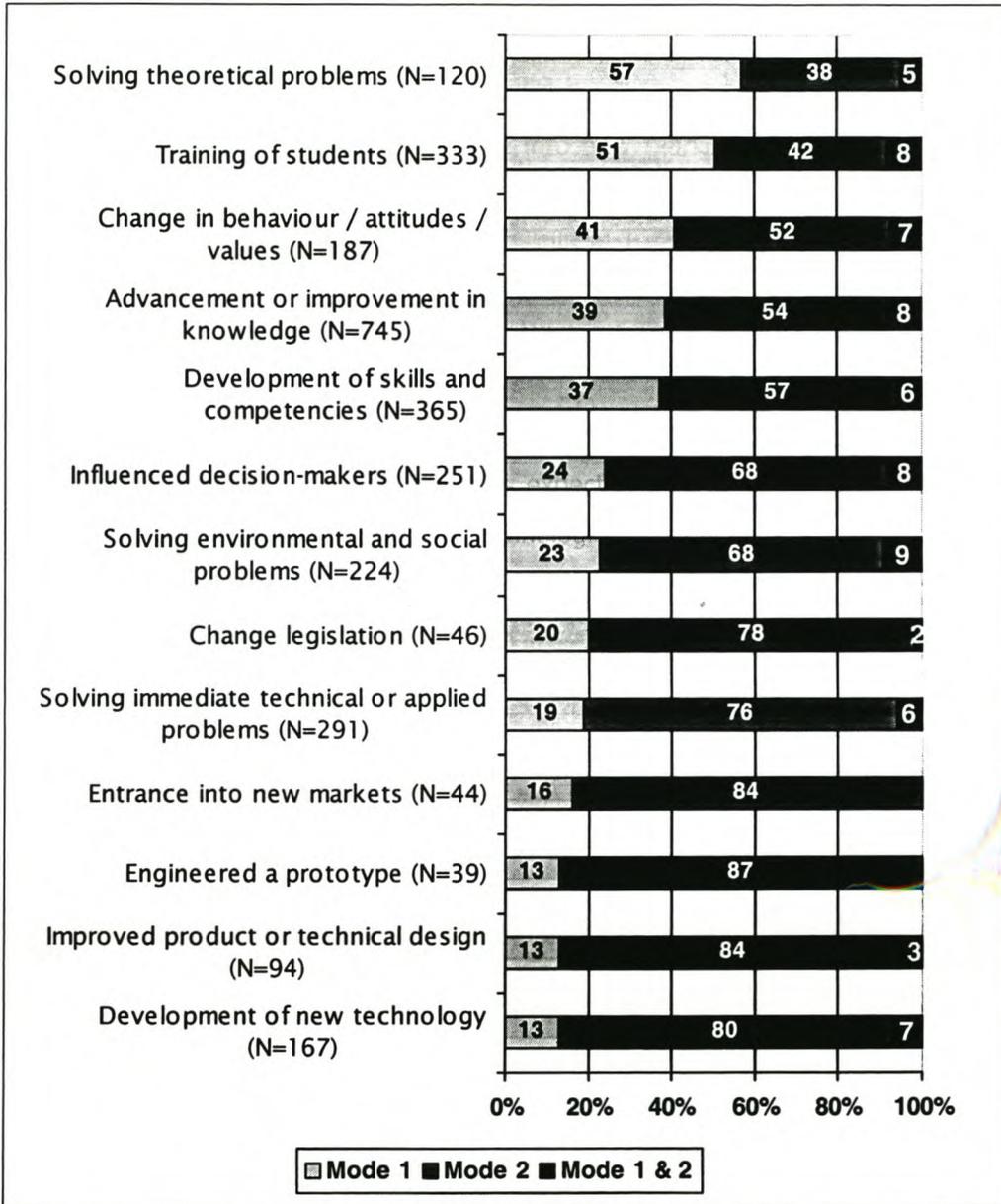
Figure 5.4   Type of utility by expected outcomes

Source: Mouton, Bailey & Boshoff (2003)

Projects that would traditionally be classified as fundamental research (e.g. those projects aimed at solving theoretical problems) scored the highest on Mode 1 type of utilisation (57%). Interestingly projects that were expected to impact on the training of students were also seen as being predominantly Mode 1. This is in line with the conceptualisation of Mouton and Bailey (2002) where the 'trained students' are seen as 'embodied knowledge' to be distinguished from 'traditional codified knowledge outputs' and knowledge applications (Cf. Figure 5.1). The results quite clearly show that mode of utilisation is strongly correlated with the perceived and expected research outcome of the study.

2.3   Mode of utilisation and scientific field

According to the Gibbons *et al.* (1994), modes of knowledge production and modes of utilisation do vary by scientific field. Some fields of science, such as theoretical physics, mathematics, cosmology, and the arts and humanities are still dominated by classic, fundamental modes of research. In contrast, fields such as engineering, agricultural sciences and policy research, as well as the recently emerging fields of biotechnology and other more interdisciplinary domains (e.g. development studies), are more typical examples where Mode 2 forms of knowledge will be more prevalent. Table 5.1 presents a cross-tabulation of mode of utilisation by scientific field. We have highlighted (in black) where the proportions of projects are above the sample average of 34% for Mode 1 utility, 59% for Mode 2 utility and 7% for Mode 1 and 2 utility combined (see Figure 5.2).

Table 5.1   Type of utility by scientific field

Type of Utility

	Mode 1 Utilisation (N=353)	Mode 2 Utilisation (N=628)	Modes 1 & 2 Utilisation (N=71)	N = 1052
Agricultural Sciences	13%	78%	9%	223
Applied Science & Technologies	20%	75%	6%	221
Arts & Humanities	56%	39%	6%	195
Biological Sciences	27%	65%	8%	197
Chemical Sciences	24%	75%	1%	71
Earth Sciences	30%	62%	8%	86
Economic & Management Sciences	30%	64%	7%	135
Engineering Sciences	15%	82%	3%	138
Environmental Sciences	13%	80%	8%	180
Health Sciences	32%	62%	6%	177
Information & Communication Technologies	29%	70%	1%	84
Marine Sciences	25%	70%	5%	20
Material Sciences	28%	70%	2%	43
Mathematical Sciences	37%	61%	2%	43
Medical Sciences: Basic	46%	50%	4%	54
Medical Sciences: Clinical	35%	58%	8%	40
Physical Sciences	33%	61%	7%	43
Social Sciences	38%	52%	9%	268

The fields that recorded the highest percentages of Mode 2 type projects are (in descending order):

- Engineering Sciences (82%)
- Environmental Sciences (80%
- Agricultural Sciences (78%)
- Chemical Sciences (75%)
- ICT, Marine Science and Material Science (70%)

The scientific fields that recorded the highest percentages of Mode 1 type projects are:

- Arts and Humanities (56%)
- Basic Medical Sciences (46%)
- Social Sciences (38%)
- Mathematical Sciences (37%)

These results seemed to confirm the 'face validity' of the re-classification into modes of utilisation as most of these results are as expected.

The scientific fields in Table 5.1 are not mutually exclusive. A project leader could have categorised his or her project within more than one scientific field. To obtain mutually exclusive categories, the responses to the various scientific fields were regrouped as follows:

(1) A social sciences project: a project that falls within the fields of arts and humanities, economic and management sciences, and social sciences or any combination thereof

(2) A natural sciences projects: a project that falls within the field of applied science and technology, biological sciences, chemical sciences, engineering, environmental sciences, information and communication sciences, marine sciences, material sciences, mathematical sciences and physical sciences, or any combination thereof

(3) A health and medical sciences project: a project that falls within health sciences, basic or clinical medical sciences, or any combination thereof

(4) An interdisciplinary social sciences project: a project that falls within any of the social sciences field as well as in either a natural sciences field or a health and medical sciences field

(5) A natural and health & medical sciences project: a project that falls in any natural science field as well as in a health or medical science field.

This broad scientific field classification was cross-tabulated with mode of utilisation and the results are presented in Figure 5.5.
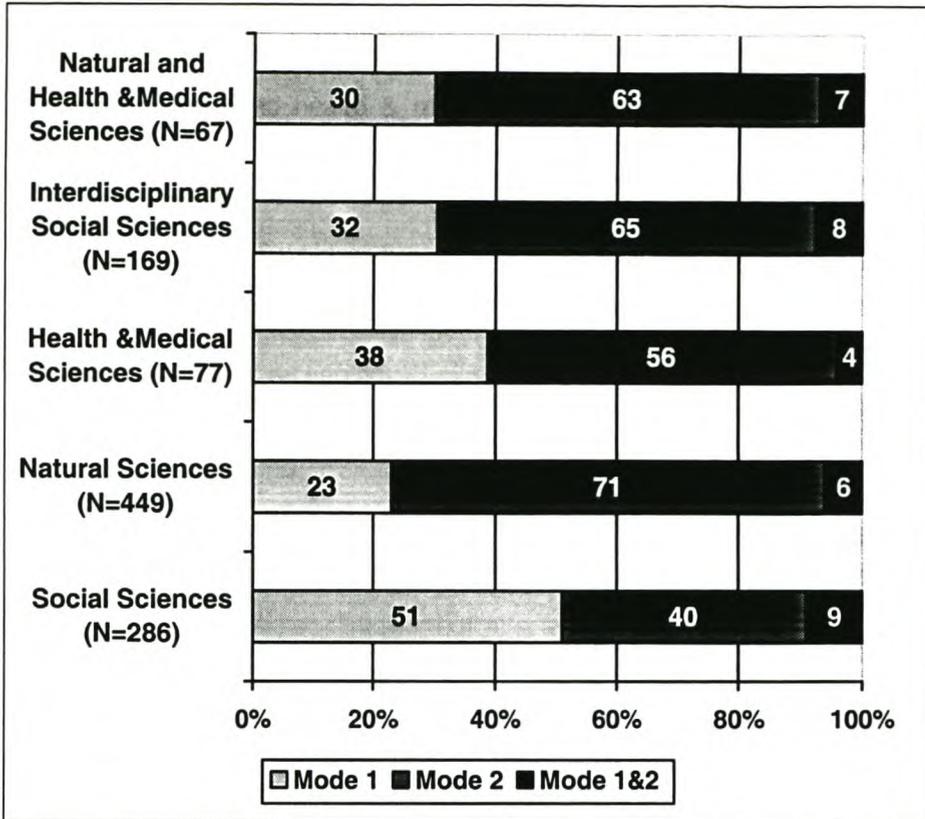
Figure 5.5   Type of utility by science culture

As Figure 5.5 reveals, projects that exclusively fall within the social sciences tend to exhibit relatively more features of Mode 1 type of utilisation (51%), whereas interdisciplinary social sciences projects represents more Mode 2 types of utilisation (65%). Mode 2 forms of utility are however highest for projects that are exclusively located within the natural sciences (71%). What is also worth noting is that – with the exception of projects in the 'pure' social sciences – projects in all other scientific fields recorded higher proportions of Mode 2 than Mode 1 forms of knowledge utilisation, illustrating perhaps the growing dominance of these forms of utilisation and the increased demand for research that has 'non-epistemic' utility.

