WORKING PARTNERSHIPS

HIGHER EDUCATION, INDUSTRY AND INNOVATION

GOVERNMENT INCENTIVISATION OF HIGHER EDUCATION-INDUSTRY RESEARCH PARTNERSHIPS IN SOUTH AFRICA

An audit of THRIP and the Innovation Fund

RESEARCH MONOGRAPH

RESEARCH PROGRAMME ON HUMAN RESOURCES DEVELOPMENT

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PREFACE

An ideal vision of the role of research partnerships between higher education and industry in a rapidly globalising knowledge economy is becoming prevalent. However, there is a great deal of dissonance between this vision and the realities of research, innovation and development in the South African context, characterised by fragmentation, inequalities and unevenness.

The HSRC's research programme on Human Resources Development has undertaken a project to explore the extent to which the networked practices that are believed to characterise the knowledge economy have indeed begun to penetrate South African higher education and industry. Where networks and partnerships have developed, how have they taken form and shape in the South African context, with specific national policy and economic imperatives? To what extent is there evidence of collaboration in knowledge generation, diffusion and/or application that will ultimately contribute to innovation? In what ways has government succeeded in promoting such partnerships?

What are the kinds of changes and benefits partnerships are bringing about in both higher education and industry?

Three high technology bands have been identified as priorities for developing a National System of Innovation that will improve South Africa's international competitiveness and economic development. The relatively new high technology fields of information and communication technology (ICT), biotechnology and new materials development have been identified as most likely to generate benefits for South Africa. These were selected as the empirical focus for the study. Understanding the conceptions and practices of research partnerships in each of these three fields will inform understanding of responsiveness to high technology needs and innovation in South Africa.

This large-scale, empirical study of necessity is primarily an exploratory one, aiming to open up the field and lay down benchmark descriptions of the partnership and network activity emerging in South African higher education and industry. It does so through a series of audits and mapping exercises, and through a series of case studies.

The study was conceptualised in terms of four distinct but closely inter-related empirical sub-studies or components. Each empirical study will be disseminated in a separate research report.

Component 1 was largely conceptual. It provided an entry point into the conceptual and comparative literature on higher education-industry partnerships, as well as an introduction to the 'state of the art' in each of the three high technology fields in South Africa, to lay a foundation for the entire study.

Component 2, the focus of the present research report, aimed to illuminate government's role in promoting research partnerships by exploring the forms of

government contribution through THRIP and the Innovation Fund, and the extent and nature of resultant partnerships. Data was gathered on industry and higher education beneficiaries, on the nature of co-operation at project level, and selected measures of the outputs of the co-operation. The report shows how partnerships, networks and innovation are developing amongst beneficiaries of government-incentivised funding in general, and in the three high technology fields specifically.

L. Powell Consultancy conducted the audits for Component 2 on behalf of the HSRC, and has written this research report.

Component 3 will focus on the supply side. It aims to map the higher education landscape, in order to investigate the scale and form of research linkages and collaborative practices between higher education institutions and industry in each of the three fields. Given the uneven capacity of higher education institutions and their differential historical legacies, and given different modes of operation of different knowledge fields, it will explore whether partnerships develop and take different forms in different institutional and knowledge contexts.

Component 4 will focus on the demand side, at enterprise level in industrial sectors related to the three high technology fields. In a limited set of cases, we will explore in-depth the dynamics of partnerships, to unpack their multi-linear, contingent and tacit dimensions, as well as consider the impact on enterprise productivity, technological innovation and knowledge production in each of the three fields.

The study has been co-funded by the Carnegie Corporation of New York.

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Glenda Kruss
Project Leader
June 2003

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- L. Powell Consultancy who designed the methodological approach, conducted the research and wrote this report.
- Dr Rocky Skeef of the National Research Foundation, who engaged with the early findings of the study and provided a critical reading of the final report.
- Dr Robin Drennan, Elaine Lemmer and other key staff of THRIP, who engaged closely with the study by commenting on the methodological approach, contributing to the development of the survey instruments used, providing datasets and undertaking a critical reading of the final report.
- Dr Eugene Lottering and Lara Sukhdeo of the Innovation Fund who engaged in the methodological design of the study and provided a critical reading of the final report.
- The higher education beneficiaries of the Innovation Fund who participated in a survey to compile a dataset.
- The industry beneficiaries of THRIP and the Innovation Fund who participated in an industry survey.

ACRONYMS

DACST: Department of Arts, Culture, Science and Technology

DoE: Department of Education

DoL: Department of Labour

DST: Department of Science and Technology (formerly DACST)

DTI: Department of Trade and Industry

FET: Further Education and Training

HAI: Historically Advantaged Institution

HBI: Historically Black Institution

HDI: Historically Disadvantaged Institution

HE: Higher Education

HEI: Higher Education Institution

HRD: Human Resources Development

HSRC: Human Sciences Research Council

HWI: Historically White Institution

HWU: Historically White University

ICT: Information Communication Technology

IDC: Independent Development Corporation

IF: Innovation Fund

IPRs: Intellectual Property Rights

MCDM: Multi Criteria Decision Model

NGOs: Non-governmental Organisations

NRF: National Research Foundation

NSDP: National Skills Development Plan

R&D: Research and Development

S&T: Science and Technology

SAQA: South African Qualifications Authority

SET: Science, Engineering and Technology

SETI: Science, Engineering and Technology Institutions

SMMEs: Small, Medium and Micro Enterprises

SPSS: Statistical Package for the Social Sciences

THRIP: Technology and Human Resources for Industry Programme

TIPTOP: Technology Innovation Programme through the Transfer of People

1

INTRODUCTION

This research report focuses on research partnerships between higher education and industry that have been incentivised by government-funded programmes. It represents Component 2 of a broader HSRC study, funded by the Carnegie Corporation of New York. The HSRC study explores research partnership and network relationships between higher education and industry in three high technology fields identified as critical for innovation in South Africa.

This Report presents empirical data gathered from a set of audits of two programmes, namely, the Technology and Human Resources for Industry Programme (THRIP) and the Innovation Fund (IF). These programmes, both currently housed at the National Research Foundation (NRF), were selected on the basis that they are at present the largest and most influential government-funded programmes in South Africa that aim to facilitate higher education-industry research linkages, as either a direct or an indirect component of their mission and practice.

1.1 The context

The study takes place against a contextual framework of higher education policy that promotes responsive higher education institutions and that recognises the significant role that higher education has to play in developing the knowledge and high-level skills that the country needs.

One of the key strategies identified to enable higher education to achieve these aims is captured in the notion of greater 'responsiveness'. The term 'responsiveness', used in the South African higher education policy context, implies that 'higher education should take seriously the problems and challenges presented by the societal context in which it operates' (National Commission on Higher Education 1996). The term refers to a 'shift of higher education to a more open and interactive system, responding to the social, cultural, political and economic needs of its environment and adapting itself to the changes in this environment'.

Kruss (2002) argues that the issue of responsiveness has taken the form of a 'symbolic policy', rather than a 'substantive policy'. She argues that the commitment to responsiveness, lying at the heart of higher education policy, has not been supported with substantive policy interventions that direct its form, how it should unfold, or what

mechanisms should be in place to promote it. Kruss argues further that the manner in which responsiveness is interpreted in practice is mediated differently across different institutions and by different sectors.

While this argument may currently have validity, international experience has highlighted the formation of higher education-industry partnerships as a key strategy for developing higher education responsiveness. Partnerships are, however, fuelled by a number of social forces that include, but are not limited to, the development of 'substantive policy' that promote and enable them. Gray and Walters (1998), for example, indicate that partnerships are driven by forces that include the shrinkage of higher education budgets; increased governmental support for industry partnerships; new demands from the global economy and changes in the way in which knowledge is produced. The authors argue that within this context, higher education-industry partnerships have grown in number, nature and stature.

One of the primary purposes of this study is to investigate the number and nature of higher education-industry partnerships, as incentivised through THRIP and the Innovation Fund. There is a significant body of literature that reviews how such collaborative endeavours operate to increase competitiveness, efficiency and social development in the context of the pressures of globalisation and the global economy.[1] Castells (1996), for example, argues that 'the ability of countries to compete in the international economy is directly related to their technological potential', a capacity that he sees as an attribute of the 'science-technology-society-system' that cannot be an attribute of individual firms. Improving national competitiveness, he argues, is increasingly dependent on the complex interaction between historically rooted political institutions and globalised economic agents. Within this context, Castells refers to increased 'networking' between organisations within the seemingly paradoxical paradigm of competition and collaboration. Organisations within different sectors are, he argues, beginning to see the benefits of working collaboratively, rather than in isolation in order that the efficiency, quality and quantity of outputs may be increased.

Gibbons et al (1994) focuses on what the authors refer to as a new mode of knowledge production, i.e., 'Mode 2' knowledge, where knowledge and information, traditionally produced in the academic realm, is increasingly linked to forms of application required in the economic and development sectors. 'Mode 2' knowledge is viewed by Gibbons et al as a 'transdisciplinary', rather than multidisciplinary form of knowledge. In this mode of knowledge production, the applied context becomes the primary locus, rather than the traditional realms of academic institutions, departments and disciplines. As such, research teams that bridge the traditional disciplinary and institutional boundaries are established around the locus of an economic or social problem.

Perlas (2002), on the other hand, has suggested the concept of 'threefolding' towards understanding the 'new social landscape'. He argues, through this concept of

[1] A comprehensive literature review has been undertaken in Component 1 of the project. See this for further details on the relevant literature.

'threefolding', that the forces, capacities and resources to change the world are clustered in the hands of business, government and global civil society – how institutions in these different sectors of society interact and respond to the 'new social landscape' will determine what kind of social life and society we have. According to Perlas, a healthy society is where the three realms mutually recognise and support each other and develop their initiatives with awareness of their potential impact on other realms.

It is in this light that the growing phenomenon of 'networks' between higher education and industry in three high technology bands – ICT, new materials development and biotechnology – is investigated.

1.2 Aim and focus of the study

The primary aim of the study is to explore the extent, forms and products of the research partnerships and linkages between industry and higher education institutions, as incentivised by government-funded projects, particularly in the three high technology fields – ICT, new materials development and biotechnology.

The study was envisaged as an audit of the research linkages and practices facilitated by the THRIP and Innovation Fund programmes. It aimed to describe the higher education and industry beneficiaries, to provide information about the motivation, initiation, operation, financing and termination of the partnership, and to provide information about the scale and nature of the products or outcomes of such partnerships.

An initial environmental scan revealed a THRIP database that allowed comprehensive investigation of these issues from the perspective of higher education beneficiaries, but a survey was required to obtain equivalent data for the Innovation Fund higher education beneficiaries.

It was determined that further information from the perspective of industry beneficiaries would provide a useful balance for understanding partnership and network practices. Accordingly, a survey of industry beneficiaries of THRIP and the Innovation Fund was conducted, which aimed to elicit conceptions of and motivations for partnerships, and the extent to which government-funded projects are believed to have aided and supported the development, management and success of research partnerships with higher education institutions.

The next chapter will describe the design and methodology of the study, of this set of surveys, data and documentary analyses from the perspective of industry and higher education beneficiaries, in greater detail.

The analysis on which this report is based thus draws on data from both THRIP and the Innovation Fund, at times separated to reflect their different nature and emphases, and at times combined to reflect their role as government-funded programmes. It also covers both the three high technology fields specifically as well as all research projects

funded by the two programmes, where appropriate. And it attempts to analyse the involvement and provide the perspective of both higher education and industry.

1.3 The structure of this report

Section A introduces and provides an overview of the THRIP and Innovation Fund programmes as two government-funded projects in South Africa (Chapter 3).

Section B provides an overview of the nature of higher education-industry partnerships from the perspective of industry beneficiaries, showing how respondents define partnerships and understand the nature of THRIP and Innovation Fund partnerships specifically, as well as a review of some of the indicators of collaboration (Chapter 4).

Section C, the heart of the report, analyses the data gathered on these government-incentivised research projects. Chapter 5 provides a brief overview of THRIP and Innovation Fund projects to lay the basis for the analysis that follows. Chapter 6 provides a breakdown of partnership budgets and expenditure. Chapter 7 goes on to describe the industry partners, while Chapter 8 focuses on the higher education institutions, and Chapter 9 focuses more specifically on the researchers involved, in THRIP and Innovation Fund projects.

Section D considers the contribution of government-funded projects. Chapter 10 begins a novel statistical analysis of the research networks and linkages involved in THRIP and Innovation Fund partnerships that is highly suggestive of the possibilities for future exploration. Chapter 11 reviews the contribution of government-funded projects by examining the form and scale of outputs in the three technological bands. Chapter 12 examines industry partners' perspectives on the contribution and sustainability of government-funded projects.

Section E provides a brief summary and conclusion, arguing that THRIP and Innovation Fund partnerships appear to have rested on a formula where mutual benefit is obtainable, and which represent exemplars of how partnerships can be used to develop science, technology and innovation in South Africa.

2

METHODOLOGY

This chapter will describe the design and the methodology of the audit in detail to provide a basis for reading the report.

2.1 Methodological aspects

The methodology for the study was designed to reflect the broader vision of value-adding partnerships encapsulated in the HSRC project. As such, an approach was adopted that aimed to include THRIP and the Innovation Fund as key stakeholders and partners in the study. In order to achieve this, a number of principles were adopted that underpinned the methodological tools and steps applied.

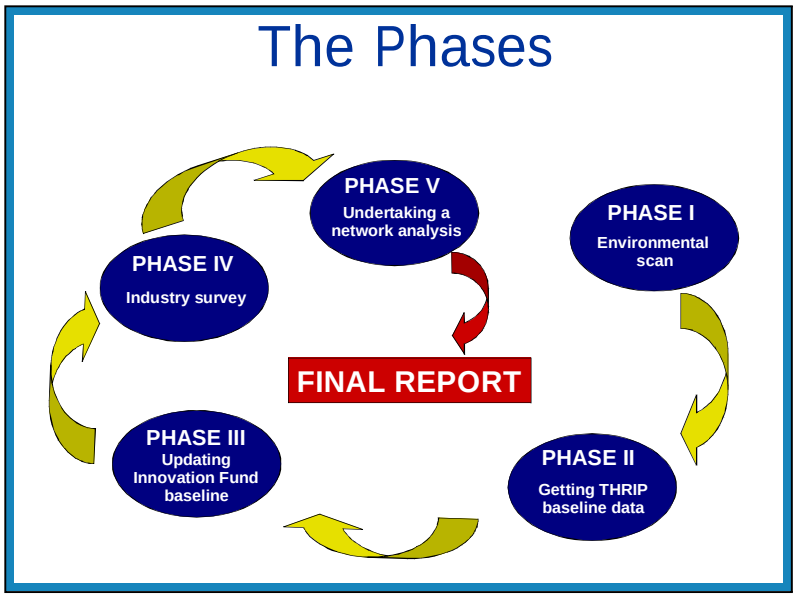
- The relationship between the HSRC, THRIP and the Innovation Fund should be developed as a long-term and sustainable relationship.
- The key stakeholders should buy into the project in a manner that enabled them to see the mutual benefit of the study to themselves and to the broader society. This encouraged close engagement and involvement in the project by THRIP. The Innovation Fund, having been moved to the National Research Foundation (NRF) only months before the study, was engaged in an intensive internal audit and re-orientation which meant that they were involved to a lesser degree. Both organisations attended a two-day workshop held at the HSRC, meetings between the HSRC research team and the programme leaders were held at the NRF and a workshop, hosted by the NRF, was held on 28 October in which preliminary findings were presented for discussion.
- Stakeholders should be provided with opportunities to input into the design, methodology of the project, as well as to engage with key findings as these emerged. Accordingly, a number of design and data complexities were discussed and resolved together with THRIP staff.

2.2 Key methodological steps

The key steps in the methodology for the audit are represented in Figure 1. Five sequential phases of data gathering and analysis included an environmental scan, the

acquisition of THRIP baseline data, updating Innovation Fund baseline data, an industry beneficiaries survey, and a statistical analysis of networks.

Figure 1: The research phases



2.2.1 Phase I – Environmental scan

An environmental scan was undertaken to review the activities of THRIP and the Innovation Fund, and to ascertain the availability of literature, reports and databases. The aim was to establish the extent to which partnerships exist in the three technological bands of ICT, biotechnology and new materials development. This exercise was performed by undertaking a scan of the documentary evidence and data available from the Innovation Fund and THRIP. In addition, in this phase a working relationship with THRIP and the Innovation Fund was developed. The environmental scan laid the basis for the approach and strategy for the subsequent phases.

A number of steps were undertaken during the environmental scan, including an Internet search, a Nexus search, an introductory interview, a documentary search, database analysis and a series of discussions with relevant players.

Internet search: An Internet search provided an excellent overview of both THRIP (www.nrf.ac.za/thrip) and the Innovation Fund (www.innovationfund.ac.za). It provided an overview of the projects, the names of relevant contact people and a sense of the missions, values and key goals of the programmes.

Introductory interview: In order to develop a solid understanding of the projects, an introductory meeting was scheduled with Dr Drennan, the Manager of THRIP, and Dr Lottering, the Director of the Innovation Fund. Attached as Appendix A is the interview schedule for these meetings, the aim of which was to:

- Introduce the project to the directors of THRIP and the Innovation Fund;

- Discuss ways in which the research project could add value to their own work;
- Discuss how they would like to engage with and work with the HSRC research team;
- Undertake a brief interview on the nature of THRIP and the Innovation Fund. The interview schedule for the introductory meeting was designed to elicit a broad understanding of the nature of the project, the data available at THRIP and the Innovation Fund that might be relevant to the study and the extent to which data and documents were available for an analysis by the three core focus areas of ICT, new materials development and biotechnology.

THRIP and the Innovation Fund were informed, during the introductory meeting, that the study would present data in an aggregated format rather than identifying the names of individuals.

Documentary search: A documentary search, undertaken at THRIP, highlighted a number of documents useful for the study. A list of all the documents is included in the Bibliography. Discussion with the Director of the Innovation Fund indicated that the Innovation Fund had limited documents available.

NEXUS search: A NEXUS search was undertaken to identify projects funded in the area of biotechnology, ICT and new materials development. The search provided lists of the research projects currently being undertaken in these three areas but did not indicate the extent to which any of these are currently being undertaken as higher education-industry partnerships. The search provided no information relevant to this study.

Other documentary search: A number of secondary sources were identified that could place this project within the broader research network in which it is located.

Database analysis: An analysis was undertaken of THRIP's database. THRIP's database, designed to support management decision-making, tracks a project proposal from application stage, to application review stage, to funding stage and to the stage of impact assessment. This database formed the basis of much of the analysis involving THRIP presented in this report. The researchers were informed that no database for Innovation Fund projects was available.

2.2.2 Phase II – Getting data from THRIP database

The specific data required from THRIP was determined after careful consideration of the general availability of data. THRIP staff provided invaluable support in identifying the data available and transferring the data from their server into the formats for analysis.

It should be noted there were a number of data issues that needed to be resolved to prepare for the specific statistical analysis undertaken in this study. In some instances, data was duplicated. For example, projects funded for more than one year, were presented for each year in which they were funded. The data had to be carefully analysed to remove and account for such duplications. There are a number of instances in which similar entries have been formulated differently, eg. 'Botany

Department' and 'Department of Botany'. In some cases, links between different aspects of projects are not clear. The data, once appropriately prepared, provided an important and reliable baseline dataset for this study. Appendix B contains a summary of the key challenges that this study encountered with the data received from THRIP, in order to conduct the proposed statistical analysis.