2.4   Mode of utilisation and source of funding

One would expect that the way in which research is conducted and therefore also disseminated and utilised be related – at least to some extent – to the source of funding. Funding agencies have different missions and target different audiences. Projects that are funded by internal sources and national funding agencies (National

Research Foundation and Medical Research Council) are more likely to be Mode 1 or at least Mode 1 and Mode 2 forms of research, given their mandate of supporting the national knowledgebase. On the other hand, research funded by business and those funds set up to promote applied research and technological innovation (Technology for Human Resources in Industry and the Innovation Fund) are more likely to be associated with Mode 2 forms of research.

A distinction was made in the survey between research conducted in the higher education sector and in the science council sector as far as sources of funding are concerned. The results for the higher education sector are presented in Figure 5.6 and for the science council sector in Figure 5.7.

As far as higher education research funding is concerned, the amounts of funding received from the researchers' own institutions (54%) were higher for projects exhibiting Mode 1 features than any of the other categories. Projects funded by the national funding agencies were more evenly split between Mode 1 and Mode 2 forms of utilisation, reflecting the fact that both agencies allowed for funding across the range of research spectrum. Again, as expected, there is a high correlation between THRIP-sponsored research and Mode 2 modes of utilisation. Similarly, research funded by the Innovation Fund and business involved predominantly Mode 2 forms of utilisation.
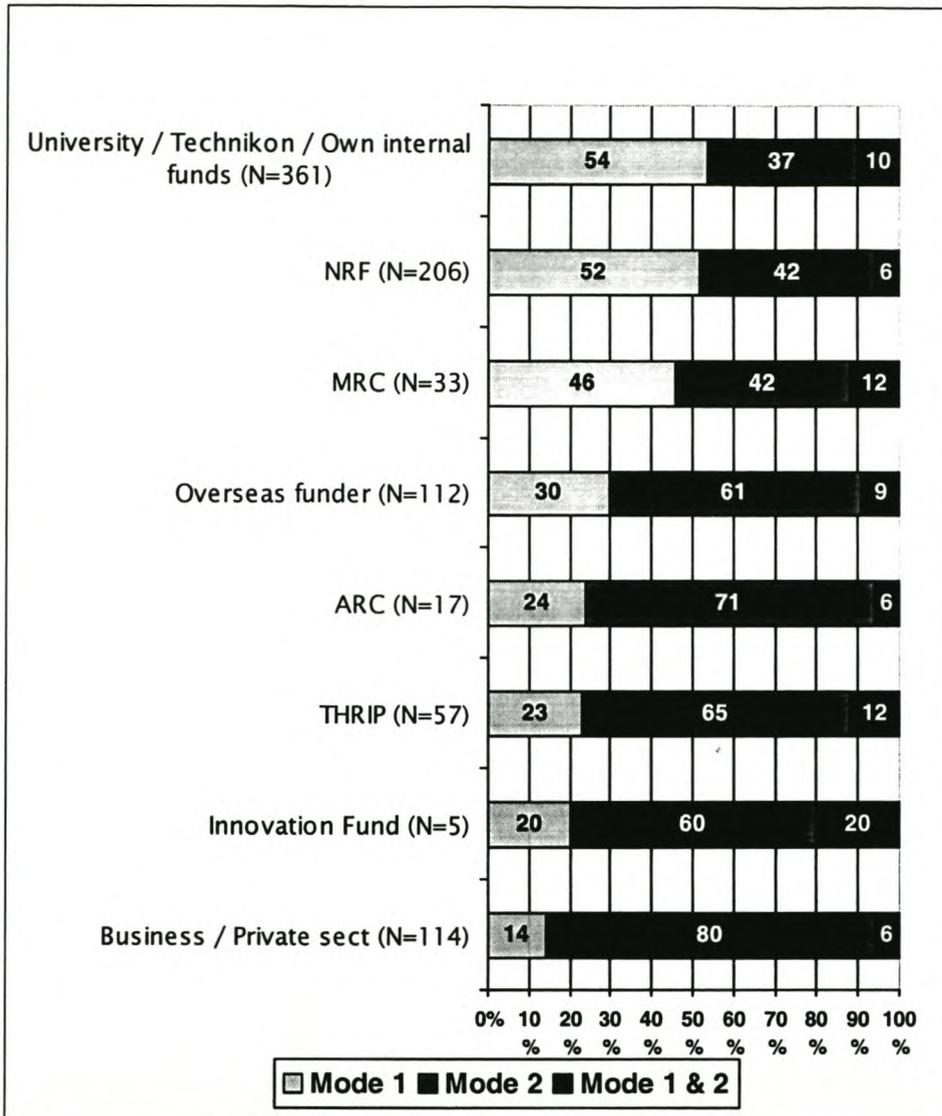
Figure 5.6   Type of utility by source of funding (universities and technikons)

Source: Mouton, Bailey & Boshoff (2003)

The results of research conducted within the science council sector were also mostly as expected. As argued by Mouton (2003), recent shifts in funding in South Africa have led to a greater concentration on directed and competitive funding in the science council sector. It is clear from an inspection of most science council budgets that contract research now dominates the research portfolios of these institutions. Figure

5.7 clearly confirms this trend; the majority of projects were funded by external contracts and the expected high correlation with Mode 2 forms of utilisation is evident.
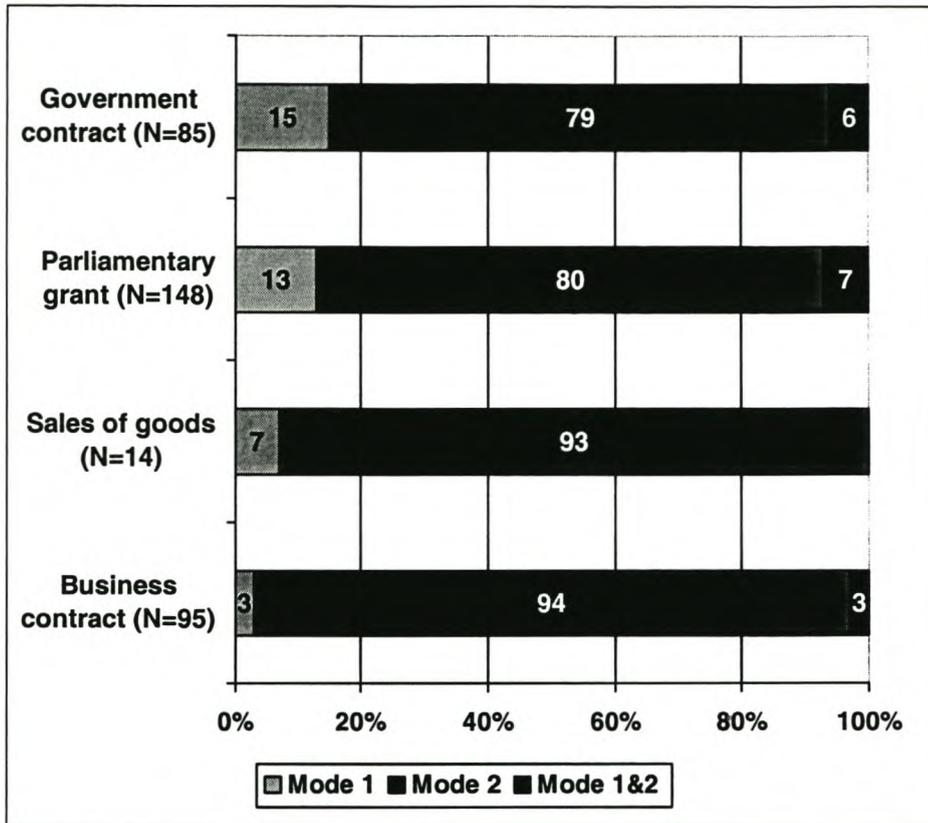
Figure 5.7   Type of utility by source of funding in science councils

Source: Mouton, Bailey & Boshoff (2003)

2.5   Mode of utilisation and mode of dissemination

There are many various ways in which project findings may be disseminated. We asked the project leaders to indicate how they communicated the results of their research, by selecting from 27 modes of communications. On the questionnaire, these modes were grouped together in six broad categories: *Publications and documents, Presentations, Patents/licences, Training and supervision, Cooperative interactions and informal meetings* and *Organisational structures*. Furthermore, for the purpose of re-analysis of the data, these six groups were further categorised into three clusters: *Academic-driven, User-driven* and *Driven through interactions and structures*.

The results of this analysis are presented in Figure 5.8. As expected, research that was academically-driven correlated quite strongly with the Mode 1 form of utilisation. In comparison, research that was user-driven had the strongest correlation with the Mode 2 form of utilisation than any of the other types of utility. There was also stronger correlation of Mode 2 form of utilisation with dissemination that was driven through interactions and structures than the correlation of this variable with the other two modes of dissemination. With the Mode 1 and Mode 2 combination, there was an even distribution of the three clusters of modes of dissemination.
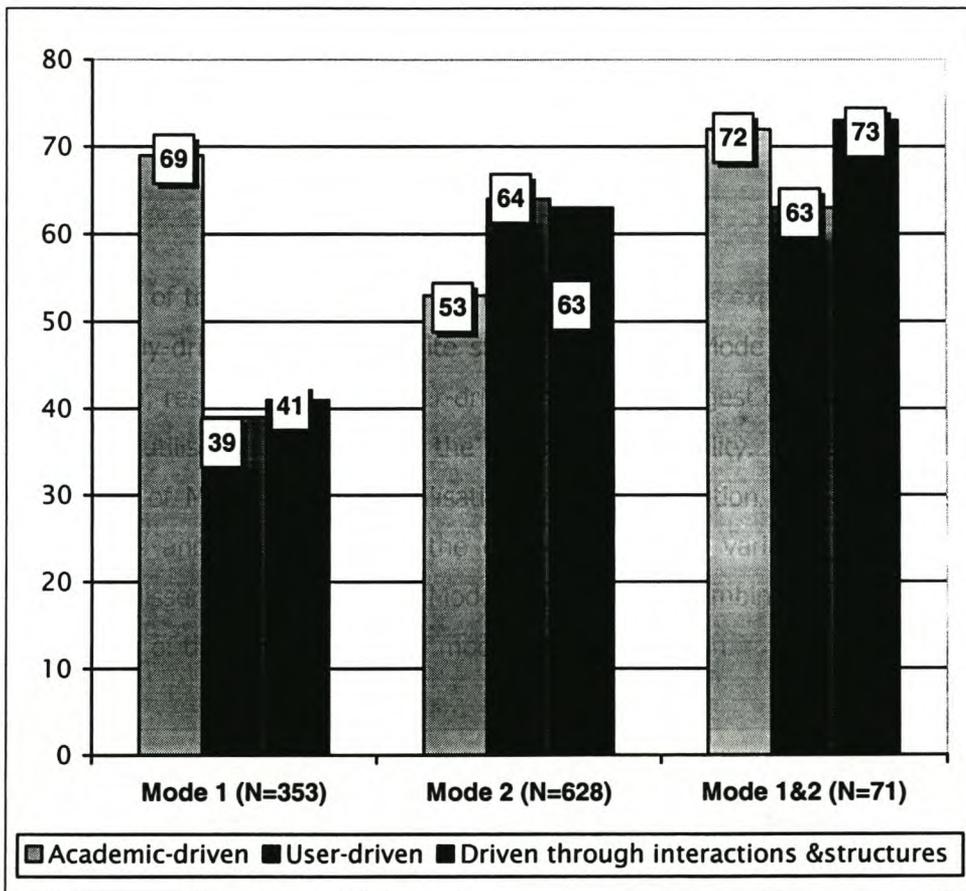
Figure 5.8   Type of utility by modes of dissemination

Source: Mouton, Bailey & Boshoff (2003)

2.6   Mode of utilisation and intended beneficiaries

Respondents were also asked to indicate who the main intended beneficiary(ies) of their research was/were (more than one option could be selected). Respondents could

99

select from a list that included other academic 'beneficiaries' (their colleagues), more diffuse beneficiaries (such as the general public) to more specific constituencies (industry, government and − where appropriate − a contracting agency). The hypothesis here was straightforward: Mode 1 types of utilisation would be strongly correlated with academic beneficiaries (two categories), whereas Mode 2 forms of utilisation would be strongly associated with stakeholders and social groups in the external environment. More specifically, it was expected that Mode 2 utilisation would be strongly related to research that had been done for a specific contracting agency.