2.2.3 Phase III – Building a baseline database for the Innovation Fund

The Innovation Fund had no database available. At the time of the study, management indicated that they were unable to make any documents available as these were being audited. An old DACST website contained the names of all the projects funded, the discipline in which they were funded and the names and contact numbers of the higher education beneficiaries. A questionnaire was designed to gather from these beneficiaries the same set of information that was obtained from THRIP. Attached as Appendix C is a copy of this questionnaire. The full population was surveyed, excluding those that were definitely not in biotechnology, ICT and new materials development. A total of 50 questionnaires were sent out and 24 were returned, a return rate of approximately 48%.

The data received from higher education beneficiaries for the Innovation Fund is, in most cases, up to date and needed little follow up, except instances where no contact data was available for higher education beneficiaries.

2.2.4 Phase IV – Surveying industry beneficiaries

This phase aimed to audit industry's perspective and experience of higher education-industry partnerships as incentivised through government-funded programmes. The survey questionnaire, attached as Appendix D, aimed to elicit information on the following:

- The scale of partnership activity in general and then in relation to THRIP and the Innovation Fund partnerships;
- The motives and purposes of engaging in an HE-industry linkage;
- The nature and functioning of the HE-industry partnership;
- The motive(s) for selecting HE or SETI partners;
- The perceived benefits of the relationships funded by THRIP and the Innovation Fund;
- The management of the HE-industry linkage;
- The outputs of the HE-industry linkages;
- The sustainability of the partnerships with HE institutions and SETIs.

A total of 282 questionnaires were sent out to industry partners. They were distributed to those individuals within industry enterprises who were designated as the THRIP or Innovation Fund project contact person. Many enterprises were involved in more than one project. In some cases the same enterprise allocated different individuals for each

project and in others the same individual was designated to several projects. Some enterprises received several questionnaires addressed to these different designated individuals. In projects where more than one industry partner was involved, questionnaires were distributed to all partner enterprises. In projects where different individuals were allocated to projects, each individual was surveyed.

Questionnaires were sent out on 16 October 2002, with the return date set for 21 October 2002. By 20 October, follow-up phone calls were made to the recipients to ensure that they had received the questionnaire and to request that they complete and return the questionnaire by the scheduled date.

On 28 October, a reminder note with a copy of the questionnaire was e-mailed to Innovation Fund and THRIP beneficiaries who had questionnaires outstanding – at that point, the return rate was 14%. Telephone follow-up calls continued until 6 November when another reminder note was sent to those industry beneficiaries that had still not returned a questionnaire. This note indicated that the final return date was 11 November.

The final response rates were such that 61% of the total of THRIP and Innovation Fund projects were covered in the survey returns. 72% of THRIP projects were covered and 46% of Innovation Fund projects were covered. In total, 83 questionnaires were returned, with 60 (72%) of these questionnaires responding to more than one project. A total of 60 questionnaires were returned for THRIP with 50 (83%) responding to more than one project and 14 for the Innovation Fund with one (7%) responding to more than one project. Eight questionnaires were returned by companies that were involved in both Innovation Fund and THRIP projects.

The lower return rate for Innovation Fund projects suggests that industry participants were less willing to participate than those funded through THRIP. Telephonic discussions support this understanding. Industry respondents seemed to have a personal understanding of THRIP and personal relations with THRIP staff whereas respondents from Innovation Fund projects seemed to have little understanding about and a more limited relationship with the Innovation Fund.

2.2.5 Phase V – Undertaking a network analysis

A network analysis was attempted by the University of Cape Town's Department of Statistics. This analysis, based predominantly on a body of literature that attempts to identify linkages between scientists and to define scientific communities, is based on the assumption that a 'working relationship' or 'working contact' indicates a linkage.[2] In the analysis of scientific communities this 'contact' or 'working relationship' is identified through citation with the unit of analysis being the research publication. For the purpose of this study, this analysis was applied to a 'contact' or 'working relationship' defined as two or more researchers, research institutions or companies

[2] Powell (2001) provides a detailed description of the methodological tools of citation analysis and co-citation analysis that provided the basis for the analysis undertaken here.

working as part of the same research team, and the unit of analysis was the project funded by the Innovation Fund or THRIP.

This analysis makes the assumption that an intellectual link exists between researchers or research institutions that work on the same projects. This analysis demanded that the following key steps be undertaken.

A. The establishment of raw matrices

In order to undertake this analysis a number of raw matrices needed to be established. In these matrices the vertical axis lists researchers (or research departments and institutions) and the horizontal axis lists researchers (or research departments and institutions). The following raw matrices were established:

- A raw matrix that indicates the extent to which researchers are working together.
- A raw matrix that indicates the extent to which research departments are working together.
- A raw matrix that indicates the extent to which research institutions are working together.

These matrices enabled the study to determine the extent to which some researchers were involved in more projects than others, as well as the networks (or working relationships) that existed between these researchers and/or research institutions.

B. Developing a co-citation matrix

The next step in this methodological tool is to translate the citation matrix to a matrix that counts the number of times in which researchers (research departments and research institutions) worked together with another researcher, research department and research institution. These matrices exist as a mirror images with the same researchers, research departments and research institutions on the vertical and horizontal axis. The results show the number of times that each has worked with the other. These matrices indicate the number of times that researchers, research departments and research institutions have worked together and develop the preparatory matrices for the correlation matrix.

C. Developing the correlation matrix

The next step in the new methodological tool is to develop a correlation matrix. The correlation matrix is developed by determining a correlation coefficient. The correlation coefficient functions as a measure of how often pairs of researchers, research departments and research institutions worked together. It serves to remove differences of scale between the researchers, specifically between those researchers who worked on many projects and those who worked on fewer projects.

In this study, various spatial mappings were undertaken of the extent to which researchers, research departments and research institutions worked together. This was done by means of multivariate analysis that was used to display inter-research

relationships in similarities matrices. Three kinds of multivariate analysis were tested: Factor analysis, clusters analysis and multi-dimensional scaling. The Statistical Package for the Social Sciences, SPSS-x, provides a clustering programme that implements a variety of hierarchical agglomerate procedures such as: Single linkages; complete linkages and average linking. Multivariate scaling provides an information-rich display of the correlation of linkages.

The correlation matrix, by clustering researchers in terms of both their proximity to each other and their distance from each other, had the potential to provide the study with a description of research relationships existing in the area. However, as indicated in later chapters, the correlations matrix provided an account of networks that are so complex that unfortunately, due to the time and budget constraints of this study, could not be studied in depth. Chapter 10 does however provide some of the initial findings.

2.3 The sample

The sample for this study comprised projects funded by the Innovation Fund and THRIP. The different partners involved in THRIP and Innovation Fund projects require explanation.

Primary beneficiary: This term, applied by THRIP, refers to the main beneficiary or higher education grant holder of each project. The main THRIP contract is a document signed between THRIP and the grant holder at the higher education institution. This term is used throughout this report to refer to the main grant holders.

Secondary beneficiary: In this report, secondary beneficiaries are defined as the industry partners to a project.

Auxiliary beneficiary: In this report, the researchers at HEIs/SETIs who form part of the project research team, are termed the auxiliary beneficiaries.

Students: These include students who work on or are funded through the project.

Primary institution: This refers to the HE institution or SETI that holds the research contract. Effectively, it is the institutional base of the primary beneficiary or grant holder.

Auxiliary institution: This refers to the HEIs/SETIs at which auxiliary researchers are located.

While the focus of this study was on THRIP and the Innovation Fund, an Internet search identified a number of smaller but relevant programmes currently operating in South Africa. These are: (i) The Support Programme for Industrial Innovation (SPII) funded by the Department of Trade and Industry (DTI) and managed by the Independent Development Corporation (IDC); (ii) the Partners in Industrial Innovation Fund (PII), which is also funded by DTI; (iii) the Venture Fund, which provides venture capital to incentivise joint ventures through the DTI; and (iv) the Lead Programmes Fund, which funds innovation through international co-operation. A preliminary review suggests that these programmes all impact, either directly or

indirectly, on higher education partnerships and/or innovation in South Africa. The extent and nature of such impact would, however, require further study. All these programmes represent attempts by the state to steer the national system of innovation in the direction made desirable by the national HE and SET policy framework.

2.3.1 The three technological fields

One of the difficulties facing a project of this kind are the varying definitions of 'biotechnology', 'ICT' and 'new materials development'.[3] A factor complicating this was that prior to 2001, THRIP had not developed a system of analysing proposals received according to subject fields. In 2001, the organisation established a process of peer review of all proposals received and found it necessary to define the proposals according to 13 subject fields that were identified by the NRF to facilitate the assessment of project proposals. These fields are termed, by the NRF, 'technological strategic areas' and are captured in Figure 2.

Figure 2: THRIP's research programmes

1. Forestry
2. Agriculture
3. Animals
4. Business
5. Health
6. Environmental waste management and Biotechnology
7. Food
8. ICT
9. Materials
10. Manufacturing
11. Process manufacturing
12. Mining and minerals processing
13. Power manufacturing and Control Engineering

In terms of the fields outlined in Figure 2, the technological bands of ICT and new materials development have been analysed according to THRIP's categorisation. Identifying projects in the field of biotechnology, however, involved extracting biotechnology projects from four related 'technological strategic areas', namely, agriculture, food, environmental waste management and health. This was done with the support and guidance of THRIP staff.

[3] The HSRC has, as part of Component 1 of the study, commissioned a series of expert papers that develop working definitions of biotechnology, ICT and new materials development.

Figure 3: Innovation Fund and subject area fields

INNOVATION FUND AREAS		
Biotechnology	**ICT**	**Value addition: Materials and advanced manufacturing**
• Molecular biology • Bioinformatics • Genomics • Proteomics • Immunology • Genetics • Molecular modelling • Structural biology	• Systems design and implementation • Information management including content/data analysis informatics, data storage, data integration and information access • ICT application in science and engineering • Enhanced communications technology, including applications in mobile and distributed work environments	• Systems integration (design and engineering) • Net shape & rapid solidification processing • Integrated sensor technologies (sensors technologies with embedded electronics and software) • Materials handling (automatic storage and retrieval) • Advanced materials

The Innovation Fund uses predominantly biotechnology, ICT and value adding as the subject fields for the submission of proposals (Figure 3). In Round 1 of Innovation Fund projects, the category of crime prevention was also included. The Director of the Innovation Fund subsequently indicated that the Innovation Fund also funds projects in Flora and Fauna. This study, in the absence of an available database from the Innovation Fund, focused only on the data available on the DACST website, which did not indicate any projects funded in the area of Flora and Fauna. As such, the Innovation Fund projects in this report were analysed according to the categorisation presented in Figure 3 which includes biotechnology, ICT and a subject field titled value addition: Materials and advanced manufacturing. In addition to applying this categorisation drawn from the DACST website, the technological field was further confirmed in the survey of higher education beneficiaries of Innovation Fund projects which required respondents to indicate the technological field of their project.

It is important to note that the data analysed in this report includes THRIP projects for the years 2001 and 2002 but includes all of the Innovation Fund projects from the inception of the organisation. THRIP projects for 2001 and 2002 were selected as THRIP did not, prior to 2001, collect data on the technological strategic fields of projects. Furthermore, the sample of 2001 and 2002 projects proved sufficient for the purposes of this study. All projects funded by the Innovation Fund since its inception were included in the study to provide for a statistically valid sample size for Innovation Fund projects.

Section A

INTRODUCTION TO GOVERNMENT-FUNDED PROJECTS

3

INTRODUCTION AND BACKGROUND TO THRIP AND THE INNOVATION FUND

The National Skills Development Strategy (NSDS) and the National Human Resource Development Strategy have been developed to overcome South Africa's rating as one of the poorest human resource development records in the world. Underpinning these national strategies is an acknowledgement of the failure of education and training in South Africa to be responsive to the changing needs of the economy and industry's interest to ensure adequate human resource development at an enterprise level. The need to bridge the gaps between the worlds of education and work has found articulation in legislation[4] passed with the aim of 'overcoming the structural rigidities and inequalities inherited from the apartheid era to meet the dual challenges of social development and the requirements to compete in the global economy' (Department of Labour 2001).

This need to bridge the historical divide between the worlds of education and research and the worlds of work is clearly articulated in the mission and strategy adopted by THRIP and the Innovation Fund. Both THRIP and the Innovation Fund aim to incentivise technological advancement through the establishment of partnerships and/or collaborative endeavours, which seek to ensure multi-institutional and multi-sectoral cross-transference of technological knowledge for the purposes of advancing SET research, SET human resource capacity and the technology outputs of research, in South Africa.

As will be discussed below, THRIP projects are specifically structured as either HE-industry or SETI-industry partnerships, thereby ensuring a cross-transference of knowledge, skills and resources, including human resources across academic institutions, government SET institutions and the industrial sector. Embedded in the THRIP project structure is the need to ensure that research outputs and project outputs can be commercialised for the purposes of achieving the organisations' overarching goals, i.e., to improve the competitiveness of South African industry in the context of globalisation and technological advancement. THRIP's emphasis on the need for HE/SET-industry partnerships to achieve these goals is evidenced in its commitment to

[4] This legislation includes the National Skills Development Strategy, The Skills Development Act, Skills Levies Act, The Employment Equity Act and other education-related acts such as the FET Act and the SAQA Act.

fund R1:R1 in instances where more than one industry partner is involved in any project and where the second highest industry contribution is at least ten per cent of the highest industry contribution. Clearly, the vision that THRIP aims to achieve through partnerships is a network society in which the resources available across institutions are brought together for the technological and human resource enhancement of the enterprises themselves and the nation as a whole.

Innovation Fund projects, on the other hand, are structured to 'encourage and enable longer-term transdisciplinary innovation projects in the higher education sector, government science councils, civil society and the private sector', once again with the purpose of ensuing economic growth, international competitiveness and human resource development in the fields of science and technology. The Innovation Fund places considerable emphasis on ensuring that research projects culminate in tangible technological advances and reserves the right to withdraw ownership of intellectual property from any funded project consortium, should it be determined that the results of the project have not been economically exploited. This indicates a strong commitment to ensuring that knowledge does not become isolated from national human resource and SET objectives.

However, despite the fact that both programmes, either as a direct part of their mission or as an indirect result thereof promote higher education-industry linkages, there are significant differences between them. This section, by providing an overview of the central thrust of both THRIP and the Innovation Fund, highlights the different missions and aims for each of these programmes and the way in which they propose to enable higher education-industry partnerships.

3.1 THE TECHNOLOGY AND HUMAN RESOURCES FOR INDUSTRY PROGRAMME (THRIP)

The Technology and Human Resources for Industry Programme (THRIP) is a programme managed by the National Research Foundation (NRF) for the Department of Trade and Industry (DTI), that aims to 'improve the competitiveness of South African industry by supporting scientific research, technology development and technology diffusion activities and enhancing the quality and quantity of appropriately skilled people' (DTI THRIP, *Guide to Research Support* 1998). The programme has been designed to foster collaboration among industry, higher education institutions (HEIs) and the government science, engineering and technology institutions (SETIs) as a means of 'contributing to the removal of past inhibitions to joint activity among these three sectors'. THRIP aims to achieve its mission by supplying grants that match contributions made by industry to project activities that qualify for THRIP support. The grant funds are provided by the DTI.

The primary objectives of the programme are to:

- Increase the number and quality of people with appropriate skills for the development and management of technology for industry;

- Promote increased interaction among researchers and technology managers in industry, higher education and government science, engineering and technology institutions (SETIs), with the aim of developing skills for the commercial exploitation of science and technology. This should promote the mobility of trained people among these sectors;
- Stimulate industry and government to increase their investment in research, technology development, technology diffusion and the promotion of innovation.

THRIP has also highlighted a number of priorities in relation to the objectives outlined above, which include:

- Supporting an increase in the number and quality of black and female graduates who intend to pursue technological and engineering careers;
- Promoting technological know-how within the small, medium and micro enterprise (SMME) sector, through the deployment of skills vested in HE institutions and SETIs;
- Facilitating and supporting multi-firm projects in which firms collaborate and share in the project outcomes.

THRIP requires that projects meet three main criteria to be eligible for consideration, which are linked to its mission statement. These are:

1. Projects must promote and facilitate scientific research, technology development, and technology diffusion, or any combinations of these;
2. All projects funded by THRIP must include a human resource development component;
3. The choice of technological focus for the activities is to be left to the industrial participants and their partners.

There are three primary mechanisms through which THRIP funds projects. These are outlined, as follows, in the THRIP *Guide to Research Support* (DTI, 1998).

1. Projects led by a researcher or researchers based at higher education institutions: In such cases, industry and THRIP invest jointly in research projects, where the research leaders are academic staff of HE institutions. Such projects ensure that industrial and academic research priorities are aligned and that students are able to develop the appropriate skills for participation in the industrial sector.
2. Participation of government SETIs in THRIP projects: The second mechanism aims at mobilising the skills base in science, engineering and technology (SET) disciplines within government SETIs in South Africa so as to contribute to bridging the existing gap between higher education institutions and SETIs. This is done through collaborative research involving SETIs, higher education

institutions and industry, in relation to industrial research priorities. This mechanism is further divided into two scenarios:

a. SETI-based expertise contracted in by higher education-based researchers: Where one or more SETI-based expert(s) collaborate on a contract basis with a HE-based researcher or research teams on THRIP projects. THRIP provides financial support through the HE institution.

b. SETI-based researcher constitutes the project leader: THRIP also supports projects where SETI-based researchers serve as project leaders.

THRIP requires that each SETI involves at least one historically black university (HBU) or technikon in one out of every three projects supported by THRIP. It is stated that this could 'significantly contribute towards building research capacity in South Africa's historically disadvantaged HE institutions'.

3. TIPTOP options: The Technology Innovation Promotion through the Transfer of People (TIPTOP) option is a set of placement mechanisms designed to promote the mobility of people participating in THRIP projects amongst the organisations involved (HEIs, SETIs and industry). There are various options in the TIPTOP mechanism.

a. Exchange of researchers and technology managers between HEIs, SETIs and industry: In terms of this option, THRIP provides support for academic researchers at HE institutions to enable them to work in industrial laboratories. THRIP also encourages and supports industrial researchers and technology managers to be temporarily seconded to HEIs or SETIs to conduct research that is of direct relevance to the industry involved.

b. Placement of SET graduates in industry, while they are working towards a higher degree on a joint research project: This option supports the placement of graduates in SET-related disciplines within industry on a contract basis to work on THRIP-approved projects. The graduate should be registered at an HE institution for a higher degree in SET. The graduate is mentored both by their academic supervisor and superiors in industry. This support is for a maximum of two years for a masters degree and three years for a doctoral degree.

c. Placement of SET graduates in SMMEs: This option involves the placement of SET graduates in SMMEs for fixed periods to work on THRIP projects.

d. Placement of SET-skilled company employees within HEIs or SETIs: This option supports the secondment of graduate employees from industry to HE institutions or SETIs to do research for THRIP projects while studying towards a higher degree. THRIP contributes 70% of the cost where the employee is either black or female, so as to stimulate growth in the number of highly skilled blacks and women in the research workforce.

The criteria for THRIP support include the following:

- The project must be a high quality science, engineering and/or technology research project, the outputs of which can potentially make a significant contribution to improving the industry partner's competitive edge;
- At least one registered student must be involved in and trained through the research; this excludes the placement of SET graduates in SMMEs;
- The project must have clearly defined scientific and/or technology outputs plus human resource outputs for each year of support;
- The project leader must have full-time employment status at the HE institution or SETI;
- At least one HE institution and one industry partner must be involved;
- The industry partner must give a clear indication that the project will directly support the specific company;
- Commitment from the industry partner must be clearly shown in terms of investment in the project; and
- Arrangement for ownership and exploitation of intellectual property arising from the project must be agreed upon between the HEI/SETI and the industry partner before commencing the project.