The results of this analysis are presented in Figure 5.9. The distribution of responses was as expected. A somewhat surprising result was that significant proportions of projects that had other academics as the intended beneficiaries still involved Mode 2 forms of utilisation. In fact, close inspection of the results for the first two categories showed that research which was aimed to benefit other scientists comprised equal proportions of Mode 1 and Mode 2 forms of utilisation, suggesting how wide the prevalence of Mode 2 forms of utilisation has become.
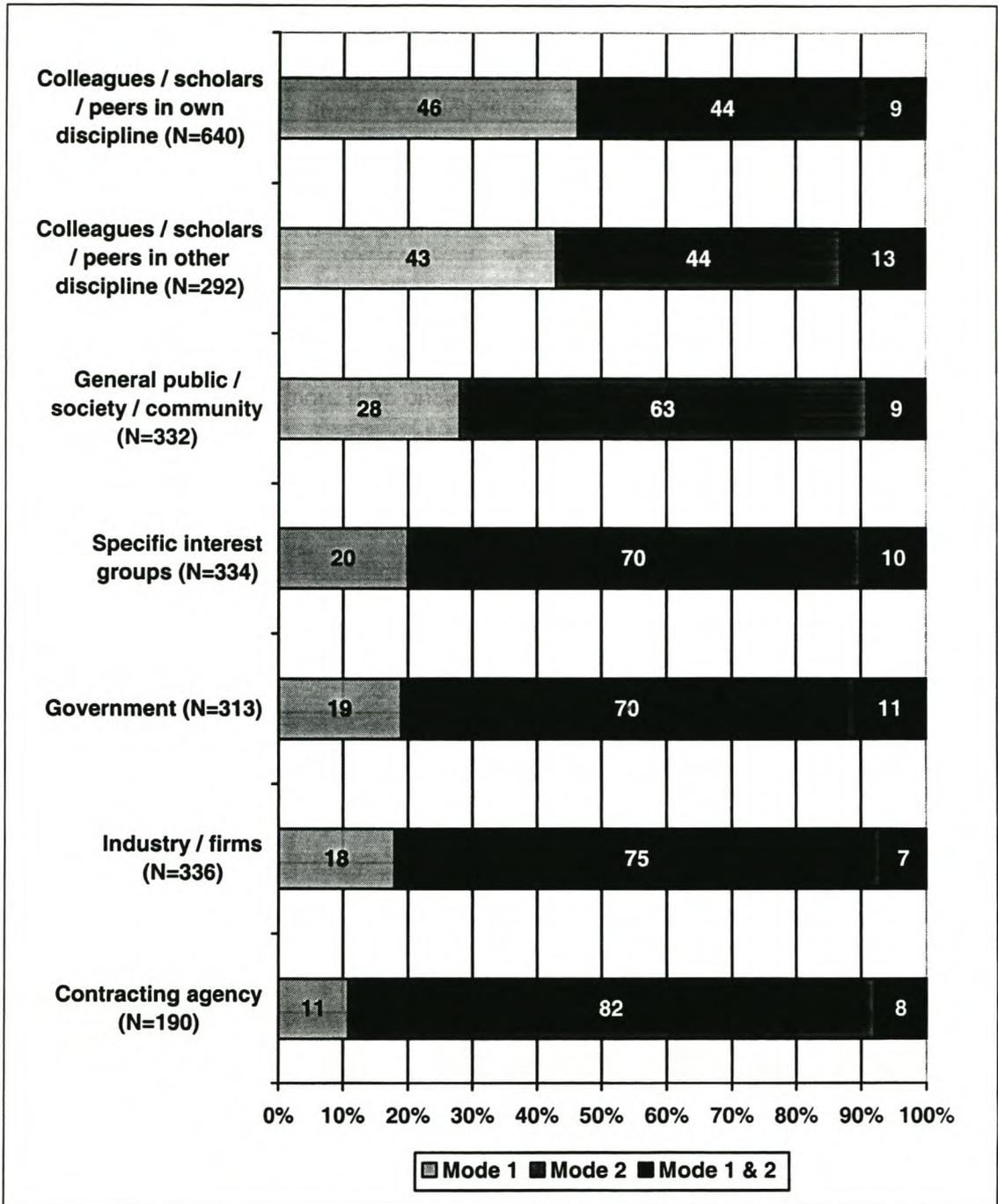
Figure 5.9   Type of utility by intended beneficiaries

Source: Mouton, Bailey & Boshoff (2003)

3.   Conclusion

From the above correlations, we have a profile of what a typical project exhibiting Mode 1 or Mode 2 or a combination of Mode 1 and Mode 2 utilisation would 'look' like. A Mode 1 type project would more likely be associated with fundamental research when it comes to triggers of research and to expected outcomes. When it comes to the intended beneficiaries, the differences are between whether the target group is an academic audience or of a group outside of the academic environment. Similarly, with dissemination, if the research is user-driven, or driven through interactions and structures, then the project would most likely display features of Mode 2 utilisation and if the research is academically driven, then the project would most likely exhibit features of Mode 1 utilisation. With sources of funding, differences between the different modes exist because the way in which research is disseminated and utilised, is related to the source of funding. In the next chapter the findings of Chapter 5 will further be discussed.

Chapter 6
Discussion and Recommendations

1. Introduction

The general aim of this thesis was to conduct a finer and deeper analysis of what researchers, in South African higher education institutes and science councils, mean by the term 'utilisation'. The question that needed answering was: "What do researchers mean when they indicate that their research findings are being utilised?" More specifically: "Was their utilisation predominantly indicative of Mode 1, Mode 2 or a combination of both modes?"

In order to address these questions, firstly a foundation was laid by reviewing available literature on research utilisation and especially on models of knowledge utilisation. From the literature it was first established that there are a wide variety of the interchangeable terms and distinctions of 'utilisation'. Thereafter, from the five models that were discussed, it was argued that some form of interaction or dissemination between users and producers is encouraged, in most models, to facilitate effective utilisation of research. This led us to argue for the adoption of the 'Network' model of Mouton and Bailey (2002) since this model is a combination of the Dissemination and Interaction models.

The second part of addressing the key research questions of the study was done by firstly analysing the responses to an open-ended question, in conjunction with other questions, of the questionnaire, and secondly through coding the responses of this question into a three-fold classification. This three-fold classification was subsequently correlated with a range of other variables presumed to correlate with research utilisation:

- Research motive of the study
- Expected outcome or value of the research project
- Scientific field of the research
- Source of funding
- Modes of disseminating the research findings, and
- Intended beneficiary(ies) of the research.

This chapter summarises the results of these findings as obtained in the previous two chapters and continues with interpreting those results. Reference is made to the relevant literature discussed in Chapter 2 and certain general recommendations are made.

2.   Findings and interpretation

In Chapters 1 and Chapter 4 the 'new' mode of knowledge production was discussed — Mode 2, proposed by Gibbons *et al.* (1994). Mode 2 knowledge production is seen as having 'grown out of' the existing traditional forms of knowledge production, Mode 1. Mode 2 does not replace Mode 1; they are different to each other in almost every way. All the projects that reported on utilisation were coded and categorised according to Mode 1, Mode 2 and a combination of Mode 1 and Mode 2.

2.1   Qualitative analysis

My qualitative analysis of the projects generated a profile of projects exhibiting one of the three categories of the mode of utilisation.

If a project displayed features predominantly within a discipline-based problem-solving or/and in a cognitive context, contributed to disciplinary knowledge and/or where the quality of the research was determined by peer review, then this project was classified as Mode 1 form of knowledge utilisation. Other features associated with this Mode of utilisation are research which is used to advance or improve existing knowledge and understanding; where others benefit or use the research to advance their research or to improve their understanding as indicated through e.g. citations, invitations to conferences, workshops, open days, etc.; where there is an intention to develop research and scientific skills and competencies; where training of students would result and where the main beneficiaries are other academics, scientists, scientists-in-training, or similar.

Mode 2 forms of utilisation generated a different profile. According to this profile, projects exhibited features which related to an application in a problem-solving context, where the research is typically transdisciplinary; show heterogeneity and

organisational diversity; employ new forms of social accountability and reflexivity; and/or where the research quality is mainly determined by social and economic criteria.

The third classification – a combination of Mode 1 and Mode 2 – generated a profile that exhibited characteristics of both Mode 1 and Mode 2.

Once the three different profiles were developed, illustrative examples of specific projects were discussed under each mode.

2.2   Quantitative analysis

The statistical analysis of the projects showed that the majority of projects exhibited features of Mode 2, with one third of projects exhibiting features of Mode 1 type of utilisation and a small proportion of projects comprising both modes of utilisation. This in itself is a very interesting result. If these results are broadly representative of public sector R&D in the country – as I believe them to be – this would constitute a first empirical confirmation of the prevalence and widespread adoption of Mode 2 forms of research in South Africa. Although there has been some speculation before that what is indeed being witnessed is a shift to more applied, strategic and Mode 2 forms of research, it has not yet been possible to verify these claims in any comprehensive and rigorous manner. The analyses of the responses to 1052 project descriptions show that nearly two thirds of these involve Mode 2 forms of knowledge production and utilisation – a clear indication that this shift is real!

The cross-tabulation of the newly constructed 'modes of utilisation' variable commenced with 'research motive'. Not surprisingly, it was found that research motives associated with fundamental research correlated strongest with the Mode 1 form of utilisation. Where the researcher was motivated to carry out research because of curiosity, or due to previous research done by him/herself, or due to his/her own interpretation of the environment, etc.– all indicating fundamental research – then the research would more than likely exhibit features of Mode 1 utilisation. This means that the research was likely to be utilised within the discipline; was conducted for the benefit of the researcher's peers and was conducted to expand on existing knowledge. Conversely, research correlated strongly with Mode 2 knowledge utilisation where researchers were motivated by external factors, such as contract research or because

105

of a funding agency requesting a proposal, or an outside firm/company approaching the researcher for the research to be done. This means the research was conducted within a specific context of application; where research was produced primarily for its use value and with the inclusion of the user's interests; etc. In other words, Mode 2 utilisation correlated strongly with research that was applied, commissioned and/or strategic.

Secondly, when the mode of utilisation was correlated with an expected outcome or value of the research project it was once again found that the outcome of projects, identified by the researcher as typical of fundamental research – e.g. solving theoretical problems, advancing or improving knowledge, etc. – portrayed features of Mode 1 utilisation. Also, it was again found that the outcome of projects that were identified by the researcher as typical of applied research – e.g. solving applied problems, changing behaviour, etc. – exhibited features of Mode 2 utilisation.

The distinction between 'embodied knowledge' and 'traditional codified knowledge outputs' and knowledge applications, as conceptualised by Mouton and Bailey (2002), was substantiated by the results of this study. Projects that were expected to impact on the training of students were also seen as being predominantly Mode 1. Projects that aimed at 'changing legislation' were seen as being predominantly Mode 1 forms of utilisation. This could be attributed to the fact that most of these projects were carried out in law faculties and thus in the field of humanities, where Mode 1 forms of knowledge are more prevalent.

The next cross-tabulation was between the mode of utilisation and scientific field. Here the departure point was the argument put forward by Gibbon's *et al.* (1994), namely that modes of knowledge production and modes of utilisation vary by scientific field. The results of this study confirmed this 'hypothesis'. Projects that exhibited Mode 2 features are typically found in fields such as: engineering sciences, environmental sciences, agricultural sciences, chemical sciences, information & communication technology, marine science and material science. Mode 1 projects are more typically located in the arts and humanities, basic medical sciences, social sciences and mathematical sciences.

Another discovery was that projects that fall within exclusively the social sciences tend to exhibit relatively more features of Mode 1 type of utilisation. On the other hand, interdisciplinary social science projects represent more Mode 2 types of utilisation and Mode 2 forms of utility are highest for projects that are located exclusively within the natural sciences.

With the cross-tabulation of mode of utilisation and source of funding the departure point was that the way in which research is conducted and also disseminated is related – to some extent at least – to the source of funding. Here a distinction was made between research funded at higher education institutions and research funded at science councils. With research funded at higher education institutions, the discovery was that research funded by internal sources e.g. from the researcher's own institute, was more likely to exhibit features of Mode 1 and research funded by national funding agencies, e.g. the NRF, would typically be mostly projects that exhibited a combination of Mode 1 and Mode 2 utilisation. This indicates that both agencies allow for funding across the range of the research spectrum because the mandate is to support the national knowledgebase. Conversely, research funded by external sources, e.g. by business, and those who set aside funds to promote applied research and technological innovation, e.g. the Innovation Fund and THRIP, is more often associated with Mode 2 forms of research. With research funded at science councils, it was found that the majority of projects were funded by external contracts, thus correlating with Mode 2 forms of utilisation.

When the mode of utilisation was cross-tabulated with the mode of dissemination it was found that research that was academically driven correlated strongly with the Mode 1 form of utilisation. On the other hand, research that was user-driven or/and driven through interactions and structures had the strongest correlation with the Mode 2 form of utilisation than any of the other types of utility.

The last correlation that was made was that of mode of utilisation with intended beneficiary. Here we found that Mode 1 types of utilisation correlated strongly with academic beneficiaries whereas Mode 2 forms of utilisation are mostly strongly associated with stakeholders and social groups in the external environment, more specifically, with research done for a specific contracting agency. The slightly more

107

unexpected result was that a significant proportion of projects that indicated other academics as the intended beneficiaries still involved Mode 2 forms of utilisation. On closer inspection we found that the research that is aimed to benefit other scientists comprises equal proportions of Mode 1 and Mode 2 forms of utilisation — suggesting again how wide the prevalence of Mode 2 forms of utilisation has become.

3. General comments and recommendations

Given the findings and interpretations of this study, I conclude with some recommendations.

3.1 Researchers

The South African government has encouraged universities, technikons, science councils, private-sector research laboratories and market intelligence divisions to work together to solve national problems. The government has encouraged this interaction and co-operation within the NSI as a policy framework for science and technology. If one looks at the key features of Mode 2 knowledge production and utilisation, it is obvious that this form of knowledge is highly congruent with research in an application problem-solving context, research that has high social accountability, etc.

The implication is that by conducting research that exhibits features of Mode 2 utilisation, such research would be more relevant to the needs of South African society at large. The results of this study show that this is indeed the case. More than two thirds of public sector R&D seems to focus on utilisation aimed at broader audiences than merely academia or the scientific community. This confirms a trend identified by Mouton (2001) that pointed to an increase in strategic and more applied research in South Africa.

However, it must be emphasised that this does not mean that all research should be applied research or strategic research. The South African government also emphasises the need for traditional, basic, fundamental research, as indicated in the following quote:

> The importance of traditional or basic research must be underscored, as it is crucial in nurturing a national intellectual culture, generating high-level and discipline-specific human resources, and providing opportunities for keeping in

touch with international scientific developments – all of which facilitate innovation (Education White Paper 3, 1997:19).

3.2 Funding bodies

Certain funding bodies fund both Mode 1 and Mode 2 type research, e.g. the NRF and the MRC; however, there are funding bodies and programmes which only fund research of a strategic kind which typically exhibits features of Mode 2 utilisation, e.g. THRIP, SANPAD, the Innovation Fund and so on. This study shows that forms of utilisation are strongly correlated with other project features. This would suggest that funding agencies should perhaps devote more attention – and perhaps require more information – about the dissemination and intended utilisation strategies funded by them. It is clear – especially from my qualitative analysis – that researchers are quite innovative in disseminating their research results utilising a wide array of modes of dissemination. My qualitative analysis has also revealed the very wide range of forms of utilisation – some more formal and others much more informal. By encouraging applicants to be more explicit about their dissemination and utilisation strategies, the potential value and impact of research funded by public funding agencies could possibly be further enhanced.

3.3 Further research

This study expanded on the results of the NACI survey on research utilisation. Through the qualitative analysis a number of interesting issues for further research has been identified. I end with three:

- The role of intermediary organisations in the utilisation of research. These organisations typically 'occupy' the space between knowledge producers and users and perform different roles in facilitating, mediating and brokering knowledge utilisation
- The qualitative analysis has started to reveal the rich texture of the wide range of meanings that 'research' and 'knowledge utilisation' enjoy. I would strongly suggest that further in-depth research – using a variety of qualitative designs – be undertaken to look more closely at disciplinary and field differences in this regard. This will contribute to a more differentiated understanding of utilisation dynamics within different institutions, sectors and scientific fields.

- Further theoretical reflection on the link between different models of utilisation, science policy (especially funding policy approaches) and different systems of innovations contexts is also required. My sense is that the field of knowledge utilisation – although currently receiving increased attention – still suffers from a lack of sustained theoretising.

References

Babbie, E. and Mouton, J. 2001. *The Practice of Social Research*. Cape Town: Oxford University Press.

Beyer, J.M. & Trice, H.M. 1982. The utilisation process: A conceptual framework and synthesis of empirical findings. *Administrative Science Quarterly*, 27: 591-622.

Bless, C. & Higson-Smith, C. 1995. Fundamentals of Social Research Methods: An African Perspective. Kenwyn: Juta.

Boshoff, N. & Mouton, J. 2003. Science policy indicators. In *Human Resources Development Review*. Education, Employment and Skills in South Africa (Chapter 9, 208-233). Cape Town: HSRC Press, and East Lansing: Michigan State University Press.

Bozeman, B. 2000. Technology transfer and public policy: A review of research and theory. *Research Policy*, 29: 627-655.

Booth, T. 1990. Researching Policy research: Issues of utilisation in decision making. *Knowledge: Creation, Diffusion, Utilisation.* 12 (1): 80-100.

Caplan, N. 1979. The Two-communities Theory and Knowledge Utilisation. *American Behavioral Scientist.* 22 (3): 459-470.

Chiang, J. 1991. From 'mission-orientated' to 'diffusion-orientated' paradigm: The new trend of U.S. Industrial Technology Policy. *Technovation.* 11 (6): 339-356.

Dunn, W.N. 1980. The Two-communities metaphor and Models of Knowledge Use. *Knowledge: Creation, Diffusion, Utilisation.* 1 (4): 515-536.

Dunn, W.N. 1983. Measuring knowledge use. *Knowledge: Creation, Diffusion, Utilisation.* 5 (1): 120-133.

Du Toit, J. 2001. The use of survey methodology to determine residents' environmental attitudes towards a modern high-rise public housing complex. Masters thesis, University of Stellenbosch.

Etzkowitz, H. & Leydesdorff, L. 1996. Emergence of a Triple Helix of University-industry-government Relations. *Science and Public Policy*, 23 (5): 279-286.

Etzkowitz, H. & Leydesdorff, L. 1997. Introduction to special issue on science policy dimensions of the Triple Helix of University-industry-government Relations. *Science and Public Policy*, 24(1): 2-5.

Etzkowitz, H. & Leydesdorff, L. 2001. The Transformation of University-industry-government Relations. *Electronic Journal of Sociology*. Downloaded on 24/01/2002. http://www.sociology.org/content/vol005.004/th.html

Frank, G.L. & Wigand, R.T. 1989. Inter-organizational communication and technology transfer: industry-government-university linkages. *International Journal of Technology Management.* 4(1): 63-76.

Frenk, J. 1992. Balancing relevance and excellence: Organizational response to link research with decision making. *Soc. Sc. Med.* 35(11): 1397-1404.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman S., Scott P. & and Trow, M. 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies.* London: Sage.

Government of the Republic of South Africa (Department of Arts, Culture, Science and Technology). 1996. White Paper on Science and Technology. Pretoria: Government Printers

Government of the Republic of South Africa (Department of Education). 1997. Education White Paper 3. A Programme for the Transformation of Higher Education. Pretoria: Government Printers

Government of the Republic of South Africa (Department of Science and Technology). 2002. South Africa's National Research and Development Strategy. Pretoria: Government Printers

Hall, G.E., Loucks, S.F., Newlove, B. W. and Rutherford, W.L. 1975. Levels of use of the innovation: A framework for analysing Innovation Adoption. *Journal of Teacher Education.* 26(1): 52-56.

Huberman, M. 1987. Steps toward an integrated Model of Research Utilisation. *Knowledge and Policy: The International Journal of Knowledge Transfer and Utilisation.* 8(4): 586-611.

Huberman, M. 1994. Research Utilisation: The State of Art. Knowledge and Policy: *The International Journal of Knowledge Transfer and Utilisation.* 7(4): 13-33.