In terms of funding, THRIP support is limited to South African HEIs and SETIs. The various funding formulae are as follows:

- R1 for R2: In this formula, THRIP contributes a maximum of R1 for every R2 invested by industry in a project that satisfies THRIP criteria.
- R1 for R1: According to this formula, THRIP will fund R1 for every R1 invested by industry when at least one of the following conditions apply:
    - Projects involve at least five students, of whom at least half are black or female;
    - Projects where SMMEs (one or more) invest financially; and
    - Projects in which more than one industrial partner contributes and the second highest industry contribution is at least 10% of the highest industry contribution.
- SETI-based expertise contracted in: Where SETI-based expertise is contracted into a project with an HE institution as the project leader, THRIP's contribution to this component will be limited to a maximum of 30% of the total THRIP contribution to the project.
- TIPTOP funding options: THRIP contributes 50% (up to a maximum of R100 000 per person on an annual basis) of the costs and the firm will pay the balance. Where placement involves SMMEs and black or female participants,

THRIP will pay 70% (up to a maximum of R140 000 per person on an annual basis) of the costs and the participating firm pays the balance. The TIPTOP funding is independent of whether or not the overall project qualifies for the R1:R2 or R1:R1 options.

Due to an increasing demand for THRIP funds, an element of prioritisation needed to be introduced in assessing applications for funding. THRIP's budget grew, as evidenced in Table 1, exponentially from 1995 to 2000. THRIP began applying a Multi-Criteria Decision Model (MCDM) to assess project proposals for funding. Beyond the minimum requirements for consideration, fundable projects are also subjected to a process of ranking in terms of MCDM criteria.

It is important to note that THRIP funds a wide variety of technological projects, the focus of which is at the discretion of the grant holders (HEIs and SETIs) and the industry partners. While all THRIP projects funded in 2001 and 2002 are included in this study, the focus is on the three critical technology fields, i.e. biotechnology, ICT and new materials development.

Table 1: THRIP expenditure 1995–2000

Year	THRIP expenditure R '000	Allocation of THRIP budget	Number of projects	Technikons	Universities	SETIs
1995/96	5 598	50.60%	78	10	68	-
1996/97	24 086	83.10%	173	9	164	-
1997/98	46 872	99.20%	399	30	366	3
1998/99	71 200	94.60%	405	33	347	25
1999/00	96 500	98.40%	384	39	325	20
2000/01	137 500	98.20%	413	49	331	33

3.2 THE INNOVATION FUND

The Innovation Fund provides grants to fund end-stage research processes, where research knowledge can be translated into 'new and improved products, processes or services'. The Innovation Fund aims to achieve the following overall objectives:

- Improve and sustain the quality of life for all South Africans;
- Develop human resources for science and technology;
- Strengthen the country's competitiveness in the international sphere; and
- Foster economic growth.

The Innovation Fund started within the Department of Arts, Culture, Science and Technology (DACST) for a trial period in the 1997/1998 financial year. The focal area for this initial trial period was crime prevention. In 1998/1999 the Fund began to operate as a full-blown programme, designed to support large-scale science,

engineering and technology (SET) innovation programmes. The key objectives of the Innovation Fund are to:

- Promote technological innovation within the research community;
- Permit the reallocation of funds from the historical patterns of government science towards the key issues of competitiveness, quality of life, environmental sustainability and harnessing information technology;
- Increase the extent to which funds for the activities of government SETIs are obtained via competitive processes; and
- Promote transdisciplinary collaboration across sectors within South Africa.

A brief introduction to the Innovation Fund was provided during an interview with Dr Lottering, Director of the Innovation Fund. He included the following objectives, in addition to the above:

- Encourage and enable longer-term, large innovation projects in the higher education sector, government science councils, civil society and the private sector;
- Promote increased networking and cross-sectoral collaboration within South Africa's national innovation system;
- Encourage close relationships between those conducting the research activities and those who will be expected to diffuse and make practical use of the results;
- Facilitate the financing of problem-oriented research involving participants from many disciplines.

The Innovation Fund is currently funding projects in the fields of biotechnology, new materials development and advanced manufacturing, ICT and Flora and Fauna.[5] According to the Innovation Fund, 'the nature of the problems/challenges addressed by this Fund should be serious enough to impede socio-economic development or affect our ability to compete in products and services. The projects must therefore involve technological innovation with a large component being research and development'. It is also specified that there 'must be some indication of benefits extending beyond those accruing to a particular organisation/business'.

The evaluation criteria for proposals submitted to the Innovation Fund include the following:

- Criteria relating to national benefit: Project proposals are required to give a clear indication of how South Africa stands to benefit from the proposed project in terms of improved efficiency, increased employment, new capital investment, exports, and import replacements;
- Criteria relating to innovation: A clear illustration must be given of the innovative nature of the projects;

[5] The methodology chapter contains further discussion on the technological fields.

- Criteria relating to technical details: Details are required on the methodology for developing technological innovation up to prototype stage and a research and development plan is required;
- Criteria relating to project potential for utilisation of results/commercialisation: Each proposal must include a strategy for commercialisation or utilisation of results.

The Innovation Fund has been set up to support large collaborative projects as a strategy for achieving enhanced technological innovation in South Africa. The minimum threshold for funding a project is R1 million per year and the maximum threshold is R5 million per year. So, while the programme does not directly aim to develop higher education-industry partnerships, there is the potential for such to be supported through the aims and mission of the Innovation Fund. In fact, a review of the project partnerships (provided later) shows that more SETIs than higher education institutions are accessing funding from the Innovation Fund.

Intellectual property generated by any project consortium is vested in the consortium and all parties are required to sign a legally binding Consortium Intellectual Property Agreement at the proposal stage of any project. The Innovation Fund Trust reserves the right to claim ownership of the Intellectual Property Rights if, after five years, it is determined that no attempt has been made to exploit the results of the project supported by public funds.

3.3 CONCLUSION

While both THRIP and the Innovation Fund incentivise higher education-industry partnerships, THRIP does so as a direct aspect of their mission and strategy while, for the Innovation Fund, such partnerships are a by-product of their strategy to encourage innovation. This is highlighted in later chapters that show that the majority of the partners involved in THRIP projects are higher education institutions as compared to the Innovation Fund, where the majority of the partners are SETIs rather than HEIs. In addition, the Innovation Fund targets larger projects with a minimum threshold of R1 million per year, while THRIP does not set a minimum project threshold.

Despite differences in mission and approach between the two programmes, both programmes have made a contribution to enabling higher education and industry linkages (as later chapters will indicate). While recognising the differences in mission and approach between the THRIP and the Innovation Fund, this study has examined collectively (and separately) the extent and nature of the contribution that these programmes have made to enabling higher education-industry linkages.

Section B

HIGHER EDUCATION-INDUSTRY PARTNERSHIPS

4

INVESTIGATING PARTNERSHIPS

The term 'partnerships' and the implementation of partnerships are understood and mediated differently in different contexts and by different stakeholders (Kruss 2002). The industry survey aimed to develop an understanding of industry respondents' perceptions of their relationships with HE partners in a project by determining their definitions of the terms 'partnership', 'collaborative relationship' and 'professional relationship'.[6]

4.1 INDUSTRY'S PERSPECTIVE OF THE NATURE OF THE RELATIONSHIP

The majority of the respondents (84%), viewed the relationship as either a 'partnership' (37%) or a 'collaborative relationship' (47%), as opposed to a 'professional relationship' (6%) (Fig 4). This indicates that industry by and large views its relationships with HEIs, as incentivised through THRIP and Innovation Fund projects, as more than a 'business arrangement' between two or more parties, but as a relationship in which there is commitment to a common set of goals and overall objectives.

4.1.1 Industry respondents' definition of 'collaboration'

Forty-seven per cent (Fig 4) of the total respondents defined their relationship with higher education as 'collaborative' and respondents showed remarkable consistency in their understanding of the term to mean a relationship based on clearly and mutually defined needs and benefits. The quotations below, extracted from the survey to industry respondents, illustrates this understanding:

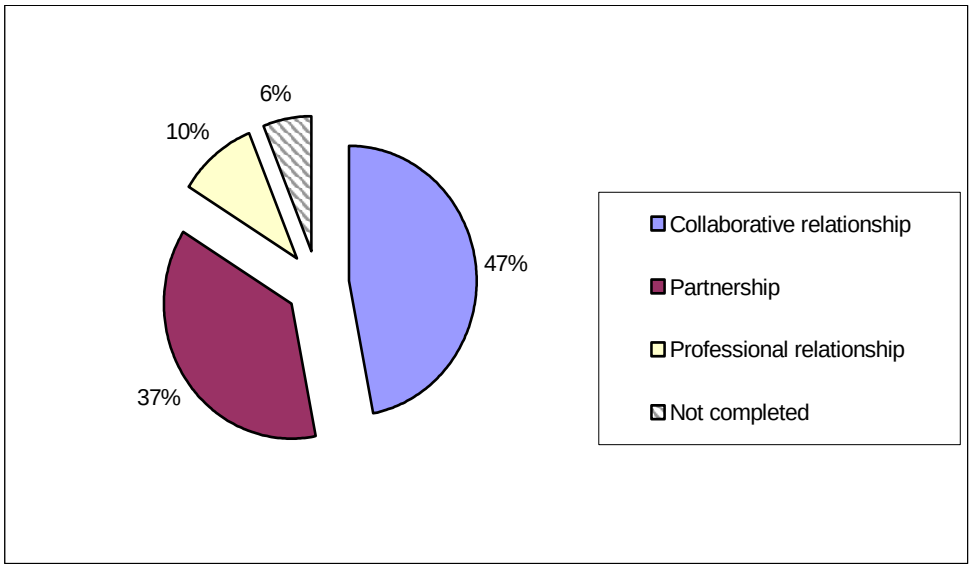
> '[A collaborative relationship is where] both parties must have clearly defined needs which are symbiotic.'
>
> 'We treat the project as a venture from which both parties derive benefits.'

[6] This section presents the findings from the industry survey. For further details on the industry survey refer to the methodology chapter and Appendix D. Due to the low returns from industry partners involved in Innovation Fund projects (see Chapter 2), the findings presented in this chapter are not disaggregated according to THRIP and the Innovation Fund. It is important to note that the distribution as presented in this chapter was tested against the THRIP and Innovation Fund returns and in all cases the distribution of responses remained constant. It appears, from this, that industry's overall perspective of partnerships does not vary much across the programmes.

'Our enterprise and higher education institutions both contribute in a complementary manner to their mutual benefit. The enterprise profits by ultimately selling its enhanced products/services … and higher education institutions profit through funding and improved infrastructure and expertise.'

'There is a joint willingness to do research and development that could be innovative for the industry. Both parties benefit: both with regards to research and development and financially.'

Figure 4: Industry recipients perspectives of the nature of the relationship between higher education and industry



One of the respondents explained mutual benefit in the context of their enterprise's partnerships as follows: 'Higher education institutions want to have a strong post-graduate programme. Our institution continually has projects from which research projects flow. We collaborate on choice of projects and the direction of research.' This is a striking example of how collaboration can ensure that the gap between the worlds of education and work can be bridged in the pursuit of mutually defined goals.

Other respondents focused more specifically on the ethics that they believe should underpin collaborative relationships, such as trust and openness. One respondent stated, 'we have a good interpersonal and professional relationship, and this matters'.

Some respondents focused on the nature of the working relationship, expressing that collaborative relationships should involve equal contributions by both parties and that team members should work in a complementary manner. One respondent stated, 'our organisation is involved in all the research along with the higher education institutions. We do not simply stand back and watch, we work together with [the] university and solve the problems. We also assist in all the physical work and setting up'. Another respondent described a similar working relationship where 'both parties contribute to the project. Our microbiologists provide data towards novel research by higher

education institutions, technical literature is shared and outcomes are mutually agreed upon'.

While these relationships are based on a very close sharing of work and responsibilities, other projects prefer to split the responsibilities, within an overall framework of collaboration. In some projects, the HE institution is responsible for the research, while the industry partner is responsible for product testing procedures. In others, the HE institution takes responsibility for the research aspect of the project, while the industry partner focuses on raising funds from donors and sponsors and creating public awareness of the project aims and outputs.

It is clear that industry partners' overall perception of THRIP and Innovation Fund relationships converges on the notion of mutual benefit within the context of mutual collaboration and mutual trust. The following quotation sums up this position:

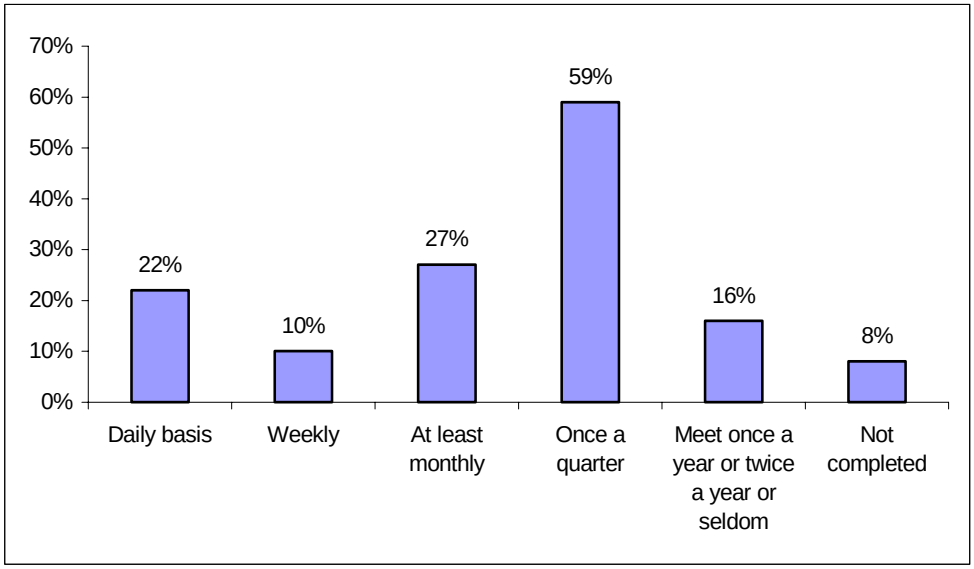
> [THRIP/Innovation Fund incentivised relationships are] win-win relationships where all parties strive for defined success with full information disclosure and mutual sharing. [The relationship should be underpinned by] trust and clear understanding of who does what and to benefit whom.

It is interesting to note that at least 14% of the respondents that defined their relationships on THRIP and Innovation Fund projects as 'collaborative', used the terms 'partnership' or 'partner' in their descriptions of the relationships.

4.1.2 Industry respondents' definition of 'partnerships'

Thirty-seven per cent of the total respondents defined the relationship between their enterprise and HEIs/SETIs as being a 'partnership', where a 'partnership' was perceived as either a more formal-contractual relationship, or as a relationship explained in the notion of 'collaboration' outlined above. For industry respondents who defined 'partnership' as a formal or contractual relationship, the difference between 'collaborative relationships' and 'partnerships' is dependent on the degree of contractual formality governing a collaborative relationship. One respondent referred to their project as a partnership in which 'a formal agreement exists between the university and industry. Interactions involve staff, students and projects being shared in a mutual relationship of trust'. Another respondent viewed the project as a partnership in which 'a joint company has been formed' to administer the project. Thus, even respondents who defined 'partnership' as a formal agreement between partners tended to imbed their notion of 'partnerships' in terms of collaboration as outlined above.

Figure 5: Frequency of meetings between industry and higher education



4.2 INDICATORS OF PARTNERSHIP AND COLLABORATIVE RELATIONSHIP

4.2.1 Frequency of meetings

Industry and HE partners meet on a relatively frequent basis. Eighty-three per cent of project partners that responded to the survey indicate that they meet with project partners at least once a quarter. A total of 41% of the respondents indicated that they meet with the project partners at least once a month, with 15% meeting on a daily basis, 7% on a weekly basis and 19% at least once a month. 42% reported that they meet with partners at least once a quarter and only 11% meet less than once or twice a year or less frequently (Fig 5).

Of those who defined their relationship as ‘collaborative’ in nature, 50% reportedly meet once a month or more, compared with 36% of those who defined the relationship as a ‘professional relationship’ and 25% of those who defined the relationship as a ‘partnership’. This relatively high frequency of meeting in ‘collaborative’ relationships supports the respondents’ definition of collaboration, wherein mutual participation and mutual benefit are highlighted as priorities. Respondents who defined the relationship as a ‘partnership’ or ‘professional relationship’ generally meet less frequently (less than once a month or more) than those who defined the relationship as ‘collaborative’ (Fig 5a, 5b and 5c).

These findings support the notion that collaboration, as opposed to contractual partnering and professional relationships, requires a closer working relationship between the parties involved and an increased investment in terms of time and human resources.