Kraak, A. & Watters, K. 1995. Investigating New Knowledge Production: A Western Cape Higher Education Case Study. Report for Task Group 2: Future Needs and Priorities, NCHE, December.

Knott, J. & Wildavsky, A. 1980. If dissemination is the solution, what is the problem? *Knowledge: Creation, Diffusion, Utilisation.* 1(4): 537-578.

Landry, R., Amara, N., & Lamari, M. 2001. Utilisation of social science research knowledge in Canada. *Research Policy.* Vol. 30: 333-349.

Larédo, P., Jolivet, E., Shove, E., Raman, S., Rip, A., Moors, E., Poti, B., Schaeffer, G., Penan, H. & Garcia, C. 2002. SocRobust, 'Management Tools and a Management Framework for Assessing the Potential of Long-Term S&T Options to Become Embedded in Society', TSER Programme of the European Commission. Final Report. Paris: Ecole des Mines, January 2002. Project SOE 1981126

Lester, J.P. 1993. The Utilisation of policy analysis by state agency officials. *Knowledge: Creation, Diffusion, Utilisation.* 14(3): 267-290.

Lester, J.P. & Wilds, J.L. 1990. The utilisation of public policy analysis: A conceptual framework. *Evaluation and Programme Planning.* 13: 313-319.

Leydesdorff, L. & Van den Besselaar, P. 1994. *Evolutionary Economics and Chaos Theory: New Directions in Technology Studies.* London: Pinter Publishers.

Maclean, D.R. 1996. Positioning Dissemination in Public Health Policy. *Canadian Journal of Public Health.* 87(2): 40-43.

Mansfield, E. 1991. Academic research and industrial innovation. *Research Policy.* 10: 1-12.

Marceau, L. 1996. University-industry-government relations: A 'complexes' equation. *Industry & Higher Education.* 10(4): 252-260.

Martin, B.R. 2003. The changing social contract for science and the evolution of the university. In A. Geuna, A.J. Salter and W.E. Steinmueller (eds.). *Science and Innovation: Rethinking the rationales for funding and governance.* United Kingdom: Edward Elgar.

McMaster, J.L. 1990. Finding Audiences, changing beliefs: The Structure of research use in Canadian Health Policy. *Journal of Health Politics, Policy and Law.* 15(3): 525-542.

Moore, G.B. & Yin, R. K. 1988. Lessons on the utilisation of research from nine case experiences in the Natural Hazards Field. *Knowledge in Society: The International Journal of Knowledge Transfer.* 1(3), 25-44

Mouton, J. 2001. *How to Succeed in your Master's and Doctoral Studies.* Pretoria: J.L. Van Schaik.

Mouton, J. 2001. Between adversaries and allies: The call for strategic science in post-apartheid South Africa. *Society in Transition: Journal of the South African Sociological Association*. 32(2), 155-172

Mouton, J. 2003. South African Science in Transition. *Science, Technology and Society*. 8(2): 235-260

Mouton, J. 1998. *Understanding Social Research*. Pretoria: J.L. Van Schaik.

Mouton, J. & Bailey, T. 2002. *Research Utilisation: A Review and Framework*. Stellenbosch University: Centre for Interdisciplinary Studies.

Mouton, J., Bailey, T. & Boshoff, N. 2003. *A Survey of Research Utilisation*. Stellenbosch University: Centre for Interdisciplinary Studies

National Advisory Council on Innovation. 2003. Utilisation of Research Findings: Extent, Dynamics and Strategies. Pretoria

Neilson, S. 2001. *Knowledge utilisation and public policy processes: A literature review*. Canada: International Development Research Centre.

Oh, C.H. 1997. Issues for the new thinking of knowledge utilisation: Introductory remarks. *Knowledge and Policy: The International Journal of Knowledge Transfer and Utilisation*. 10(3): 3-10.

Oh, C.H. & Rich, R.F. 1996. Explaining use of information in public policymaking. *Knowledge and Policy: The International Journal of Knowledge Transfer and Utilisation*. 9(1): 3-35.

Ravjee, Neetha. 2000. "Modes" of Knowledge Production and Higher Education in South Africa: a Critical Review of the Literature on the Gibbons Thesis. Paper presented at the workshop entitled "New Knowledge Production – Interrogating the Gibbons Thesis from the South African Perspective". Education Policy Unit, Stellenbosch University. March 2000.

Rich, R.F. 1979. The pursuit of knowledge. *Knowledge: Creation, Diffusion, Utilisation*. 1(1): 6-30.

Rich, R.F. 1991. Knowledge Creation, Diffusion, Utilisation. *Knowledge: Creation, Diffusion, Utilisation*. 12(3): 319-337.

Rip, A. 2002. Strategic research, post-modern universities and research training. Paper presented at the International Conference on Science, Training and Careers, 21-22 October 2002.

Scott, A., Steyn, G., Geuna, A., Brusoni, S. & Steinmueller, E. 2001. *The economic returns to basic research and the benefits of university-industry*

relationships: *A literature review and update of findings*. Report to the Office of Science and Technology by SPRU – Science and Technology Policy Research. University of Sussex.

Shinn, T. 2000. The "Triple Helix" and "New Production of Knowledge" as socio-cognitive fields. Paper presented at the Triple Helix conference in Rio de Janeiro. April 2000.

Vergragt, P.J. 1988. The social shaping of industrial innovations. *Social Studies of Science*, 18: 483-513.

Webber, D.J. 1987. Legislators' use of policy information. *American Behavioural Scientist.* 30(6): 612-631.

Weingart, P. 1997. From "Finalisation" to "Mode 2": Old wine in new bottles? *Social Science Information*. 36(4): 591-613.

Weiss, C. 1979. The many meanings of Research Utilisation. *American Society for Public Administration.* Vol. 29: 426-431.

Weiss, C. 1980. Knowledge Creep and Decision Accretion. *Knowledge: Creation, Diffusion, Utilisation.* 1(3): 381-404.

Weiss, C. 1991. Policy research as advocacy: Pro and con. *Knowledge & Policy.* 4(1/2). Online at Database: *Academic Search Premier.*

<div align="right">**Appendix A**</div>

Questionnaire Schedule for Higher Education Institutions

PUBLIC SECTOR R&D IN SOUTH AFRICA:
THE PRODUCTION AND UTILISATION OF RESEARCH

A. YOUR BACKGROUND

1. Title:

Dr	1
Mr	2
Mrs	3
Ms	4
Prof	5

2. ....

3. First names: ....

4. Institution: ....

5. Department/Centre/Division/Institute: ....

6. Position (e.g. senior researcher): ....

7. How long have you been involved in research? .... (years)

8. Have you ever worked in any of the sectors listed below? If yes, please indicate how long you have worked in the sector(s) concerned.

	Yes	No	If yes, for how many years?
Government	Y	2	.... (years)
Industry	1	2	.... (years)
Science council	1	2	.... (years)
Business	1	2	.... (years)
Private/consulting	1	2	.... (years)
Other	1	2	.... (years)
....			

116

9.   Highest educational qualification completed:

Bachelors (BA, B.Tech, etc.) / Higher Diploma	1
Honours	2
Masters (M.Sc, M.Tech, etc.)	3
Doctorate (Ph.D, D.Tech, etc.)	4

10.   Gender:

| Female | 1 |
| Male | 2 |

11.   Year of birth: 19.............

In order to complete Section B, please select one research project that meets the criteria listed below. The project you select could either be a stand-alone research study or a project within a longer-term research programme. The criteria are:

- The project was completed in the last five years (completion is taken to mean that results or findings have been generated, and/or that the project has been reported on)
- You were the primary/principal investigator or project leader on the project
- You devoted significant research time and resources to the project.

B.   RESEARCH PROJECT

12.   Title: ....
....
....

13.   Please give a brief description of the research topic (*e.g. the quantification of resistances to blood flow in the lower limb arterial system using an inverse transmission line model; current trends in the selection of students for Higher Education, etc.*)
....
....
....

117

14. In which broad research domain(s) do the research activities mainly fall? (*Tick all applicable categories.*)

Agricultural sciences	1
Applied sciences and technologies	2
Arts and humanities	3
Biological sciences	4
Chemical sciences	5
Earth sciences	6
Economic and management sciences	7
Engineering sciences	8
Environmental sciences	9
Health sciences	10
Information and communication technologies	11
Marine sciences	12
Material sciences	13
Mathematical sciences	14
Medical sciences: Basic	15
Medical sciences: Clinical	16
Physical sciences	17
Social sciences	18
Other	19
(Specify: ....)	

15. What triggered the research? (*Tick all applicable categories.*)

Previous research by yourself	1
Own curiosity or research interest	2
Colleague(s) approaching you to form part of a team	3
An outside firm/ company/ institution approaching you	4
Own interpretation of the immediate/ future environment	5
A funding agency requesting proposals	6
A tender/ contract research	7
Other	8
(Specify: ....)	

16. (a) What year did the project start? .... (year)

(b) What year did it end? .... (year)

17. Approximately how much of your total working time did you devote to this project during the course of the project?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

18. (a) How much funding (grants, awards, contracts) did you have for the project in total?

Less than R50 000	1
R50 000 – R99 000	2
R100 000 – R249 000	3
R250 000 – R499 000	4
R500 000 – R999 000	5
R1 000 000 – R2 000 000	6
More than R2 000 000	7

(b) Please tick the major source(s) of funding:

National Research Foundation (NRF)	1
THRIP	2
Innovation Fund	3
University/ Technikon/ Own internal funds	4
Business/ private sector	5
Overseas funder/ foundation	6
Medical Research Council (MRC)	7
Agricultural Research Council (ARC)	8
Water Research Commission	9
Other (Specify: ....)	10

19. (a) Did you collaborate with others on the project?

Yes	1
No	2

(b) If yes, please indicate in which sectors your collaborator(s) work. (*Tick all applicable categories*)

Other academics/ scholars	1
Government	2
Science council(s)	3
NGOs	5
Industry/ business	5
Other (Specify: ....)	6

119

20. Which THREE of the following best describe the overall expected value/ outcome of the research? Please rate the extent to which you believe that these outcomes have been attained.

		Highly successful	Successful to some extent	Not successful at all
Advancement or improvement in knowledge	1	1	2	3
Solving of theoretical problems	2	1	2	3
Solving immediate technical or applied problems	3	1	2	3
Solving environmental or social problems	4	1	2	3
Development of skills and competencies	5	1	2	3
Training of students	6	1	2	3
Change in behaviour/ attitudes/ values	7	1	2	3
Influenced decision-makers	8	1	2	3
Change legislation	9	1	2	3
Development of new technology	10	1	2	3
Improved product or technical design	11	1	2	3
Engineered a prototype	12	1	2	3
Entrance into new markets	13	1	2	3
Other (Specify: ....)	14	1	2	3

21. Which intended beneficiaries did you have in mind when you conceptualised the research? (*Tick all applicable categories.*)

Colleagues/ scholars/ peers in own discipline (Specify: ....)	1
Colleagues/ scholars/ peers in other disciplines (Specify: ....)	2
The contracting agency (Specify: ....)	3
Industry/ firms (Specify: ....)	4
Government (Specify: ....)	5
Specific interest groups (e.g. farmers, consumers) (Specify: ....)	6
General public/ society/ community	7
Other (Specify: ....)	8

120

22.   Did the intended beneficiaries recognise/ utilise/ implement the research as planned?

Yes, to some extent	1
Yes, to little extent	2
No, not at all	3
Don't know	4

If <u>yes</u> (some/ little extent), please answer Question 23 and then go to Question 25

If <u>no</u>, please go to Question 24.

If you <u>don't know</u>, please go to Question 25.

23.   Please describe how the research has been utilised/ implemented/ applied by the intended beneficiaries. (*Give concrete examples.*)

....

....

....

....

....

Go to Question 25.

24.   In your opinion, why hasn't the research been utilised/ implemented/ applied by the intended beneficiaries as planned?

....

....

....

....

....

....

25.   What form of support did you provide to the intended beneficiaries? (*Training, writing a manual, etc.*)

....

....

....

....

....

26. How did you communicate the results of your research? (*Please indicate the mode of communication as well as the number of outputs – i.e. the number of articles, reports, books, patents, licenses and workshops that resulted from this project directly or indirectly.*)

Publications and documents	Mode	Number
Articles in refereed scientific journals	1	
Articles in refereed technical journals	2	
Articles in popular journals	3	
Contract reports	4	
Books/ monographs	5	
Chapters in books	6	
Published conference proceedings	7	
Written input to official policy documents	8	
Technical manuals	9	
Presentations		
Presentations to predominantly academic audiences	10	
Presentations to predominantly non-academic audiences	11	
Presentations to expert committees/ panels	12	
Presentations at public hearings	13	
Presentations at fairs/ exhibitions/ road shows	14	
Patents/ licences		
Through patenting	15	
Through licensing	16	
Training and supervision		
Training through workshops	17	
Training through coursework	18	
Supervision of masters and doctoral students	19	
Cooperative interactions and informal meetings		
Consultations/ technical assistance to potential users	20	
Personnel exchanges/ secondments	21	
Informal meetings with potential users/ teams	22	
Organisational structures		
Through participation in consortia	23	
Through science parks	24	
Through spin-off companies	25	
Through technology transfer offices	26	
Through technology incubators	27	
Other	28	
(Specify: ....)		

27.   (a) Did postgraduate students work on the project?

Yes	1
No	2

        (b) If yes, how many postgraduate students received/ will receive their degree as a result of their work on the research project?

        .... (number of masters students)
        .... (number of doctoral students)

28.   (a) Have there been any unintended beneficiaries of your research?

Yes	1
No	2
Don't know	3

        (b) If yes, please describe (i) who the unintended beneficiaries are and (ii) how they have utilised/ implemented/ applied the research.
        (i)...
        ....
        ....
        (ii) ....
        ....
        ....
        ....
        ....

29.   Additional comments (Anything about your research not covered by this questionnaire or something about the questionnaire itself):
        ....
        ....
        ....
        ....

                    THANK YOUR VERY MUCH FOR YOUR TIME AND EFFORT

Questionnaire Schedule for Research Councils

PUBLIC SECTOR R&D IN SOUTH AFRICA:
THE PRODUCTION AND UTILISATION OF RESEARCH

A.   YOUR BACKGROUND

1.   Title:

Dr	1
Mr	2
Mrs	3
Ms	4
Prof	5

2.   ....

3.   First names: ....

4.   Institution: ....

5.   Department/Centre/Division/Institute: ....

6.   Position (e.g. senior researcher): ....

7.   How long have you been involved in research? .... (years)

8.   Have you ever worked in any of the sectors listed below? If yes, please indicate how long you have worked in the sector(s) concerned.

	Yes	No	If yes, for how many years?
Government	1	2	.... (years)
Industry	1	2	.... (years)
University	1	2	.... (years)
Technikon	1	2	.... (years)
Business	1	2	.... (years)
Private/consulting	1	2	.... (years)
Other	1	2	.... (years)
....			

9.   Highest educational qualification completed:

Bachelors (BA, B.Tech, etc.) / Higher Diploma	1
Honours	2
Masters (M.Sc, M.Tech, etc.)	3
Doctorate (Ph.D, D.Tech, etc.)	4

10.   Gender:

Female	1
Male	2

11.   Year of birth: 19.............

In order to complete Section B, please select one research project that meets the criteria listed below. The project you select could either be a stand-alone research study or a project within a longer-term research programme. The criteria are:

- The project was completed in the last five years (completion is taken to mean that results or findings have been generated, and/or that the project has been reported on)
- You were the primary/principal investigator or project leader on the project
- You devoted significant research time and resources to the project.

B.   RESEARCH PROJECT

12.   Title: ....
....
....
....

13.   Please give a brief description of the research topic (*e.g. the quantification of resistances to blood flow in the lower limb arterial system using an inverse transmission line model; current trends in the selection of students for Higher Education, etc.*)
....
....
....
....
....

14. In which broad research domain(s) do the research activities mainly fall? (*Tick all applicable categories.*)

Agricultural sciences	1
Applied sciences and technologies	2
Arts and humanities	3
Biological sciences	4
Chemical sciences	5
Earth sciences	6
Economic and management sciences	7
Engineering sciences	8
Environmental sciences	9
Health sciences	10
Information and communication technologies	11
Marine sciences	12
Material sciences	13
Mathematical sciences	14
Medical sciences: Basic	15
Medical sciences: Clinical	16
Physical sciences	17
Social sciences	18
Other	19
(Specify: ....)	

15. What triggered the research? (*Tick all applicable categories.*)

Previous research by yourself	1
Own curiosity or research interest	2
Colleague(s) approaching you to form part of a team	3
An outside firm/ company/ institution approaching you	4
Own interpretation of the immediate/ future environment	5
A funding agency requesting proposals	6
A tender/ contract research	7
Other	8
(Specify: ....)	

16. (a) What year did the project start? .... (year)

     (b) What year did it end? .... (year)

17. Approximately how much of your total working time did you devote to this project during the course of the project?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

18. (a) How much funding (grants, awards, contracts) did you have for the project in total?

Less than R250 000	1
R250 000 – R499 000	2
R500 000 – R999 000	3
R1 000 000 – R1 999 000	4
R2 000 000 – R5 000 000	5
More than R5 000 000	6

(b) Please tick the major source(s) of funding:

Parliamentary grant	1
Business contract	2
Government contract	3
Sale of goods	4
Other (Specify: ....)	5

19. (a) Did you collaborate with others on the project?

Yes	1
No	2

(b) If yes, please indicate in which sectors your collaborator(s) work. (*Tick all applicable categories*)

Academics/ scholars	1
Government	2
Science council(s)	3
NGOs	4
Industry/ business	5
Other (Specify: ....)	6

20. Which THREE of the following best describe the overall expected value/ outcome of the research? Please rate the extent to which you believe that these outcomes have been attained.

		Highly successful	Successful to some extent	Not successful at all
Advancement or improvement in knowledge	1	1	2	3
Solving of theoretical problems	2	1	2	3
Solving immediate technical or applied problems	3	1	2	3
Solving environmental or social problems	4	1	2	3
Development of skills and competencies	5	1	2	3
Training of students	6	1	2	3
Change in behaviour/ attitudes/ values	7	1	2	3
Influenced decision-makers	8	1	2	3
Change legislation	9	1	2	3
Development of new technology	10	1	2	3
Improved product or technical design	11	1	2	3
Engineered a prototype	12	1	2	3
Entrance into new markets	13	1	2	3
Other (Specify: ....)	14	1	2	3

21. Which intended beneficiaries did you have in mind when you conceptualised the research? (*Tick all applicable categories.*)

Colleagues/ scholars/ peers in own discipline (Specify: ....)	1
Colleagues/ scholars/ peers in other disciplines (Specify: ....)	2
The contracting agency (Specify: ....)	3
Industry/ firms (Specify: ....)	4
Government (Specify: ....)	5

Specific interest groups (e.g. farmers, consumers) (Specify: ....)	6
General public/ society/ community	7
Other (Specify: ....)	8

22. Did the intended beneficiaries recognise/ utilise/ implement the research as planned?

Yes, to some extent	1
Yes, to little extent	2
No, not at all	3
Don't know	4

If <u>yes</u> (some/ little extent), please answer Question 23 and then go to Question 25

If <u>no</u>, please go to Question 24.

If you <u>don't know</u>, please go to Question 25.

23. Please describe how the research has been utilised/ implemented/ applied by the intended beneficiaries. (*Give concrete examples.*)

....

....

....

....

....

Go to Question 25.

24. In your opinion, why hasn't the research been utilised/ implemented/ applied by the intended beneficiaries as planned?

....

....

....

....

....

....

25. What form of support did you provide to the intended beneficiaries? (*Training, writing a manual, etc.*)

....

....

....

....

....

....

....

26.   How did you communicate the results of your research? (*Please indicate the mode of communication as well as the number of outputs – i.e. the number of articles, reports, books, patents, licenses and workshops that resulted from this project directly or indirectly.*)

Publications and documents	Mode	Number
Articles in refereed scientific journals	1	
Articles in refereed technical journals	2	
Articles in popular journals	3	
Contract reports	4	
Books/ monographs	5	
Chapters in books	6	
Published conference proceedings	7	
Written input to official policy documents	8	
Technical manuals	9	
Presentations		
Presentations to predominantly academic audiences	10	
Presentations to predominantly non-academic audiences	11	
Presentations to expert committees/ panels	12	
Presentations at public hearings	13	
Presentations at fairs/ exhibitions/ road shows	14	
Patents/ licences		
Through patenting	15	
Through licensing	16	
Training and supervision		
Training through workshops	17	
Training through coursework	18	
Supervision of masters and doctoral students	19	
Cooperative interactions and informal meetings		
Consultations/ technical assistance to potential users	20	
Personnel exchanges/ secondments	21	
Informal meetings with potential users/ teams	22	
Organisational structures		
Through participation in consortia	23	

Through science parks	24
Through spin-off companies	25
Through technology transfer offices	26
Through technology incubators	27
Other	28
(Specify: ....)	

27.   (a) Did postgraduate students work on the project?

Yes	1
No	2

(b) If yes, how many postgraduate students received/ will receive their degree as a result of their work on the research project?

.... (number of masters students)

.... (number of doctoral students)

28.   (a) Have there been any unintended beneficiaries of your research?

Yes	1
No	2
Don't know	3

(b) If yes, please describe (i) who the unintended beneficiaries are and (ii) how they have utilised/ implemented/ applied the research.

(i)...

....

....

(ii)...

....

....

....

29.   Additional comments (Anything about your research not covered by this questionnaire or something about the questionnaire itself):

....

....

....