Figure 5a: Collaborative relationship

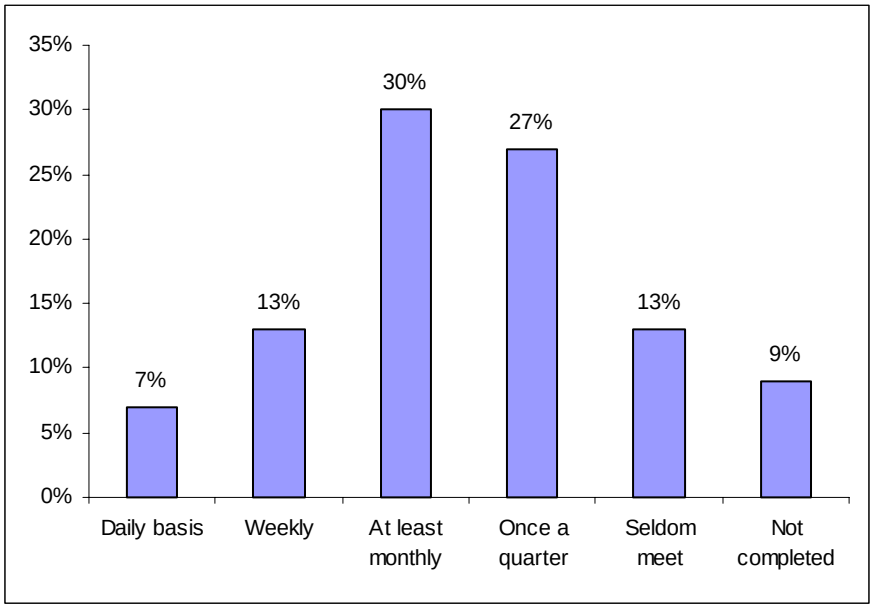


Figure 5b: Partnership

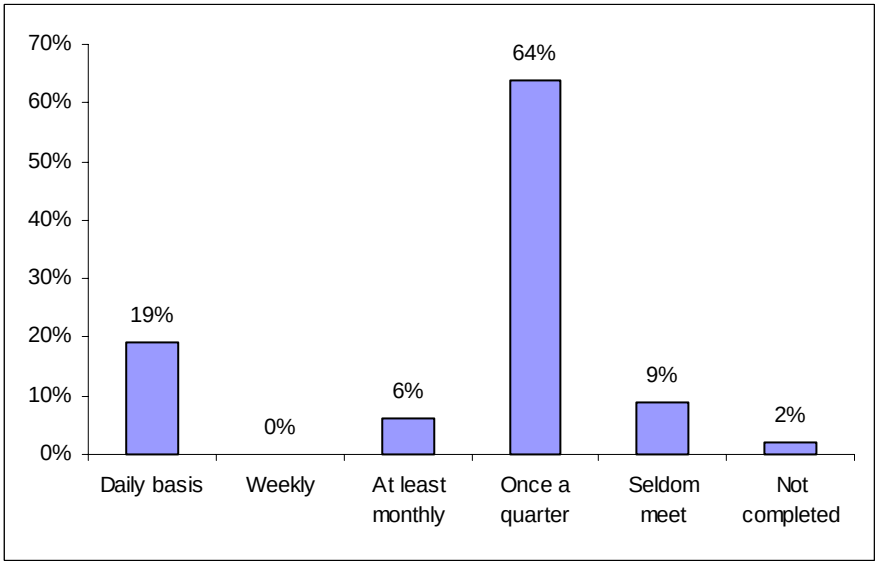
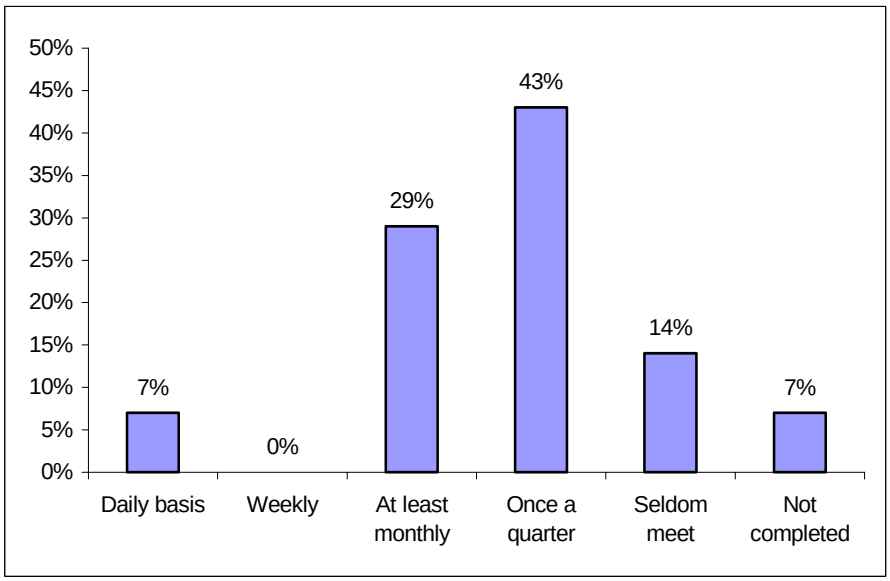


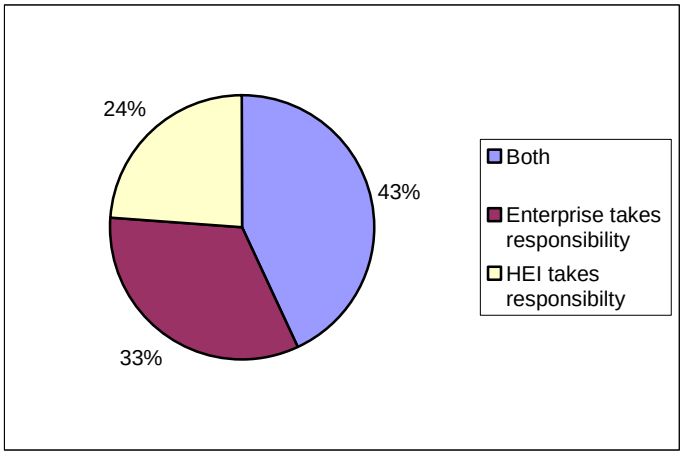
Figure 5c: Professional relationship



4.2.2 Nature of communication

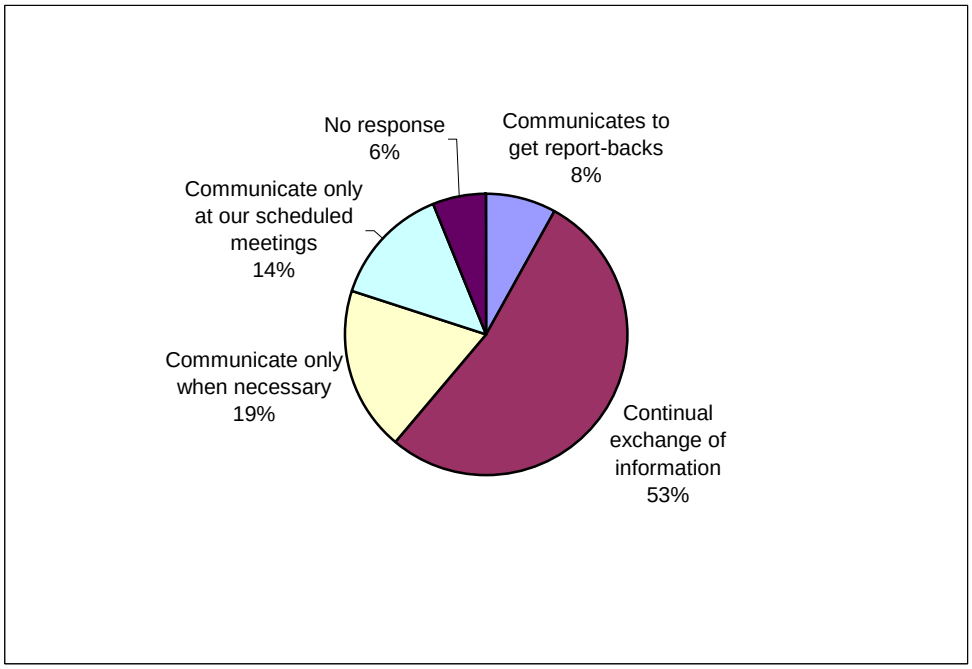
Figure 6 indicates that 43% of the respondents indicated that both HE institutions and industry partners share the responsibility for communication within the project team. A further 33% of the respondents reported that industry takes the overall responsibility for communication. These results are notable, as industry is regularly viewed as taking the 'hands-off' approach of contributing funds but not actively participating in the relationship beyond that scope. These findings suggest a very different scenario, where industry, in fact, takes even more responsibility for communication overall than the HE institution (or grant holder in the case of THRIP projects), and that buy-in into the project is well established for the industrial partners.

Figure 6: Nature of the communication – who takes responsibility?



An analysis of the direct form of communication (Fig 7) indicates that 53% of the respondents report a continual exchange of information between the industry partner and HE institution. This, too, serves to confirm the extent of industry involvement in THRIP and Innovation Fund projects as being 'hands-on' and collaborative. 19% of the respondents indicated that they communicated only when necessary. 14% indicated that they communicate through scheduled meetings and only 8% reported that their enterprise only communicates with HE institution to get report-backs.

Figure 7: Form and nature of the communication



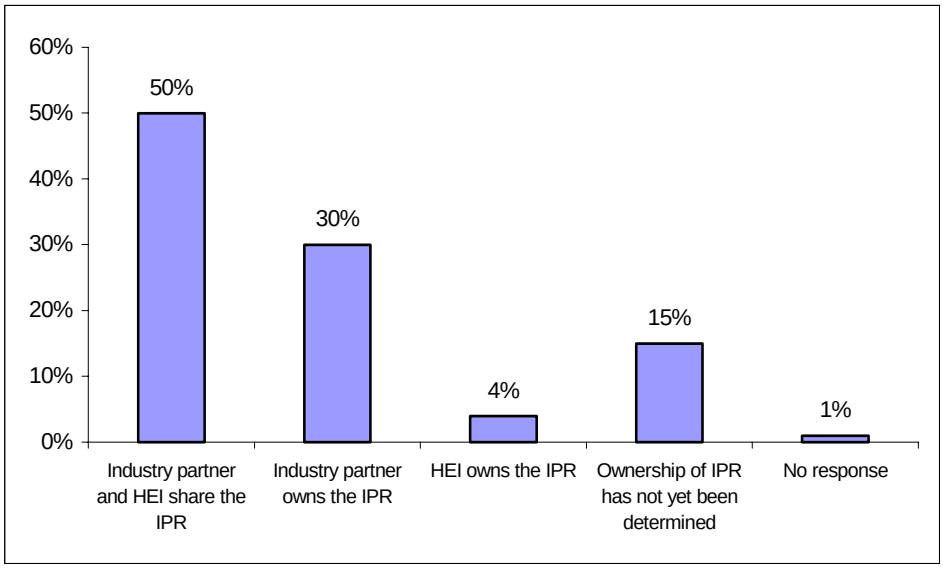
Overall, the nature of communication between HEIs and industry partners supports the view that the relationships are based on mutual participation and input, and that there is a strong argument to be made for viewing the relationships as genuine efforts to bridge the gaps between the worlds of academia and industry, and the worlds of education and work.

4.2.3 Ownership of intellectual property

The findings on the ownership of intellectual property have been analysed from the industry questionnaires. Industry was asked to indicate, from their perspective and experience, the nature of the intellectual property ownership.

Figure 8 outlines which of the partners in THRIP and Innovation Fund projects own the intellectual property generated in the course of the relationship. As the figure illustrates, 50% of the HEIs and industry partners share the Intellectual Property Rights (IPRs), while 30% of the projects allocate the IPRs to industry alone and 4% to the HE institution alone. In 15% of the cases, partners had not resolved IPR ownership and 1% did not respond to this question.

Figure 8: Who owns the IPR?



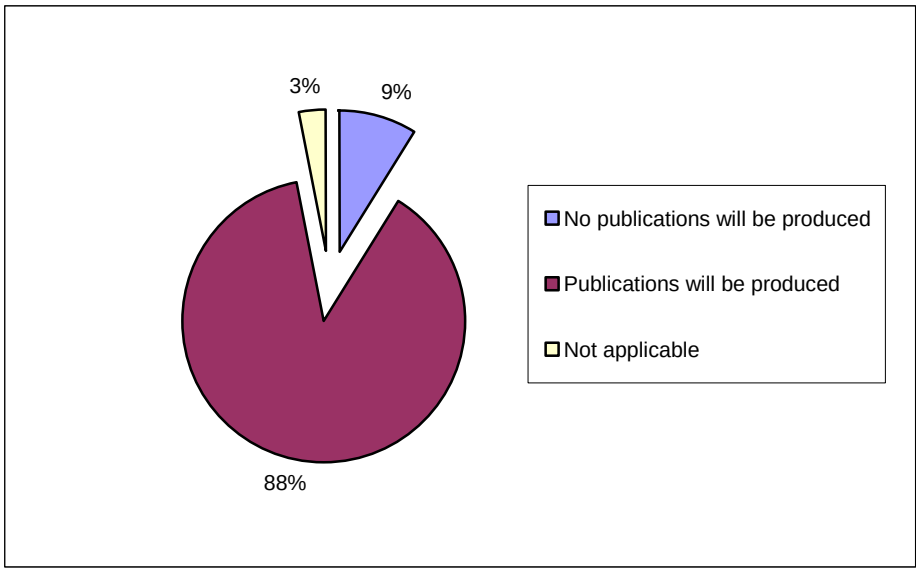
The ownership of Intellectual Property Rights is a critical indicator of the extent to which projects are mutually collaborative and mutually beneficial (Powell 1999). The issue of IPRs is pertinent to higher education institutions, as IPR arrangements may heavily impact on HE institutions' traditional role of producing new knowledge and basic research (Walshok 1995). Blumenthal (1986), in a study on university-industry research relationships, argues that one of the risks to universities in the context of HE-industry partnerships is a tendency towards increased secrecy due to industry placing increasing restrictions on publications. By the same token, however, industry may be reluctant to share IPRs, so as to maintain the competitive advantage within their sub-sectors and to exploit the outcomes of research projects for profitable gain. This may account for why as much as 30% of all IPRs are vested with industry partners alone. Ping (1980), however, argues that despite the risks to universities, there is a considerable body of scholarly work that suggests that the interaction between scientists doing applied research may enhance the work of both universities (including the traditional role of basic research) and the work of industry.

THRIP does not prescribe how IPRs are to be distributed, but does require that the parties agree upon the distribution of these rights before commencement of any project. THRIP also requires that such an agreement should not restrict the publication of research results for more than two years after the completion date of the project. The Innovation Fund, however, requires that intellectual property be vested with the consortium of the partners and reserves the right to claim ownership of intellectual property if, after five years, the funder is able to determine that no attempt has been made to exploit the results of the project.

4.2.4 Publications

Figure 9 indicates that the vast majority of respondents (88%) report that publications have been or will be generated as a result of THRIP/Innovation Fund projects. Only 9% report that publications will not be produced and in 3% of the cases, the respondents indicated that the question was not relevant to their project.

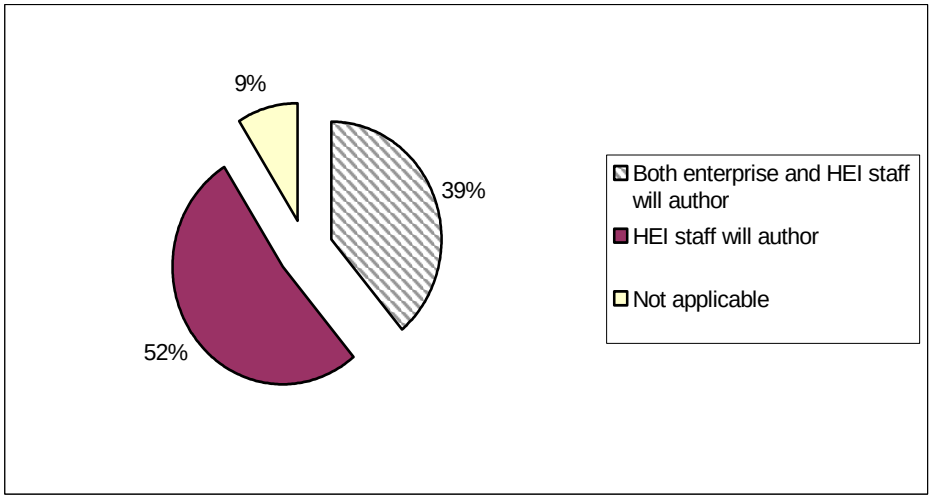
Figure 9: Are publications going to be or have they been produced from the research work?



It is important to note that high publication levels are an important consideration for maintaining and upholding scientific rigour, as well as prompting and generating new research outputs in related areas. This is especially critical for HE institutions, where the numbers of publication outputs are monitored as indicators of academic performance and institutional success.

Figure 10 illustrates that 91% of the completed and envisaged publications involved, or will involve HE institution staff as authors (52% as single authors and 39% as co-authors with industry partners). These findings support strongly the argument presented by Ping (1980), in suggesting that involvement in HE institution-industry partnerships will contribute to, rather than deflect from, the traditional HE role of producing and publishing research.

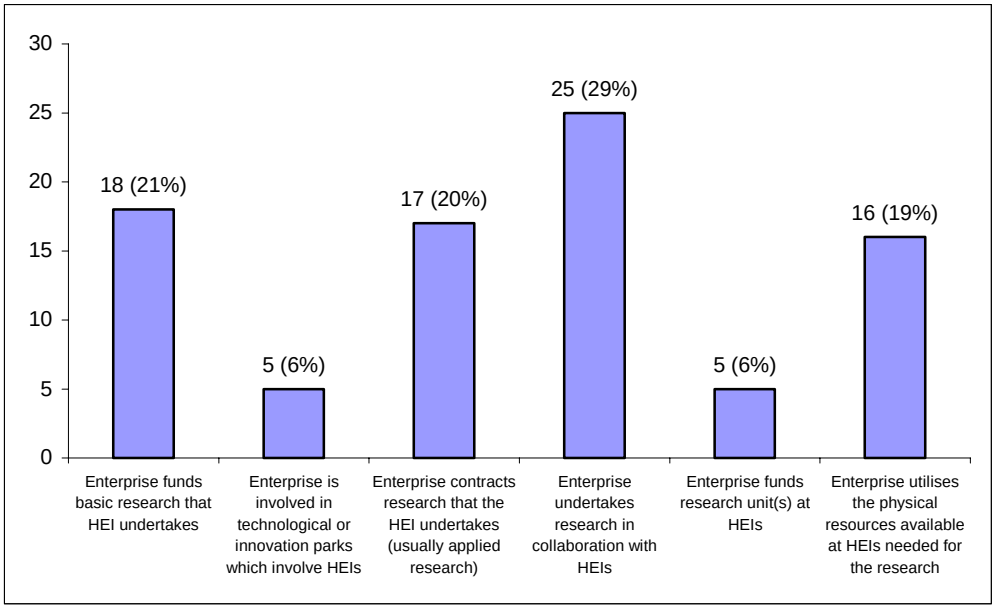
Figure 10: Who are the authors of the publications?



4.3 INDUSTRY'S PERCEPTION OF THE NATURE OF THE PARTNERSHIPS

Figure 11 indicates that almost a third of the respondents felt that they undertake the research in collaboration with HE institutions, rather than the research being outsourced or contracted to HE institutions.

Figure 11: Nature of partnership – from industry's perspective



In 21% of the cases, the enterprise funds basic research that is undertaken by the HE institution. This is interesting, as there is much literature that argues that industry is primarily involved in funded research that can be directly applied in an industrial

context. In support of this view, 20% of the respondents indicated that much of the research is contracted to HE institutions and is applied research.

Nineteen per cent report that they rely on using the physical resources available at HE institutions for research purposes. This highlights the role of HE institutions in contributing expertise, research resources and facilities that would be too expensive and cumbersome for industry to replicate. In a few instances (6%), the partnerships are such that industry funds HE institution-based research units or is involved with the development of Innovation Parks or Technology Parks in collaboration with HE institutions.

4.4 CONCLUSION

The results indicate, overall, that industry understood 'collaborative relationships' to mean relationships based on mutual participation and mutual benefit, and understood the term 'partnerships' to represent more formal, contractually-based relationships. It must be noted, however, that the definitions of 'collaborative relationships' and 'partnerships' did overlap and that mutual benefit and collaboration were considered characteristics of both.

The findings outlined in this section suggest that the HE-industry relationships reviewed here are largely founded on the principles of mutual co-operation, mutual participation, mutual benefit and trust. Moreover, the notion that industry partners limit their interaction to supervising the application of their funding contributions is largely refuted. A review of the nature of the relationships between partners indicates that industry is playing a hands-on, fully participatory role in THRIP/Innovation Fund-incentivised projects. It is clear from industry's perspective that they are investing time and resources in the relationships, and in some instances, even driving the relationships in terms of communication and collaboration.

It is also clear that HE institutions are benefiting in terms of the IPRs and publications that are generated from research outputs, in contestation with the literature that reviews the negative impact of HE-industry partnerships on HE institutions (Powell 2002).

Although these findings represent industry's perspective, and are not complemented by a similar investigation of HE institutions' perspectives, this analysis provides the basis for re-assessing concerns that HE-industry partnerships may impact negatively on the traditional role of HE. They suggest that the partnerships have resulted in tangible benefits and advantages being gained on both sides.

This does not attempt to suggest that all HE-industry partnerships are inherently beneficial, but rather that THRIP and Innovation Fund partnerships do appear to have rested on a formula where mutual benefit is obtainable and which could represent exemplars of how HE-industry partnerships could better be structured and managed to ensure that the gains are mutually equitable.