THANK YOUR VERY MUCH FOR YOUR TIME AND EFFORT

Onderhoudskedule vir Hoër Onderwys-instellings

PUBLIEKE SEKTOR N&O IN SUID-AFRIKA:	
DIE PRODUKSIE EN BENUTTING VAN NAVORSING	

A. U AGTERGROND

1. Titel:

Dr	1
Mnr	2
Mev	3
Me	4
Prof	5

2. Van: ....

3. Voorname: ....

4. Instelling (Universiteit/Technikon): ....

5. Departement/Sentrum/Afdeling/Instituut: . ...

6. Posisie (bv. senior lektor): ....

7. Hoe lank is u al betrokke by navorsing? .... (jaar)

8. Het u ooit tevore in enige van die onderstaande sektore gewerk? Indien ja, dui asseblief aan hoe lank u in die betrokke sektor(e) gewerk het.

	Ja	Nee	Indien ja, hoeveel jaar?
Regering	1	2	.... (jaar)
Industrie/Bedryf	1	2	.... (jaar)
Wetenskapsraad	1	2	.... (jaar)
Besigheid/maatskappy	1	2	.... (jaar)
Privaat/konsultasie	1	2	.... (jaar)
Ander	1	2	.... (jaar)

9. Hoogste opvoedkundige kwalifikasie voltooi:

Baccalareus (BA, B.Tech, ens.) / Gevorderde Diploma	1
Honneurs	2
Meesters (M.Sc, M.Tech, ens.)	3
Doktoraat (Ph.D, D.Tech, ens.)	4

10. Geslag:

Vroulik	1
Manlik	2

11. Geboortejaar: 19.............

Vir Afdeling B moet u asseblief een navorsingsprojek selekteer wat aan die onderstaande kriteria voldoen. Die projek kan 'n losstaande navorsingsprojek wees of 'n projek binne 'n langtermyn navorsingsprogram. Die kriteria is:

- Die projek is in die laaste vyf jaar voltooi ("voltooi" beteken dat daar resultate of bevindinge is en/of dat reeds oor die projek gerapporteer is)
- U was die projekleier of primêre navorser van die projek
- U het betekenisvolle tyd en hulpbronne aan die projek spandeer.

B.   NAVORSINGSPROJEK

12.   Titel: ....
....
....

13.   Gee asseblief 'n kort beskrywing van die navorsingsonderwerp (*Bv. ontwikkeling van generators vir opwekking van elektrisiteit vanaf wind of dierkrag; huidige tendense in die keuring van studente vir Hoër Onderwys ens.*)

....
....
....
....
....

14. In watter breë navorsingsdomein(e) kan die navorsing grotendeels geklassifiseer word? (*Merk alle toepaslike kategorieë.*)

Landboukundige wetenskappe	1
Toegepaste wetenskappe en tegnologieë	2
Lettere en wysbegeerte	3
Biologiese wetenskappe	4
Chemiese wetenskappe	5
Aardwetenskappe	6
Ekonomiese en bestuurswetenskappe	7
Ingenieurswetenskappe	8
Omgewingswetenskappe	9
Gesondheidswetenskappe	10
Informasie- en kommunikasietegnologieë	11
Marine wetenskappe	12
Materiaalwetenskappe	13
Wiskundige wetenskappe	14
Mediese wetenskappe: Basies	15
Mediese wetenskappe: Klinies	16
Fisiese wetenskappe	17
Sosiale wetenskappe	18
Ander (Spesifiseer: ....)	19

15. Wat het tot die navorsing aanleiding gegee? (*Merk alle toepaslike kategorieë.*)

Vorige navorsing deur uself	1
Eie nuuskierigheid of navorsingsbelangstelling	2
Kollega(s) het u genader om deel van 'n span te vorm	3
'n Eksterne firma/ maatskappy/ instelling het u genader	4
Eie interpretasie van die onmiddellike/ toekomstige omgewing	5
'n Befondsingsliggaam het 'n navorsingsvoorstel vereis	6
'n Tender/ kontraknavorsing	7
Ander (Spesifiseer: ....)	8

16.   (a) Watter jaar het die projek begin? .... (jaar)

        (b) Watter jaar het dit geëindig? .... (jaar)

17.   Ongeveer hoeveel van u totale werkstyd oor die duur van die projek het u op die projek spandeer?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

18.   (a) Hoeveel befondsing (toekennings, kontrakte) het u in totaal vir die projek?

Minder as R50 000	1
R50 000 – R99 000	2
R100 000 – R249 000	3
R250 000 – R499 000	4
R500 000 – R999 000	5
R1 000 000 – R2 000 000	6
Meer as R2 000 000	7

        (b) Wat is die hoofbron(ne) van befondsing?

Nasionale Navorsingstigting (NNS)	1
THRIP	2
Innovasiefonds	3
Universiteit/ Technikon/ Eie interne fondse	4
Besigheids-/ private sektor	5
Oorsese befondser/ stigting	6
Mediese Navorsingsraad (MNR)	7
Landbounavorsingsraad	8
Waternavorsingskommissie	9
Ander (Spesifiseer: ....)	10

135

19. (a) Het u met ander saamgewerk op die projek?

Ja	1
Nee	2

(b) Indien ja, dui asseblief aan in watter sektor(e) u medewerkers werk. (*Merk alle toepaslike kategorieë*)

Ander akademici	1
Regering	2
Wetenskapsraad	3
Nie-regeringsorganisasie	4
Industrie/ besigheid	5
Ander (Spesifiseer: ....)	6

20. Watter DRIE van die volgende beskryf die navorsing se verwagte waarde/ uitkoms/ nut die beste? Dui asseblief aan die mate waartoe u glo dat die uitkoms bereik is.

		Hoogs suksesvol	Tot sekere mate	Geensins suksesvol
Bevordering van of toename in kennis	1	1	2	3
Oplos van teoretiese probleme	2	1	2	3
Oplos van onmiddellike tegniese of toegepaste probleme	3	1	2	3
Oplos van omgewings- of sosiale probleme	4	1	2	3
Ontwikkeling van vaardighede en bekwaamhede	5	1	2	3
Opleiding van studente	6	1	2	3
Verandering in gedrag/ houdings/ waardes	7	1	2	3
Beïnvloeding van besluitnemers	8	1	2	3
Verandering van wetgewing	9	1	2	3
Ontwikkeling van nuwe tegnologie	10	1	2	3
Verbeterde produk of tegniese ontwerp	11	1	2	3
Totstandbringing van 'n prototipe	12	1	2	3
Toetrede tot nuwe markte	13	1	2	3
Ander (Spesifiseer: ....)	14	1	2	3

21. Watter teikengroepe ("intended beneficiaries") het u in gedagte gehad toe u die navorsing gekonseptualiseer het? (*Merk alle toepaslike kategorieë.*)

Kollegas/ eweknieë in eie dissipline (Spesifiseer: ....)	1
Kollegas/ eweknieë in ander dissiplines (Spesifiseer: ....)	2
Organisasie wat die ondersoek gekontrakteer het (Spesifiseer: ....)	3
Industrie/ maatskappye (Spesifiseer: ....)	4
Regering (Spesifiseer: ....)	5
Spesifieke belangegroepe (bv. boere, verbruikers) (Spesifiseer: ....)	6
Algemene publiek/ samelewing/ gemeenskap	7
Ander (Spesifiseer: ....)	8

22. Het die teikengroep/gebruikers die navorsing benut/geïmplementeer/aangewend soos beplan?

Ja, tot 'n sekere mate	1
Ja, tot 'n geringe mate	2
Nee, glad nie	3
Weet nie	4

Indien <u>ja</u> (sekere/ geringe mate), beantwoord asseblief Vraag 23 en gaan dan na Vraag 25.

Indien <u>nee</u>, gaan asseblief na Vraag 24.

Indien jy nie <u>weet nie</u>, gaan asseblief na Vraag 25.

23. Beskryf asseblief hoe die navorsing deur die teikengroep/gebruikers benut/geïmplementeer/ aangewend is. (*Gee konkrete voorbeelde.*)

....

....

....

....

....

Gaan na Vraag 25.

137

24. Hoekom is die navorsing, na u mening, nie deur die bedoelde gebruikers/teikengroep aangewend soos beplan nie?

   ....

   ....

   ....

   ....

25. Watter vorm van ondersteuning het u aan die teikengroep/gebruikers verskaf? (*Opleiding, die skryf van 'n handleiding ens.*)

   ....

   ....

   ....

26. Hoe het u die resultate van die ondersoek gekommunikeer/gedissemineer? (*Dui asseblief die vorm van kommunikasie aan sowel as die getal uitsette – d.i. die getal artikels, verslae, boeke, patente, lisensies en werkswinkels wat direk of indirek uit die projek voortgevloei het.*)

Publikasies en dokumente	Vorm	Getal
Artikels in eweknie-beoordeelde wetenskaplike joernale	1	
Artikels in eweknie-beoordeelde tegniese joernale	2	
Artikels in populêre joernale	3	
Kontrakverslae	4	
Boeke/ monografieë	5	
Hoofstukke in boeke	6	
Gepubliseerde konferensieverrigtinge	7	
Geskrewe bydraes tot amptelike beleidsdokumente	8	
Tegniese handleidings	9	
Aanbiedings		
Aanbiedings voor hoofsaaklik akademiese gehore	10	
Aanbiedings voor hoofsaaklik nie-akademiese gehore	11	
Aanbiedings voor komitees/ panele van kundiges	12	
Aanbiedings by openbare verhore ("public hearings")	13	
Aanbiedings by vertonings/ uitstallings/ padskoue ("road shows")	14	
Patente/ lisensiëring		
Deur patente	15	
Deur lisensiëring	16	
Opleiding en supervisie		
Opleiding deur werkswinkels	17	

Opleiding deur kursuswerk	18
Supervisie van meersters- en doktorale studente	19
Koöperatiewe interaksies en informele ontmoetings	
Konsultasie/ tegniese bystand aan potensiële gebruikers	20
Personeeluitruilings/ -sekonderings	21
Informele ontmoetings met potensiële gebruikers/ spanne	22
Organisatoriese strukture	
Deur deelname aan konsortia	23
Deur wetenskapsparke	24
Deur "spin-off" maatskappye	25
Deur tegnologie-oordrag kantore	26
Deur tegnologiese inkubators	27
Ander	28
(Spesifiseer: ....)	

27.   (a) Het enige nagraadse studente op die projek gewerk?

Ja	1
Nee	2

(b)   Indien ja, hoeveel nagraadse studente het graad gekry/ gaan graad kry as gevolg van hul betrokkenheid by die projek?

.... (getal magisterstudente)

.... (getal doktorale studente)

28.   (a) Is daar enige onverwagte/ onbedoelde begunstigdes ("unintended beneficiaries") van die navorsing?

Ja	1
Nee	2
Weet nie	3

(b) Indien ja, verduidelik asseblief (i) wie die onbedoelde begunstigdes is en (ii) hoe hul die navorsing benut/ geïmplementeer/ aangewend het.

(i) ....

....

(ii) ....

....

139

29. Addisionele opmerkings (Enigiets omtrent u navorsing wat nie deur die vraelys gedek word nie of dalk iets omtrent die vraelys self):

....

....

....

....

....

BAIE DANKIE VIR U TYD EN MOEITE

Onderhoudskedule vir Wetenskapsrade

| PUBLIEKE SEKTOR N&O IN SUID-AFRIKA: |
| DIE PRODUKSIE EN BENUTTING VAN NAVORSING |

A.   U AGTERGROND

1.   Titel:

Dr	1
Mnr	2
Mev	3
Me	4
Prof	5

2.   Van: ....

3.   Voorname: ....

4.   Instelling: ....…..

5.   Departement/Sentrum/Afdeling/Instituut: . …………………………………………………

6.   Posisie (bv. senior navorser): ………………………………………………………….

7.   Hoe lank is u al betrokke by navorsing? ....…… (jaar)

8.   Het u ooit tevore in enige van die onderstaande sektore gewerk? Indien ja, dui asseblief aan hoe lank u in die betrokke sektor(e) gewerk het.

	Ja	**Nee**	Indien ja, hoeveel jaar?
Regering	1	2	.... (jaar)
Industrie/Bedryf	1	2	.... (jaar)
Universiteit	1	2	.... (jaar)
Technikon	1	2	.... (jaar)
Besigheid/maatskappy	1	2	.... (jaar)
Privaat/konsultasie	1	2	.... (jaar)
Ander	1	2	.... (jaar)
....			

9.   Hoogste opvoedkundige kwalifikasie voltooi:

Baccalareus (BA, B.Tech, ens.) / Gevorderde Diploma	1
Honneurs	2
Meesters (M.Sc, M.Tech, ens.)	3
Doktoraat (Ph.D, D.Tech, ens.)	4

10.   Geslag:

Vroulik	1
Manlik	2

11.   Geboortejaar: 19.............

Vir Afdeling B moet u asseblief een navorsingsprojek selekteer wat aan die onderstaande kriteria voldoen. Die projek kan 'n losstaande navorsingsprojek wees of 'n projek binne 'n langtermyn navorsingsprogram. Die kriteria is:

- Die projek is in die laaste vyf jaar voltooi ("voltooi" beteken dat daar resultate of bevindinge is en/of dat reeds oor die projek gerapporteer is)
- U was die projekleier of primêre navorser van die projek
- U het betekenisvolle tyd en hulpbronne aan die projek spandeer.

B.   NAVORSINGSPROJEK

12.   Titel: ....
        ....
        ....

13.   Gee asseblief 'n kort beskrywing van die navorsingsonderwerp (*Bv. ontwikkeling van generators vir opwekking van elektrisiteit vanaf wind of dierkrag; huidige tendense in die keuring van studente vir Hoër Onderwys ens.*)
        ....
        ....
        ....

14. In watter breë navorsingsdomein(e) kan die navorsing grotendeels geklassifiseer word? (*Merk alle toepaslike kategorieë.*)

Landboukundige wetenskappe	1
Toegepaste wetenskappe en tegnologieë	2
Lettere en wysbegeerte	3
Biologiese wetenskappe	4
Chemiese wetenskappe	5
Aardwetenskappe	6
Ekonomiese en bestuurswetenskappe	7
Ingenieurswetenskappe	8
Omgewingswetenskappe	9
Gesondheidswetenskappe	10
Informasie- en kommunikasietegnologieë	11
Marinewetenskappe	12
Materiaalwetenskappe	13
Wiskundige wetenskappe	14
Mediese wetenskappe: Basies	15
Mediese wetenskappe: Klinies	16
Fisiese wetenskappe	17
Sosiale wetenskappe	18
Ander (Spesifiseer: ....)	19

15. Wat het tot die navorsing aanleiding gegee? (*Merk alle toepaslike kategorieë.*)

Vorige navorsing deur uself	1
Eie nuuskierigheid of navorsingsbelangstelling	2
Kollega(s) het u genader om deel van 'n span te vorm	3
'n Eksterne firma/ maatskappy/ instelling het u genader	4
Eie interpretasie van die onmiddellike/ toekomstige omgewing	5
'n Befondsingsliggaam het 'n navorsingsvoorstel vereis	6
'n Tender/ kontraknavorsing	7
Ander (Spesifiseer: ....)	8

16.   (a) Watter jaar het die projek begin? .... (jaar)

        (b) Watter jaar het dit geëindig? .... (jaar)

17.   Ongeveer hoeveel van u totale werkstyd oor die duur van die projek het u op die projek spandeer?

10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

18.   (a) Hoeveel befondsing (toekennings, kontrakte) het u in totaal vir die projek?

Minder as R250 000	1
R250 000 – R499 000	2
R500 000 – R999 000	3
R1 000 000 – R1 999 000	4
R2 000 000 – R5 000 000	5
Meer as R5 000 000	6

        (b) Wat is die hoofbron(ne) van befondsing?

Parlementêre toekenning	1
Besigheidskontrak	2
Regeringskontrak	3
Verkoop van goedere	4
Ander (Spesifiseer: ....)	5

19.   (a) Het u met ander saamgewerk op die projek?

Ja	1
Nee	2

144

(b) Indien ja, dui asseblief aan in watter sektor(e) u medewerkers werk. (*Merk alle toepaslike kategorieë*)

Akademici	1
Regering	2
Wetenskapsraad	3
Nie-regeringsorganisasie	4
Industrie/ besigheid	5
Ander (Spesifiseer: ....)	6

20. Watter DRIE van die volgende beskryf die navorsing se verwagte waarde/ uitkoms/ nut die beste? Dui asseblief aan die mate waartoe u glo dat die uitkoms bereik is.

		Hoogs suksesvol	Tot sekere mate	Geensins suksesvol
Bevordering van of toename in kennis	1	1	2	3
Oplos van teoretiese probleme	2	1	2	3
Oplos van onmiddellike tegniese of toegepaste probleme	3	1	2	3
Oplos van omgewings- of sosiale probleme	4	1	2	3
Ontwikkeling van vaardighede en bekwaamhede	5	1	2	3
Opleiding van studente	6	1	2	3
Verandering in gedrag/ houdings/ waardes	7	1	2	3
Beïnvloeding van besluitnemers	8	1	2	3
Verandering van wetgewing	9	1	2	3
Ontwikkeling van nuwe tegnologie	10	1	2	3
Verbeterde produk of tegniese ontwerp	11	1	2	3
Totstandbringing van 'n prototipe	12	1	2	3
Toetrede tot nuwe markte	13	1	2	3
Ander (Spesifiseer: ....)	14	1	2	3

145

21. Watter teikengroepe ("intended beneficiaries") het u in gedagte gehad toe u die navorsing gekonseptualiseer het? (*Merk alle toepaslike kategorieë.*)

Kollegas/ eweknieë in eie dissipline (Spesifiseer: ....)	1
Kollegas/ eweknieë in ander dissiplines (Spesifiseer: ....)	2
Organisasie wat die ondersoek gekontrakteer het (Spesifiseer: ....)	3
Industrie/ maatskappye (Spesifiseer: ....)	4
Regering (Spesifiseer: ....)	5
Spesifieke belangegroepe (bv. boere, verbruikers) (Spesifiseer: ....)	6
Algemene publiek/ samelewing/ gemeenskap	7
Ander (Spesifiseer: ....)	8

22. Het die teikengroep/gebruikers die navorsing benut/geïmplementeer/aangewend soos beplan?

Ja, tot 'n sekere mate	1
Ja, tot 'n geringe mate	2
Nee, glad nie	3
Weet nie	4

Indien <u>ja</u> (sekere/ geringe mate), beantwoord asseblief Vraag 23 en gaan dan na Vraag 25.

Indien <u>nee,</u> gaan asseblief na Vraag 24.

Indien jy nie <u>weet nie,</u> gaan asseblief na Vraag 25.

23. Beskryf asseblief hoe die navorsing deur die teikengroep/gebruikers benut/geïmplementeer/ aangewend is. (*Gee konkrete voorbeelde.*)

....

....

....

....

....

Gaan na Vraag 25.

146

24. Hoekom is die navorsing, na u mening, nie deur die bedoelde gebruikers/teikengroep aangewend soos beplan nie?

....
....
....
....
....
....
....

25. Watter vorm van ondersteuning het u aan die teikengroep/gebruikers verskaf? (*Opleiding, die skryf van 'n handleiding ens.*)

....
....
....
....
....
....

26. Hoe het u die resultate van die ondersoek gekommunikeer/gedissemineer? (*Dui asseblief die vorm van kommunikasie aan sowel as die getal uitsette – d.i. die getal artikels, verslae, boeke, patente, lisensies en werkswinkels wat direk of indirek uit die projek voortgevloei het.*)

Publikasies en dokumente	Vorm	Getal
Artikels in eweknie-beoordeelde wetenskaplike joernale	1	
Artikels in eweknie-beoordeelde tegniese joernale	2	
Artikels in populêre joernale	3	
Kontrakverslae	4	
Boeke/ monografieë	5	
Hoofstukke in boeke	6	
Gepubliseerde konferensieverrigtinge	7	
Geskrewe bydraes tot amptelike beleidsdokumente	8	
Tegniese handleidings	9	
Aanbiedings		
Aanbiedings voor hoofsaaklik akademiese gehore	10	
Aanbiedings voor hoofsaaklik nie-akademiese gehore	11	
Aanbiedings voor komitees/ panele van kundiges	12	

Aanbiedings by openbare verhore ("public hearings")	13	
Aanbiedings by vertonings/ uitstallings/ padskoue ("road shows")	14	
Patente/ lisensiëring		
Deur patente	15	
Deur lisensiëring	16	
Opleiding en supervisie		
Opleiding deur werkswinkels	17	
Opleiding deur kursuswerk	18	
Supervisie van meersters- en doktorale studente	19	
Koöperatiewe interaksies en informele ontmoetings		
Konsultasie/ tegniese bystand aan potensiële gebruikers	20	
Personeeluitruilings/ -sekonderings	21	
Informele ontmoetings met potensiële gebruikers/ spanne	22	
Organisatoriese strukture		
Deur deelname aan konsortia	23	
Deur wetenskapsparke	24	
Deur "spin-off" maatskappye	25	
Deur tegnologie-oordrag kantore	26	
Deur tegnologiese inkubators	27	
Ander (Spesifiseer: ....)	28	

27.   (a) Het enige nagraadse studente op die projek gewerk?

Ja	1
Nee	2

(b)   Indien ja, hoeveel nagraadse studente het graad gekry/ gaan graad kry as gevolg van hul betrokkenheid by die projek?

.... (getal magisterstudente)

.... (getal doktorale studente)

28.   (a) Is daar enige onverwagte/ onbedoelde begunstigdes ("unintended beneficiaries") van die navorsing?

Ja	1
Nee	2
Weet nie	3

148

(b) Indien ja, verduidelik asseblief (i) wie die onbedoelde begunstigdes is en (ii) hoe hul die navorsing benut/ geïmplementeer/ aangewend het.

(i) ....

....

....

(ii) ....

....

....

....

....

....

29. Addisionele opmerkings (Enigiets omtrent u navorsing wat nie deur die vraelys gedek word nie of dalk iets omtrent die vraelys self):

....

....

....

....

....

BAIE DANKIE VIR U TYD EN MOEITE