Section C

ABOUT GOVERNMENT-FUNDED PROJECTS

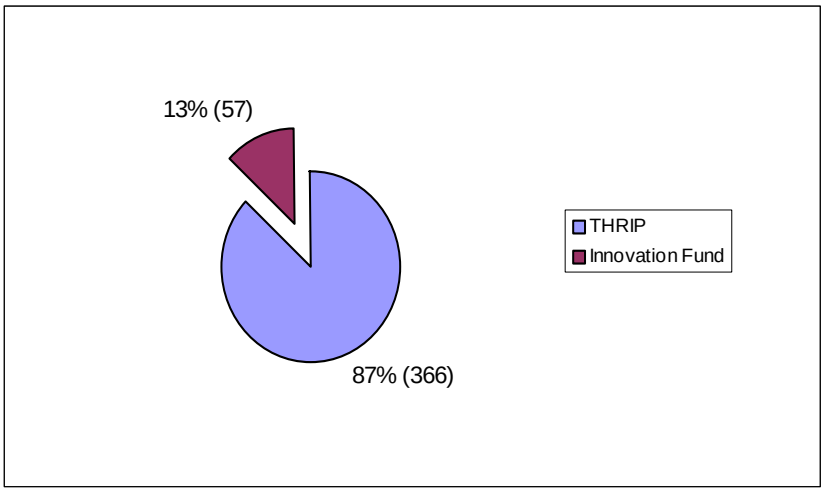
5

PARTNERSHIP PROJECTS

A total of 423 partnership projects were incentivised through THRIP and the Innovation Fund (Fig 12) in the period under review.[7] This total includes all industry and HEI/SETI partnerships.[8] In many cases, the partnership projects are complex networks that include more than one HEI/SETI and more than one industry partner.

Of the 423 projects, 13% (57 projects) are projects incentivised through the Innovation Fund and 87% (366 projects) through THRIP (Fig 12). Chapter 3 indicated that the Innovation Fund targets large interventions, with budgets at a minimum of R1 million per year. This may account for the smaller number of projects.

Figure 12: Total projects by the Innovation Fund and THRIP

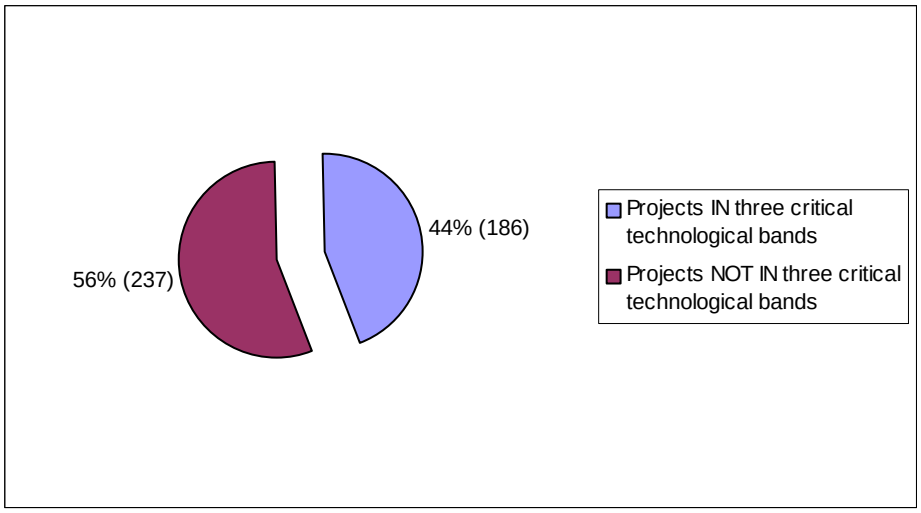


These partnerships include projects in the three priority technological fields of biotechnology, ICT and new materials development as well as projects in forestry, agriculture, minerals, power, manufacturing, animal husbandry and crime prevention. Of the 423 projects, 44% (186) are in the three technological areas identified as the focus of this study, namely biotechnology, ICT and new materials development (Fig 13).

[7] The methodology section provides an overview of the scope of the study. It indicates that THRIP projects for 2001 and 2002 were selected as the sample of this study, while all projects initiated since the inception of the Innovation Fund, were included.

[8] Details of the HEI and/or SETI partners are discussed in Chapter 8 and that of the industry partners in Chapter 7.

Figure 13: Total projects by the three critical technological bands



Of these 186 projects, 35% (66) are in biotechnology, 28% (53) in ICT and 37% (67) in new materials development (Fig 14). Figure 15 illustrates that 12% of projects funded by the Innovation Fund are not in the three critical technological bands, while Figure 16 shows that 63% of THRIP projects are not in the three bands.

Figure 14: Total projects for the Innovation Fund and THRIP by the three critical technological bands

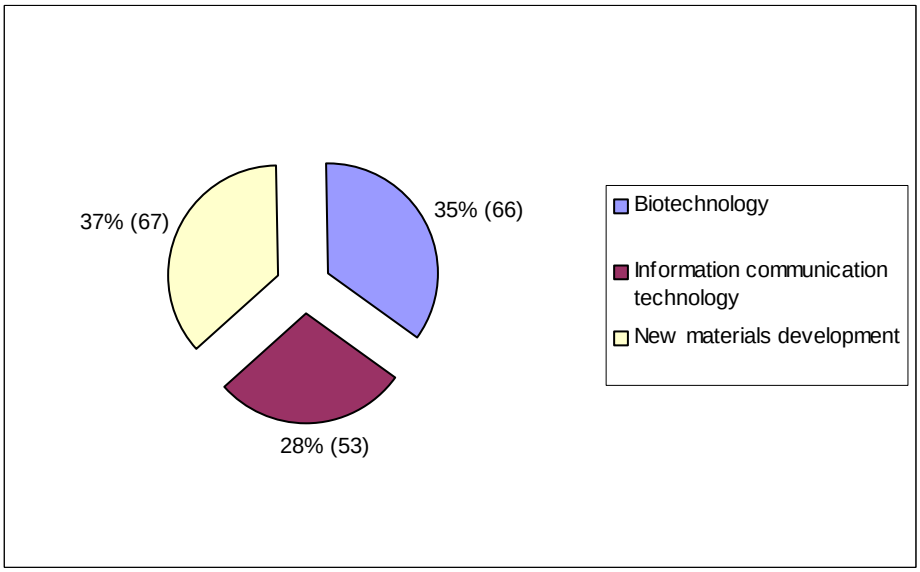


Figure 15: Total projects for the Innovation Fund compared by the three critical technological bands

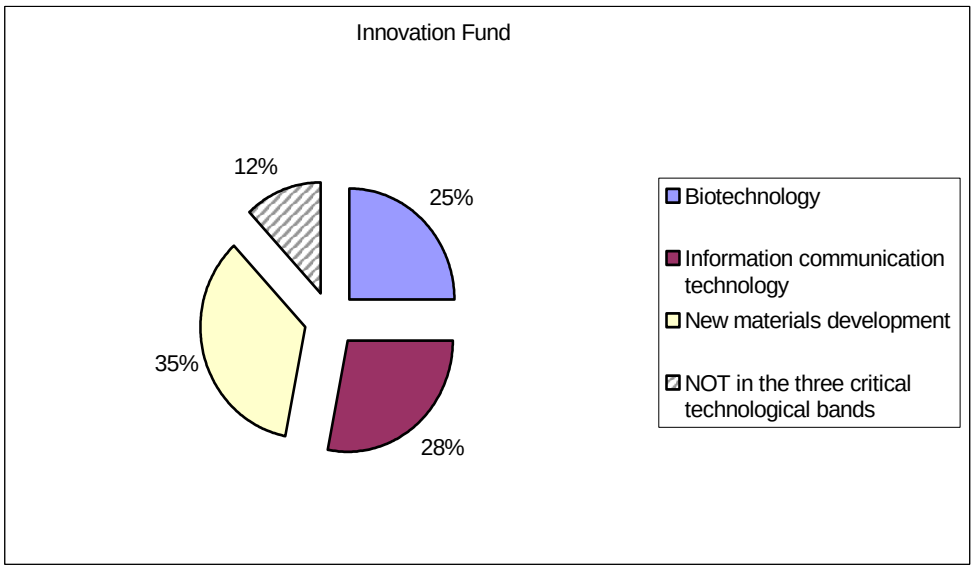
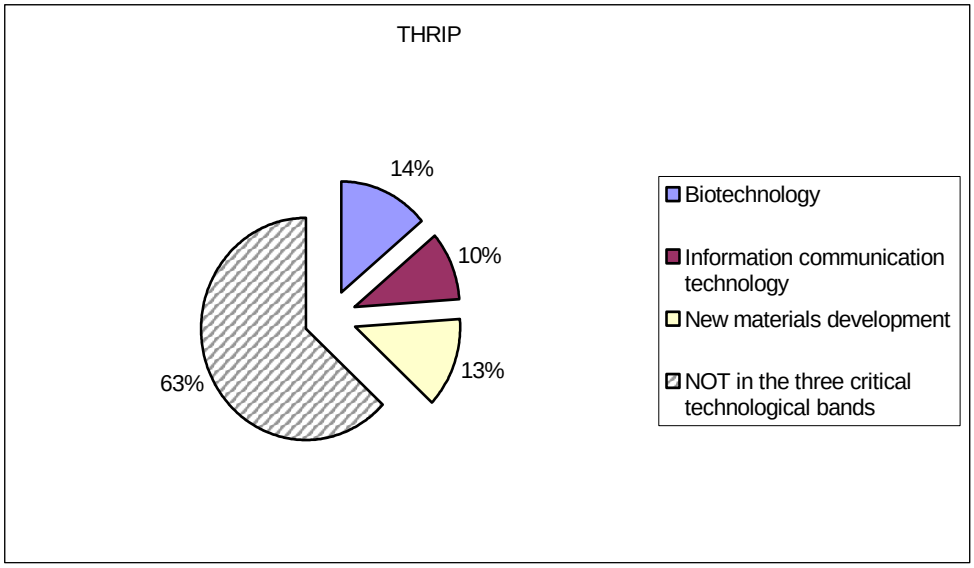


Figure 16: Total projects for THRIP compared by the three critical technological bands



It must be noted that this data does not provide an evaluative assessment of the extent to which THRIP and the Innovation Fund contribute to the three critical technological bands identified for this study. Chapters 3 and 4 indicated that while THRIP funds projects across thirteen technological focus bands, the Innovation Fund focuses predominantly on the three technological fields of ICT, new materials development and biotechnology. This is supported by a comparison between the figures which show that 25% of Innovation Fund projects are in the field of biotechnology, compared with 14% of THRIP projects; 28% of Innovation Fund projects fall into the ICT band, compared with a smaller 10% of THRIP projects and 35% of the Innovation Fund projects are related to new materials development, compared with a smaller 13% in

THRIP (Fig 15 and Fig 16). A comparison of the total numbers of projects show that THRIP funds, overall, more projects in biotechnology, ICT and new materials development than the Innovation Fund.

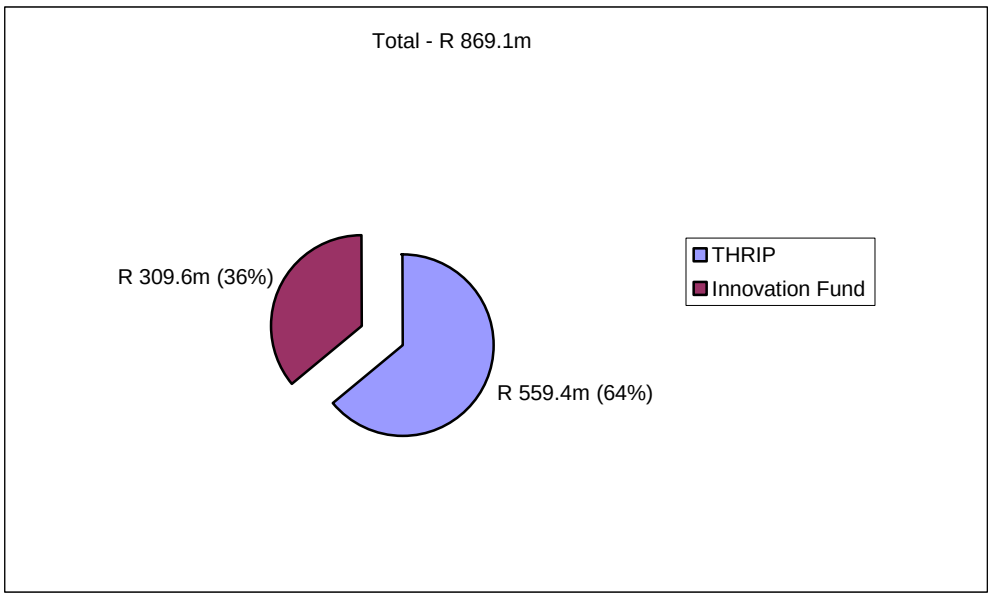
This chapter has shown that THRIP and the Innovation Fund make a marked contribution to incentivising higher education-industry linkages in the three technological bands as well as in other technological areas. The degree and extent of this contribution can only be measured against the total population of HE-industry partnerships in South Africa and is outside the scope of this study.

6

PARTNERSHIP EXPENDITURE

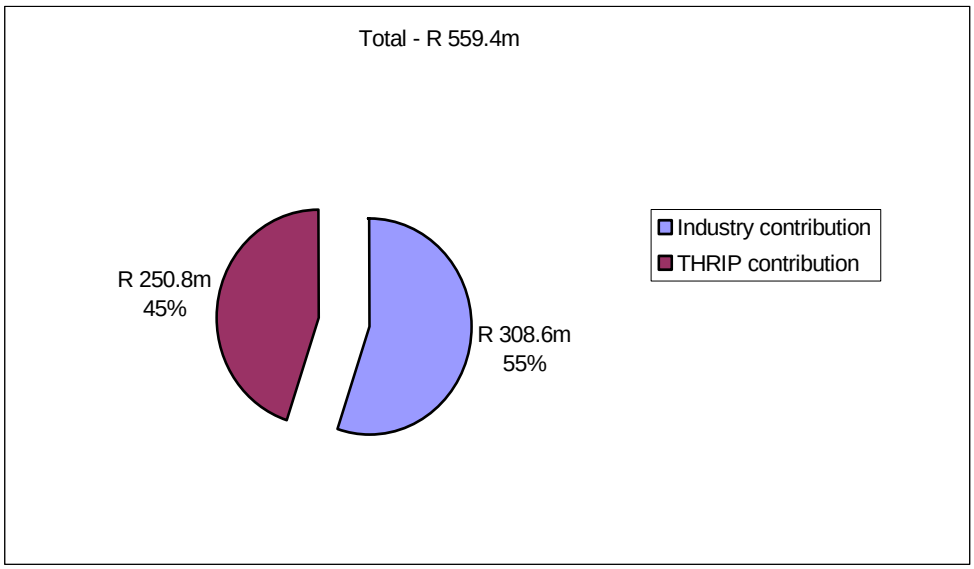
A total of R869.1 million was spent by THRIP and the Innovation Fund on HEI/SETI-industry linkages in the period under review. THRIP expenditure amounts to R559.4 million (64%) and Innovation Fund expenditure to R309.6 million (36%) (Fig 17). THRIP expenditure is divided between state expenditure and industry contributions. Industry contributions account for 55% (R308.6 million) of total THRIP expenditure (Fig 18).

Figure 17: Total expenditure by THRIP and the Innovation Fund[9]



[9] Expenditure for THRIP refers to projects funded in 2000/01. The budget allocations for five projects for the Innovation Fund (Project ID: 11101, 11103, 11115, 12101, 12113) was not reflected on the Internet site used as the primary source for this information. As such the Innovation Fund budget excludes these project budgets. (See methodology for further information on the Innovation Fund projects and the methods used to extract information.)

Figure 18: Total THRIP expenditure by industry and THRIP contribution



6.1 EXPENDITURE BY THE THREE CRITICAL TECHNOLOGICAL BANDS

Expenditure across the three technological bands comprises 54% (R466.8 million) of total THRIP and Innovation Fund expenditure. The remaining 46% (R402.3 million) is designated to projects that do not fall within the three bands (Fig 19). Since 54% of all THRIP and Innovation Fund projects are in the three bands, this implies that projects in these areas collectively account for a higher ratio of expenditure than projects not in these bands.

In the Innovation Fund, the vast majority of funding (98%) is allocated to projects within the three bands. New materials development receives a slightly higher proportion of the overall allocations (Fig 20). THRIP, in comparison, allocates 30% of its budget to projects within the three bands, with 12% of expenditure on projects in biotechnology, 10% in ICT and 8% in new materials development (Fig 21).

The average cost of projects falling within the three bands is evident in Figure 24, where all projects in the three bands fall above the average project costs, as compared to projects not in these bands. Figure 25 illustrates that the costs of Innovation Fund projects in the three bands are all slightly higher than the average, with biotechnology projects costing R1.2 million more than the average, ICT costing just R300 000 above the average and new materials development R600 000 above the average. Projects not in the three bands have considerably lower costs than the overall average. Figure 26 reviews the average costs per project area for THRIP. In this case, both biotechnology and new materials development costs are below the average, and ICT costs on the average. Projects that are not in the three bands, however, are fixed at slightly above the average, in contrast with the Innovation Fund.

Figure 19: Expenditure for the three technological bands

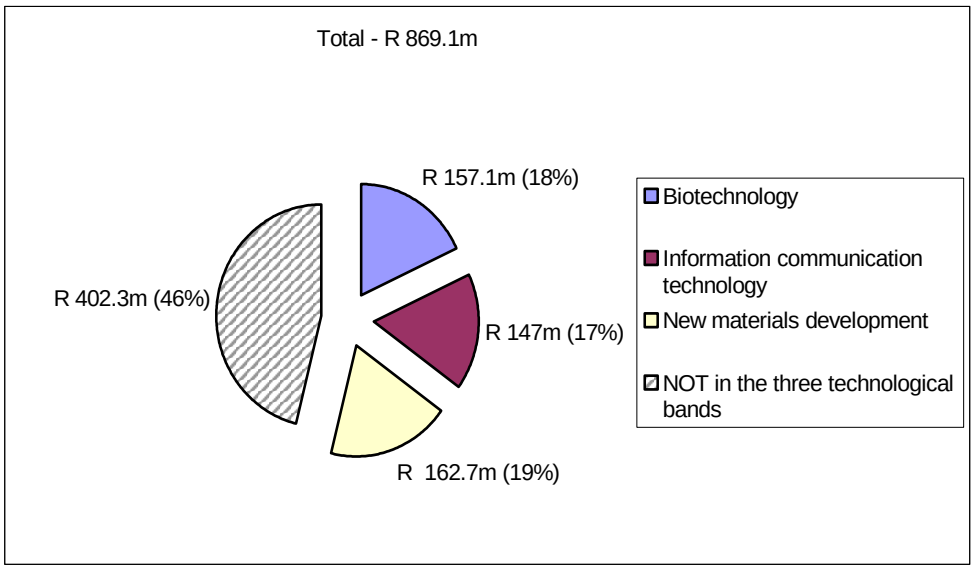


Figure 20: Expenditure for the three technological bands for Innovation Fund projects

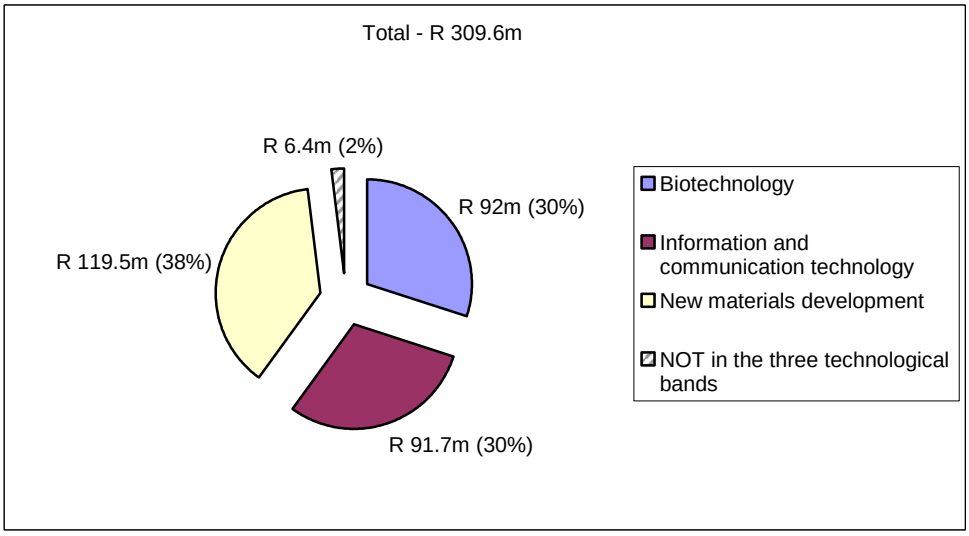
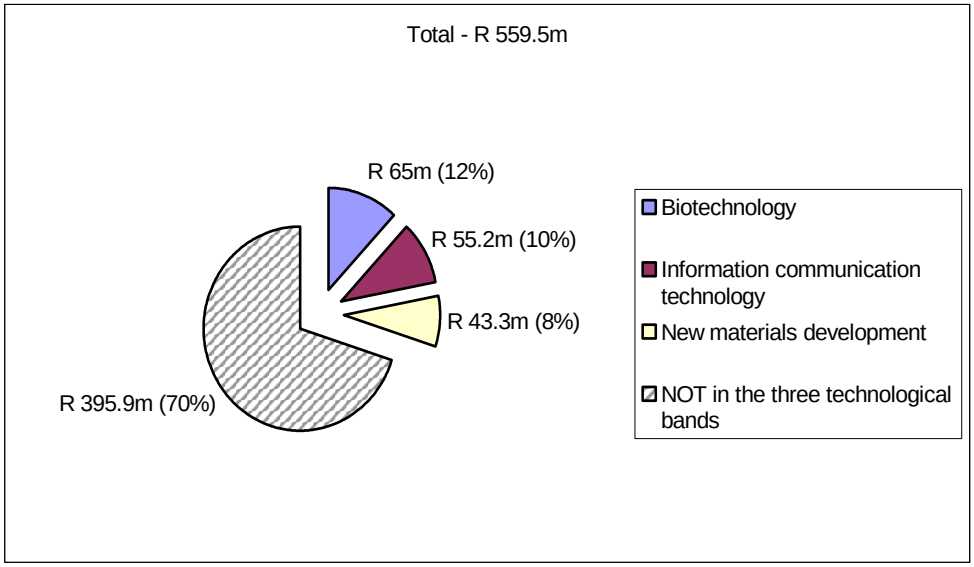


Figure 21: Expenditure for the three technological bands for THRIP-funded projects



6.2 AVERAGE EXPENDITURE BY PROJECT

The average expenditure per project for THRIP projects is R1.5 million, while the average expenditure for Innovation Fund projects is R5.4 million per year (Fig 22). As noted previously, the Innovation Fund targets larger projects with a minimum value of R1 million per year. In terms of lowest and highest expenditure per project, the lowest funded project by the Innovation Fund totals R1.6 million, whereas the lowest funded THRIP project is significantly lower, at R200 000 (Fig 23). Interestingly, THRIP's highest funded project totals R20.7 million, as compared to R14.5 million funded by the Innovation Fund.

Figure 27 provides the highest and lowest expenditure per project for THRIP and Innovation Fund projects by technological band. The figure illustrates that the most costly project falls within the ICT band (R14.5 million), followed by a biotechnology project (R13.9 million) and a new materials development project (R12 million). The variations between the bands by highest and lowest project expenditure do not vary significantly overall.

Figure 28 provides the highest and lowest expenditure per project for the Innovation Fund, where an ICT project cost is the highest, followed by a materials development project and a biotechnology project. The lowest expenditure per project are all above R1 million, in line with the Innovation Fund's policy to target larger projects for funding. Figure 29 provides the same information for THRIP projects. The highest ICT project expenditure is significantly lower than that of the Innovation Fund and is also lower than THRIP's highest project expenditure in the other technological bands. Also in contrast to the Innovation Fund, THRIP's highest project expenditure falls outside of the three bands and is R20.7 million, which is considerably higher than any of the HSRC band projects.

Figure 22: Average cost per project for the Innovation Fund and THRIP

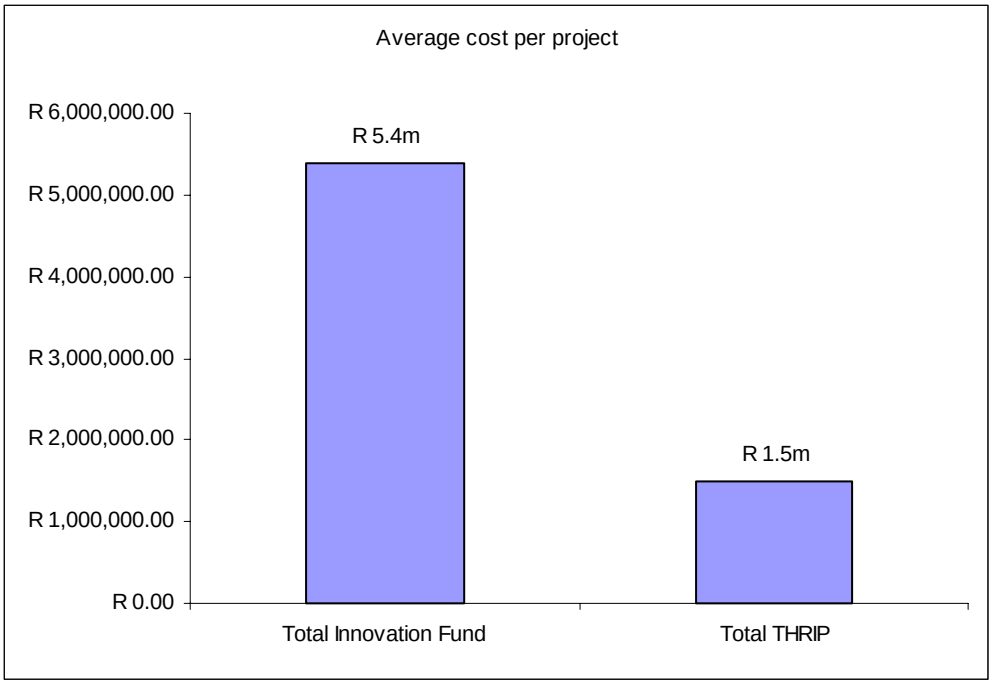


Figure 23: Funding by project by lowest and highest funded project

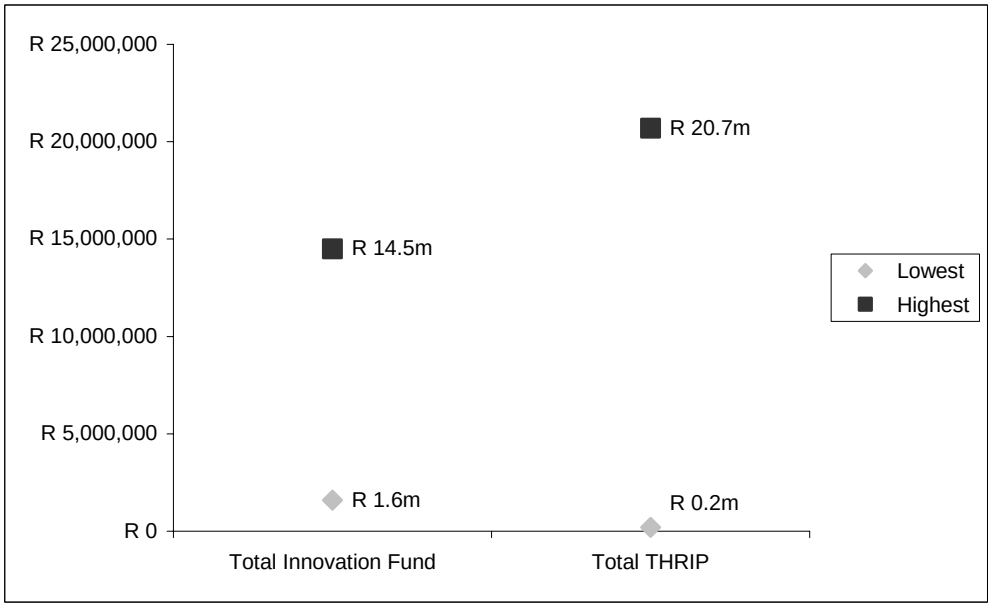


Figure 24: Average cost per project for the three technological bands

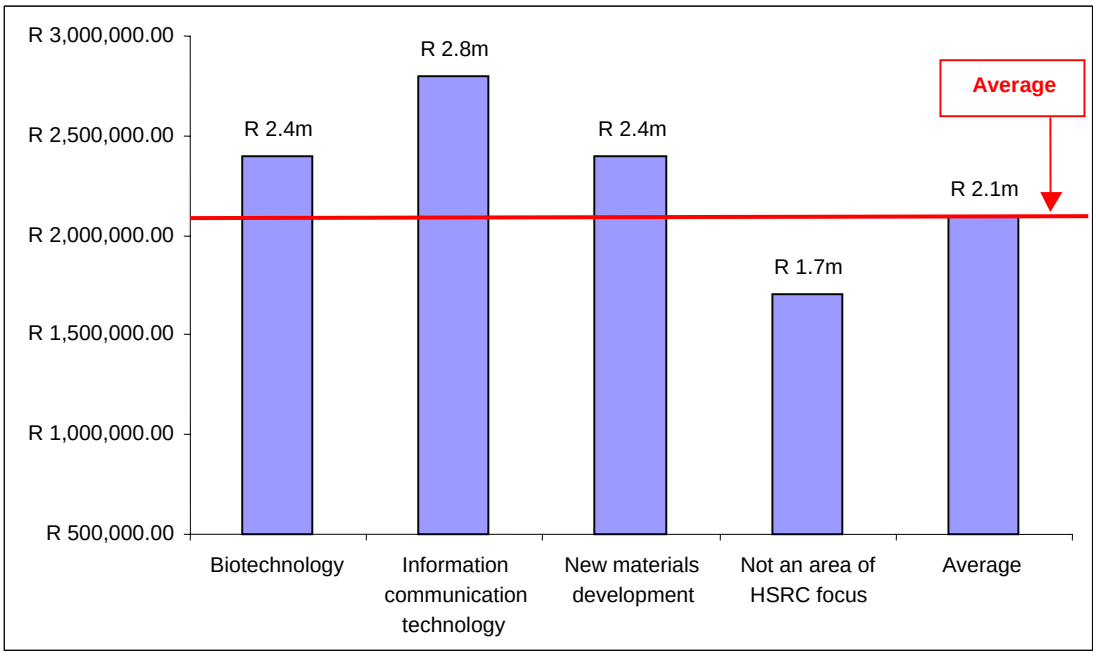


Figure 25: Average cost per project for the three technological bands for Innovation Fund-funded projects

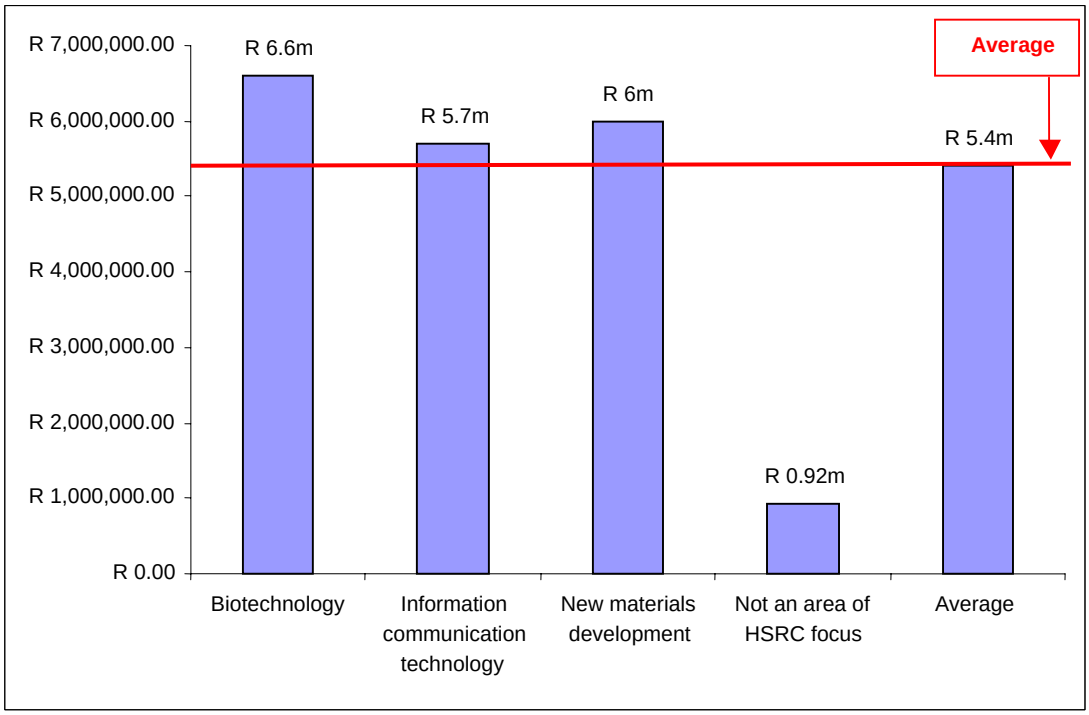


Figure 26: Average cost per project for the three technological bands for THRIP-funded projects

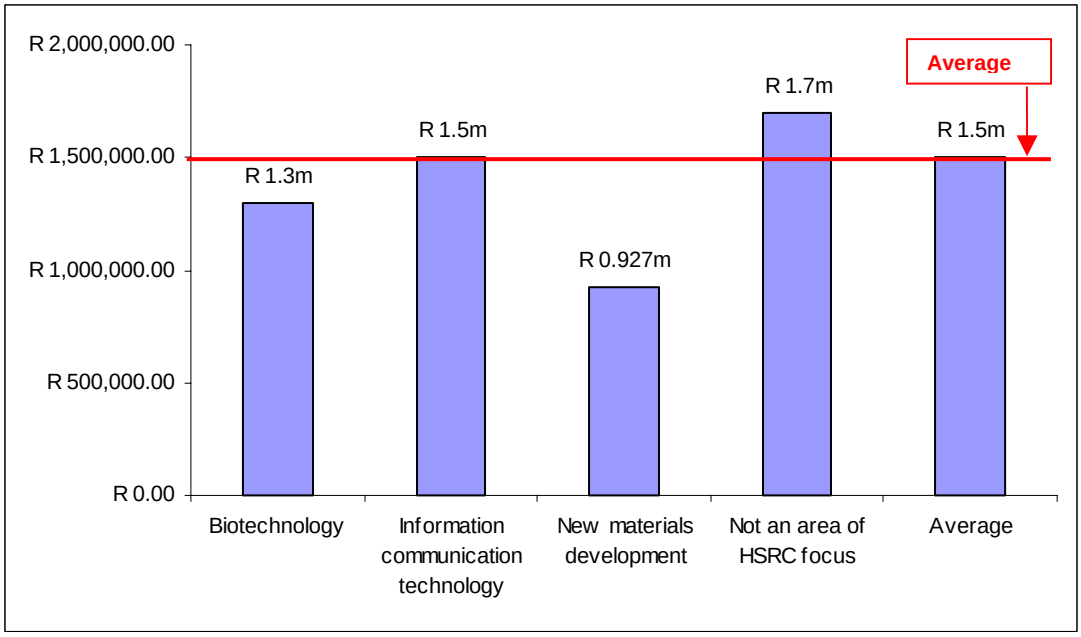


Figure 27: Highest and lowest cost by project for THRIP and the Innovation Fund together

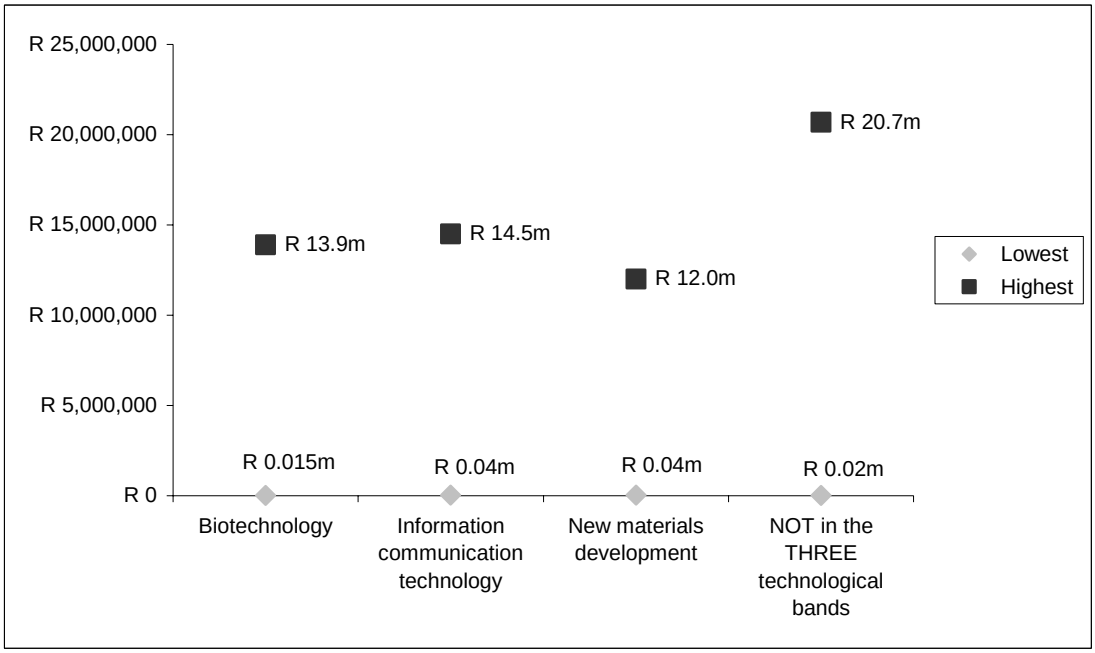


Figure 28: Highest and lowest cost by project for the Innovation Fund

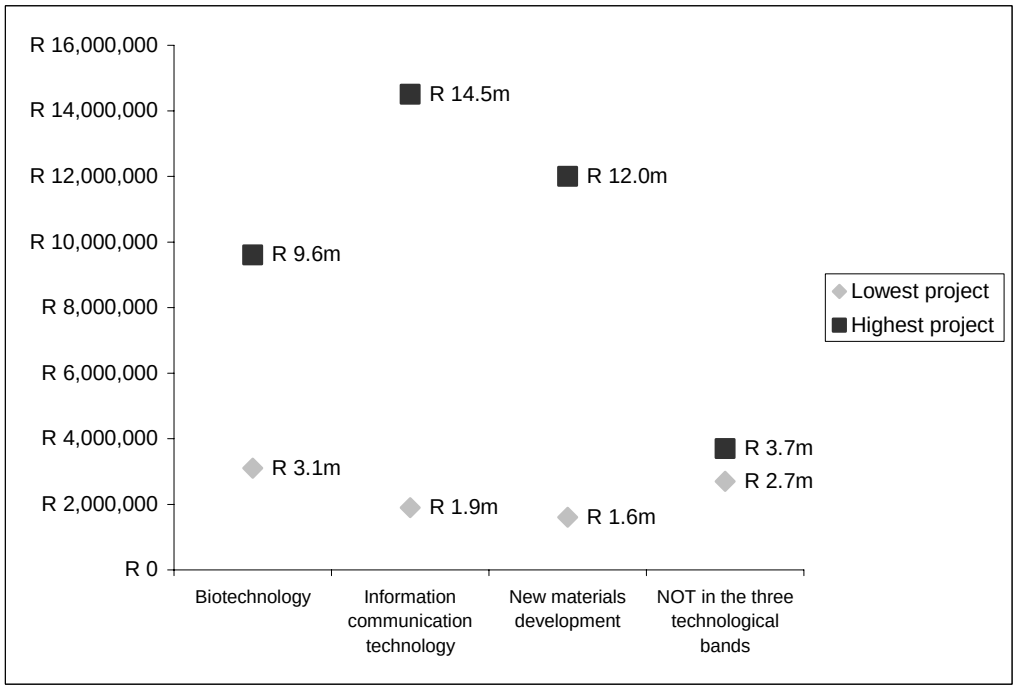
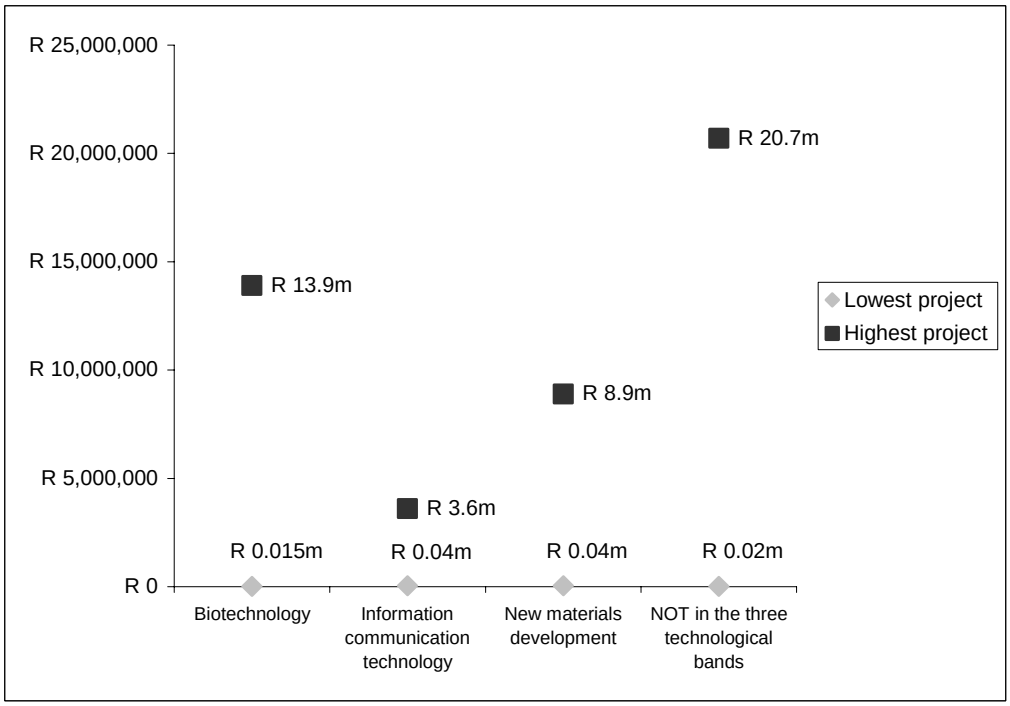


Figure 29: Highest and lowest cost by project for THRIP



6.3 AVERAGE EXPENDITURE BY HEI/SETI[10]

The expenditure by institutional type was calculated by allocating the full grant to what THRIP terms the grant holder (or the grant-holding institution) and to what the Innovation Fund terms the project co-ordinator (project co-ordinating institution). In this sense, the expenditure does not necessarily reflect the real income to these institutions as many of these institutions work collaboratively and in partnership with other institutions. In the absence of a detailed audit of each project in which the actual income to each institution can be calculated, the figures presented in this section were analysed to indicate the income to grant-holding institutions for THRIP and co-ordinating institutions for the Innovation Fund.

Figure 30 illustrates that total expenditure by institutional type is biased towards universities (59%), followed by SETIs (37%) and by technikons to a significantly lesser degree (4%). Figure 31 illustrates that THRIP funding is heavily biased towards universities (75%), with a smaller proportion being allocated to SETIs (19%) and technikons (6%). As shown in Figure 32, Innovation Fund expenditure, by contrast, is largely directed to SETIs (72%), followed by universities (28%). None of the funding to date for the Innovation Fund has been linked to technikons.

Figure 30: Expenditure by institutional type

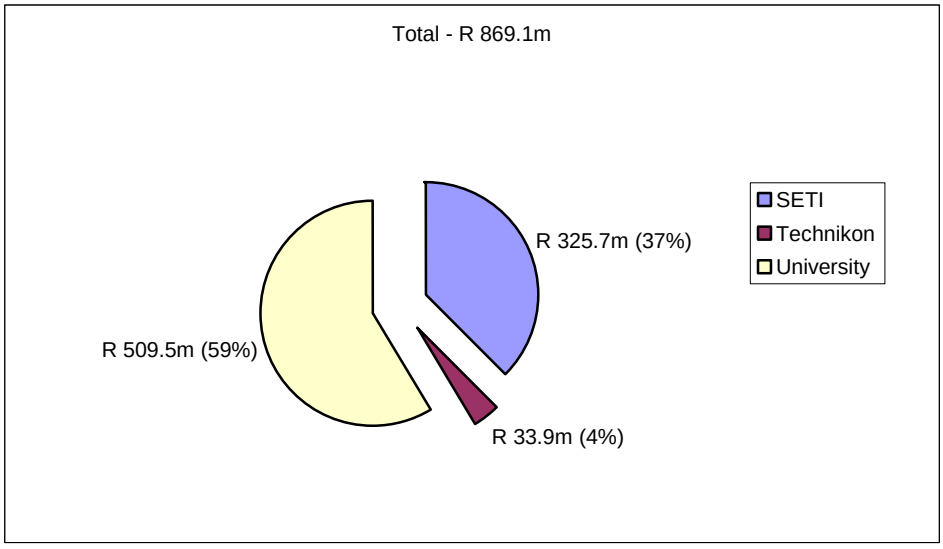


Figure 33 illustrates the expenditure for each HE institution involved in a partnership funded by THRIP or the Innovation Fund. Figure 33a reviews the distribution of funding across the 23 institutions indicated in Figure 33. As illustrated, there are only a small number of institutions (4) that are awarded up to 75% of the total funding. Figure 33 shows that the Universities of Stellenbosch, Cape Town, Pretoria and Potchefstroom

[10] Please note that the category SETI is used to refer predominantly to SETIs, but in the case of Innovation Fund projects also includes research units and other research organisations.

are awarded this 75%. The remaining funding is distributed across the remaining 19 institutions. Technikons (both historically advantaged and historically disadvantaged combined) are responsible for only 6% of the total expenditure. Historically black universities (HBUs) are responsible for a total of only 4% of the expenditure.

Figure 31: Expenditure by institutional type for THRIP-funded projects

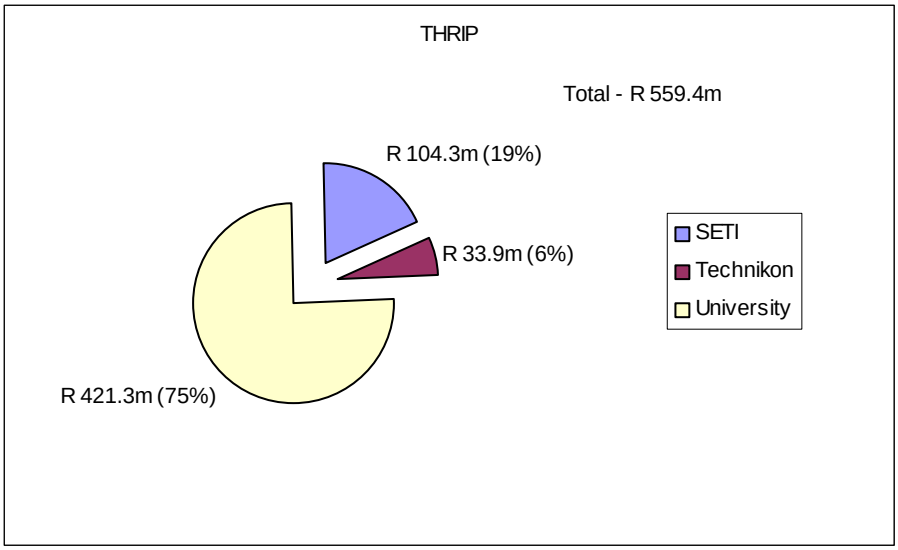


Figure 32: Expenditure by institutional type for Innovation Fund projects

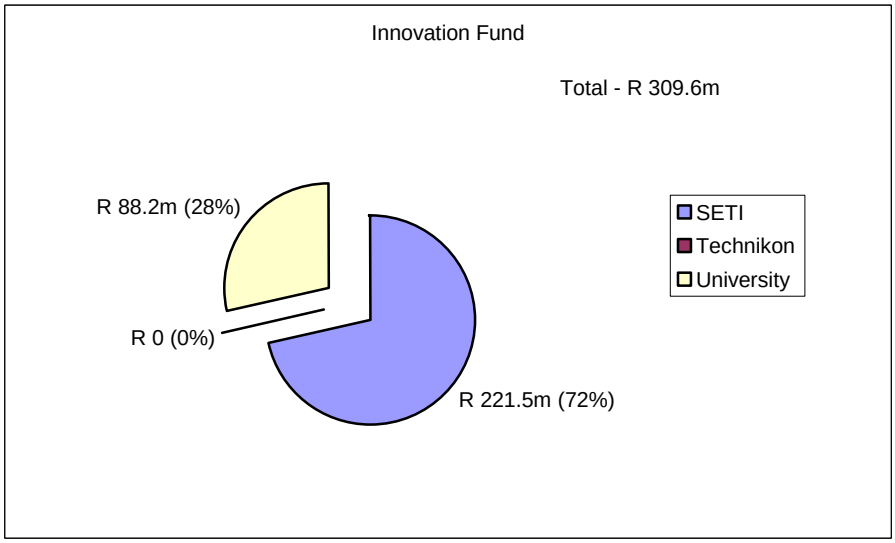


Figure 33: Expenditure by HEI – for THRIP and Innovation Fund projects together

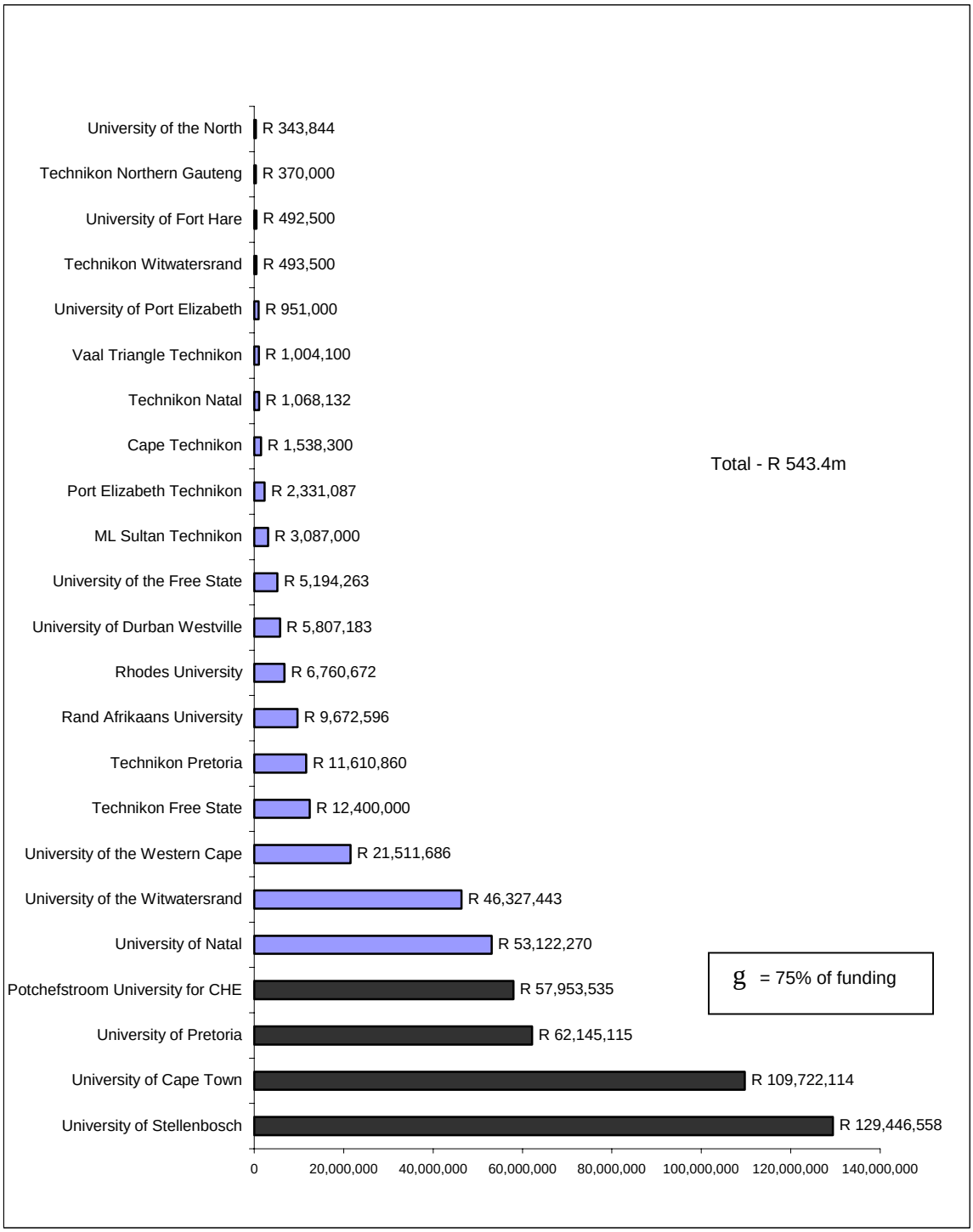


Figure 33a: Distribution of funding across institutions for THRIP and the Innovation Fund

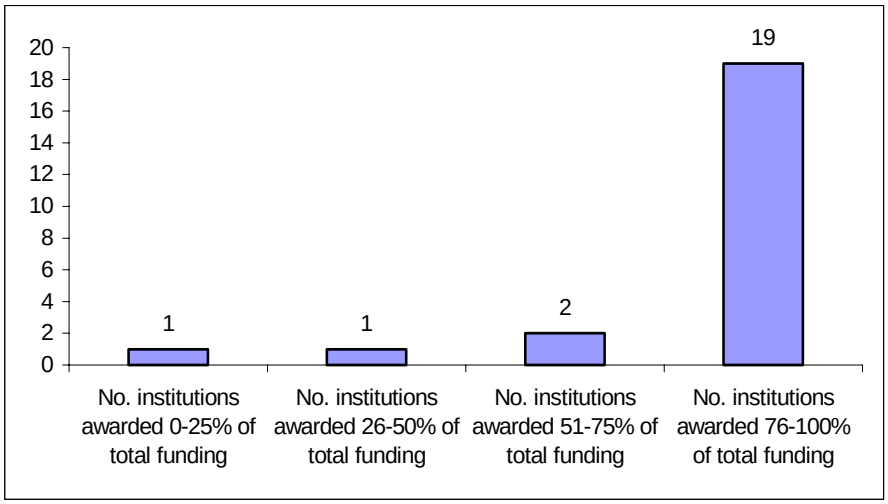


Figure 34 provides expenditure per institution for THRIP. As illustrated, five historically white universities account for a total of 75% of THRIP expenditure. In a THRIP *Evaluation Report* (DTI, 1997), THRIP acknowledges that the vast majority of its funding is located within a small number of historically white universities (HWUs) and comments that 'differing participation rates no doubt reflect a range of factors, such as the mix of disciplines within HE institutions, research traditions and attitudes towards working with industry'. At the time of the evaluation report in 1997 there were no THRIP allocations to historically black universities (HBUs), a factor which has changed over the period since 1997. A calculation based on Figure 34 on page 54 reveals that for projects funded in 2001/2002, 6% of total THRIP expenditure was allocated to historically black universities.

Figure 34a: Distribution of funding across institutions for THRIP

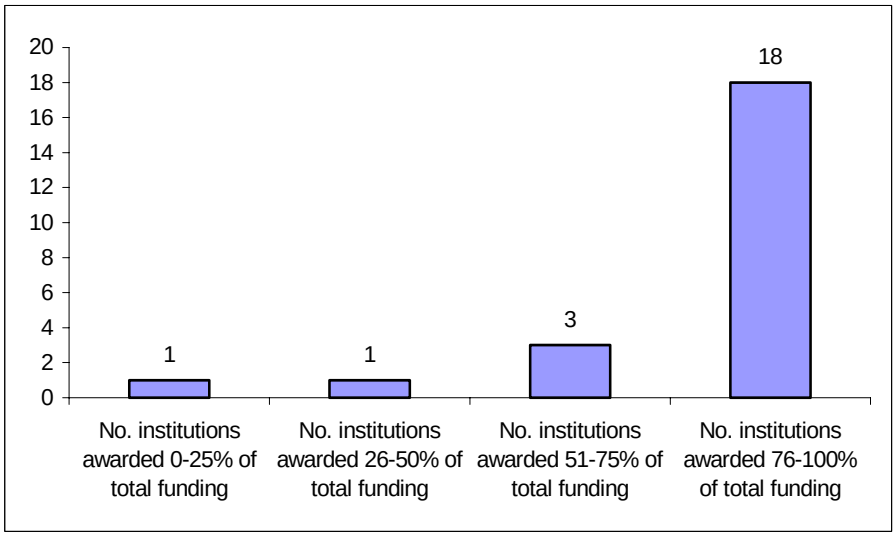


Figure 34: Expenditure by HEI – for THRIP projects

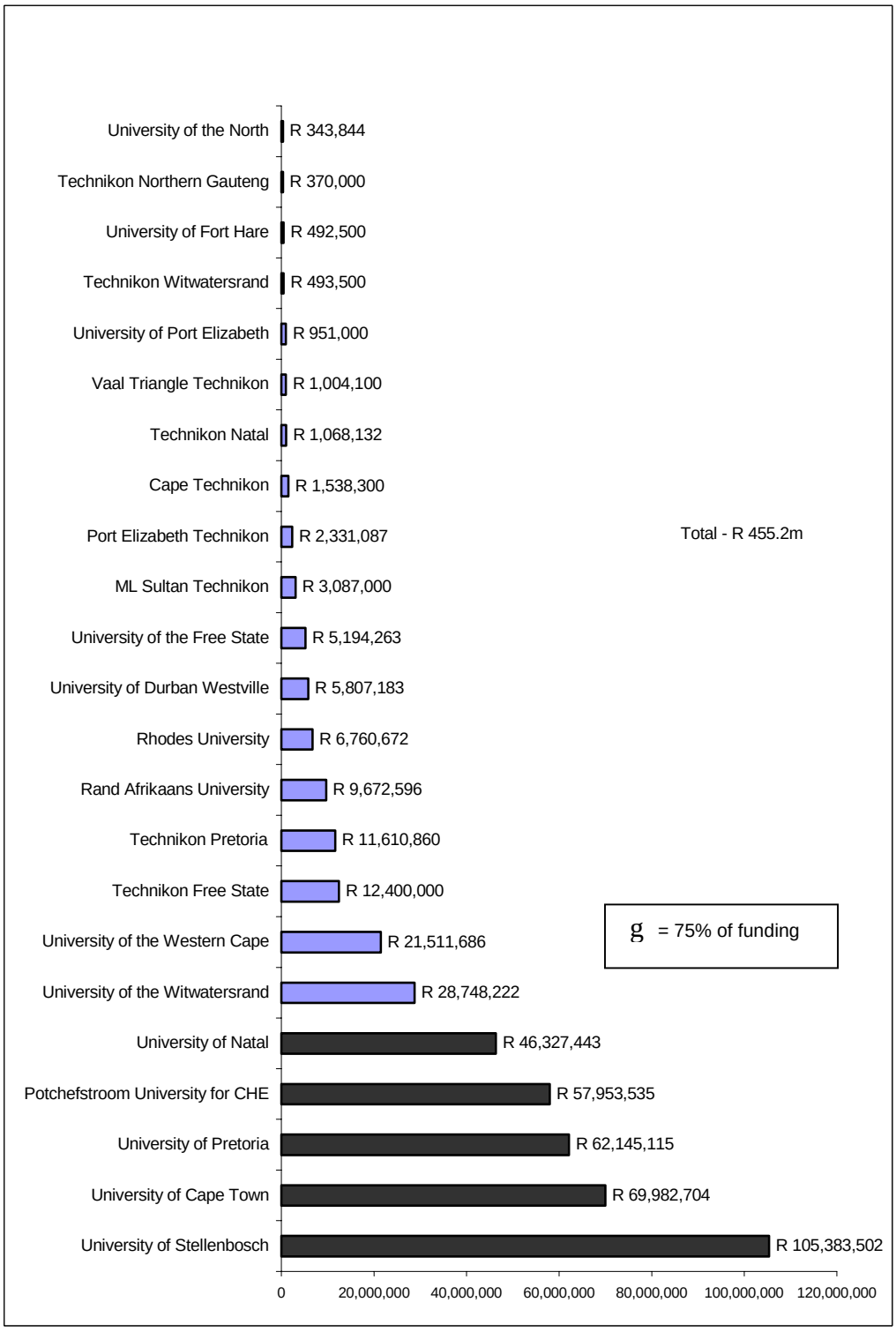
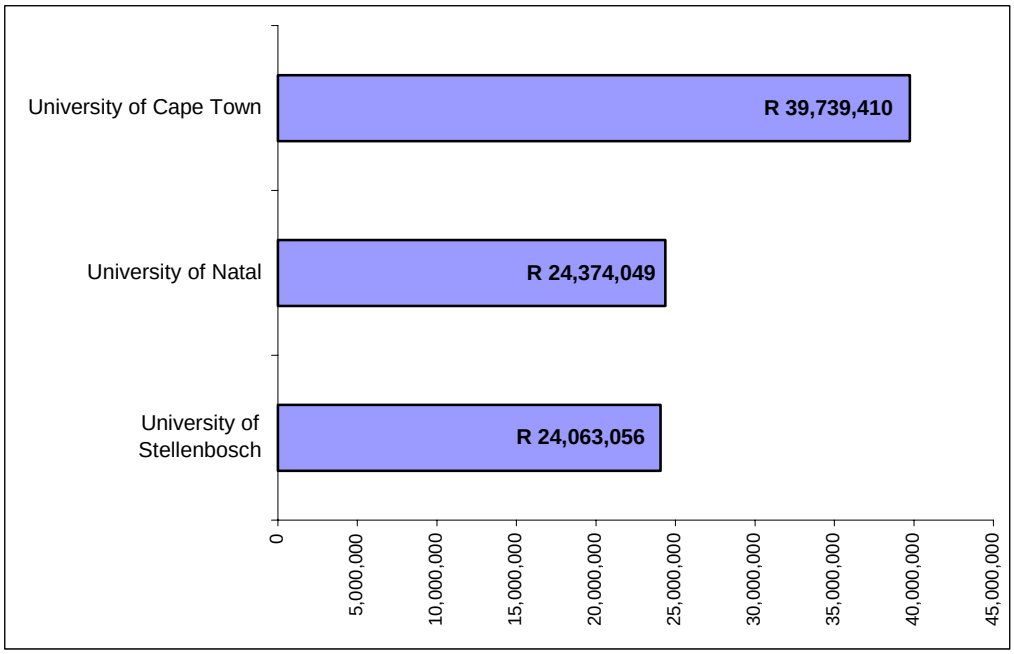


Figure 35 illustrates the Innovation Fund expenditure by institution. As the figure illustrates, all Innovation Fund expenditure is located in three HWUs at present, i.e., the University of Cape Town (45%), University of Natal (27.5%) and University of Stellenbosch (27.5%).

Figure 35: Expenditure by HEI – for Innovation Fund projects



6.4 AVERAGE EXPENDITURE BY HEI/SETI AND TECHNOLOGICAL BAND

Figure 36 reviews expenditure by institutional type in the three technological bands. The figure illustrates that more than 55% of biotechnology and ICT expenditure is located in universities and most of the remaining expenditure in SETIs. Technikons do not receive much funding in either of these areas. While this is to be expected for a field such as biotechnology, which is not traditionally located at technikons, it is interesting that there is very little ICT expenditure at technikons. The majority of new materials expenditure is located in SETIs (68%), with 30% located in universities. Once again, technikons receive a very small proportion of this funding (about 2%). It is interesting to note that in the case of projects or partnerships not in any of the three bands, universities are the predominant recipients (73%), followed by SETIs (20%) and a much higher proportion of technikons (7%).

Figure 36: Expenditure by institutional type by three technological bands

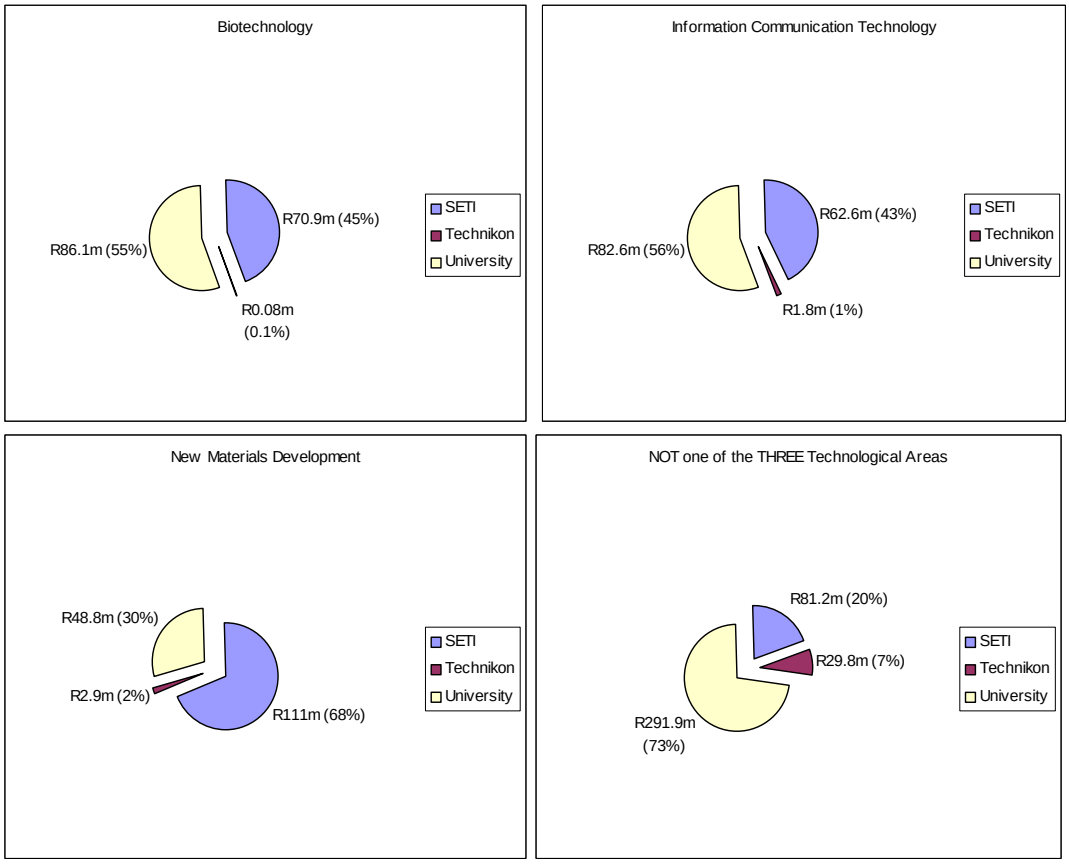


Figure 37 illustrates total expenditure for THRIP and the Innovation Fund on projects in biotechnology. Here it is interesting to note that the University of Natal, which does not form one of the top three institutions in terms of expenditure for the total figures, is the third highest recipient of funding. The University of the Western Cape, which is an historically disadvantaged institution (HDI), is responsible for approximately 9% of the expenditure in biotechnology. Figure 37a illustrates the distribution of funding by the field of biotechnology and illustrates that a total of seven institutions account for 76-100% of expenditure. No single project accounts for more than 25% of the total expenditure.

Figure 38 illustrates the expenditure for projects funded in the field of ICT. Here the Universities of Cape Town and Stellenbosch are the predominant recipients, and, along with the Universities of Potchefstroom and Natal, account for 75% of total Innovation Fund and THRIP expenditure. The three technikons, Pretoria, Witwatersrand and ML Sultan, account for 17% of the total expenditure in ICT (compared to 0.1% to technikons in the field of biotechnology). In addition, up to 5% of the total expenditure is attributed to the three HDIs, the University of the Western Cape, the University of Durban-Westville and Fort Hare University.

Figure 37: Expenditure by HEI – for projects funded in the area of biotechnology

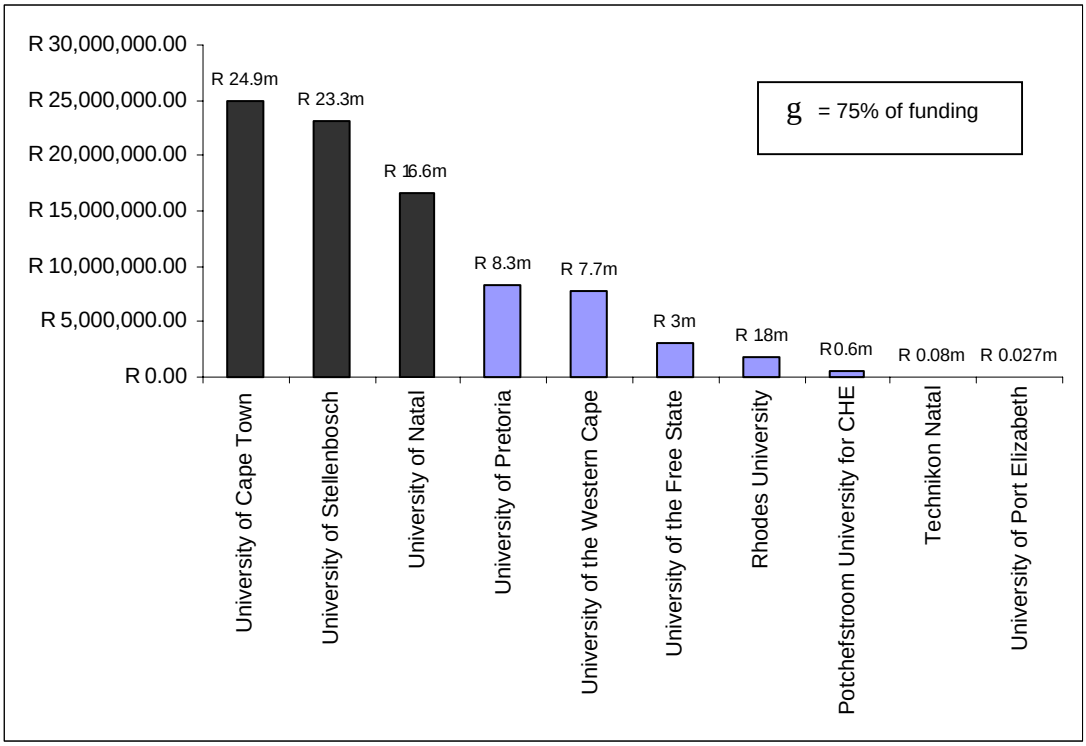


Figure 37a: Distribution of funds by technological areas across institutions

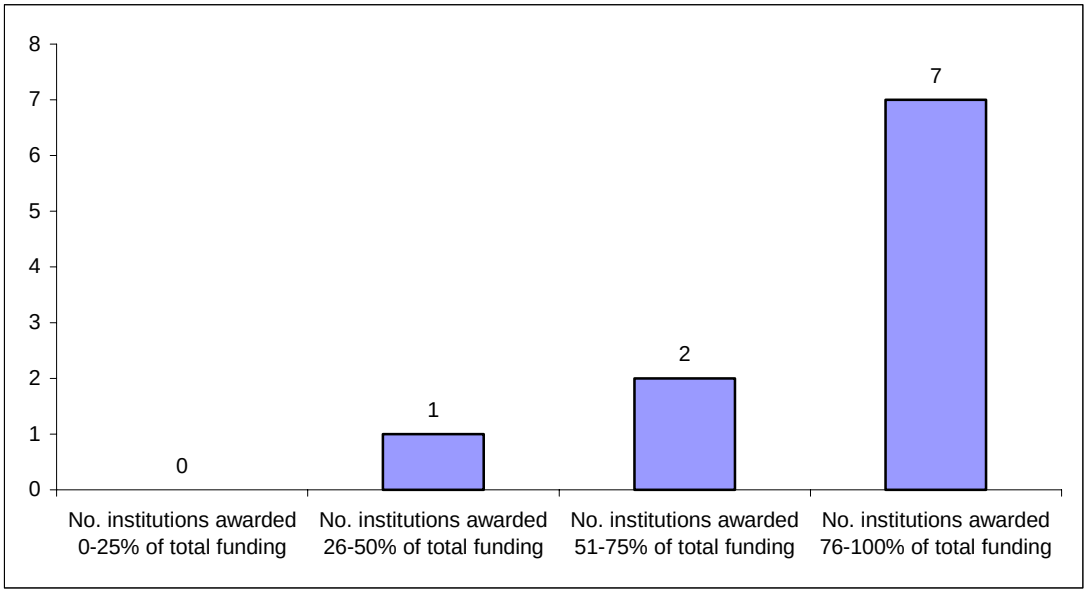


Figure 38a illustrates that seven institutions account for 76-100% of the expenditure in ICT and as in the case with biotechnology, no single ICT project or partnerships accounts for 25% or more of the total funding.

Figure 38: Expenditure by HEI – for projects funded in the area of ICT

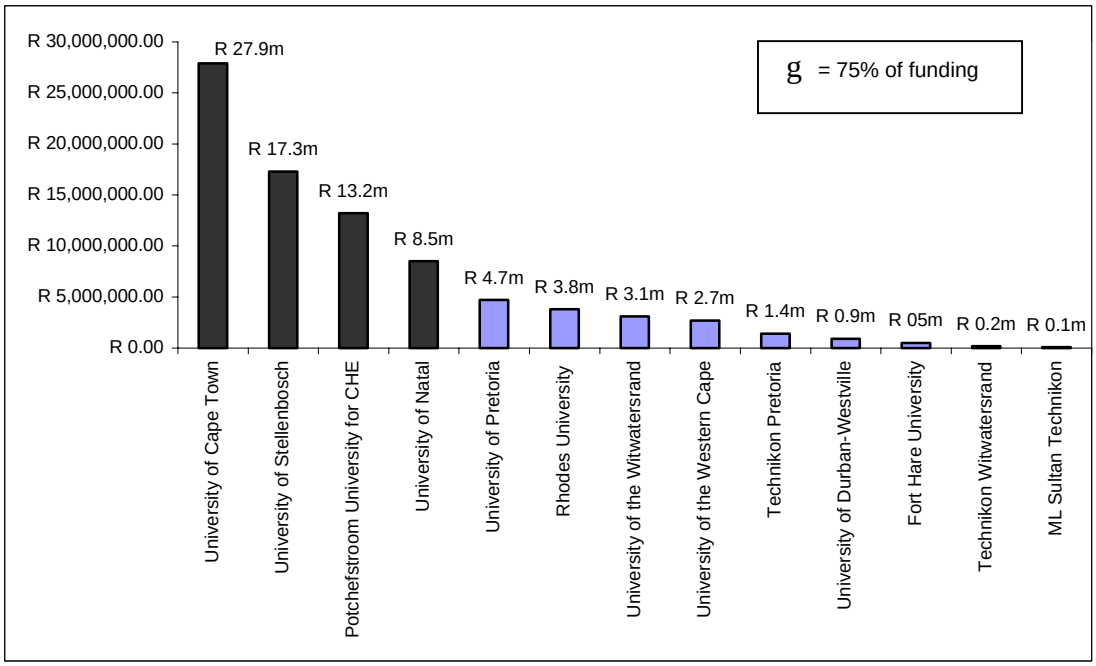


Figure 38a: Distribution of funds by technological areas across institutions

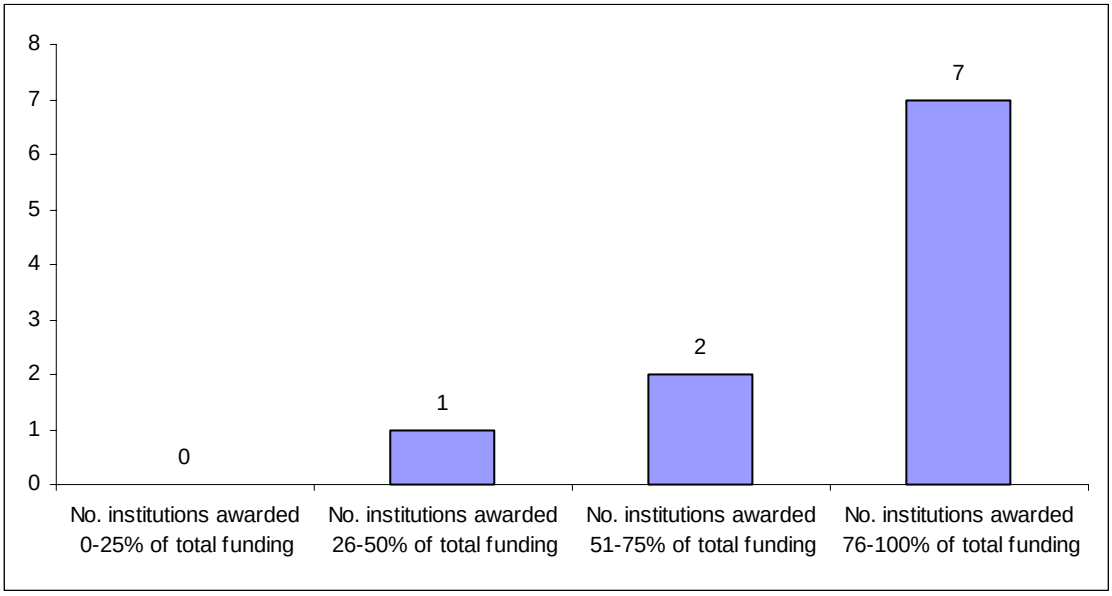


Figure 39 reviews expenditure by HE institutions in the field of new materials development. Here the University of the Witwatersrand is the major recipient, followed by the University of Stellenbosch. The University of the Witwatersrand is not accountable for any expenditure in the field of biotechnology and only a small proportion in the field of ICT. Technikons are responsible for 4% of total expenditure in new materials development and HDIs for less than 1% in the field. Figure 39a illustrates that 13 of the total 15 institutions are responsible for 76-100% of the total expenditure in new materials development and, once again, no institution is responsible for 25% or more of the total expenditure.

Figure 39: Expenditure by HEI – for projects funded in the area of new materials development

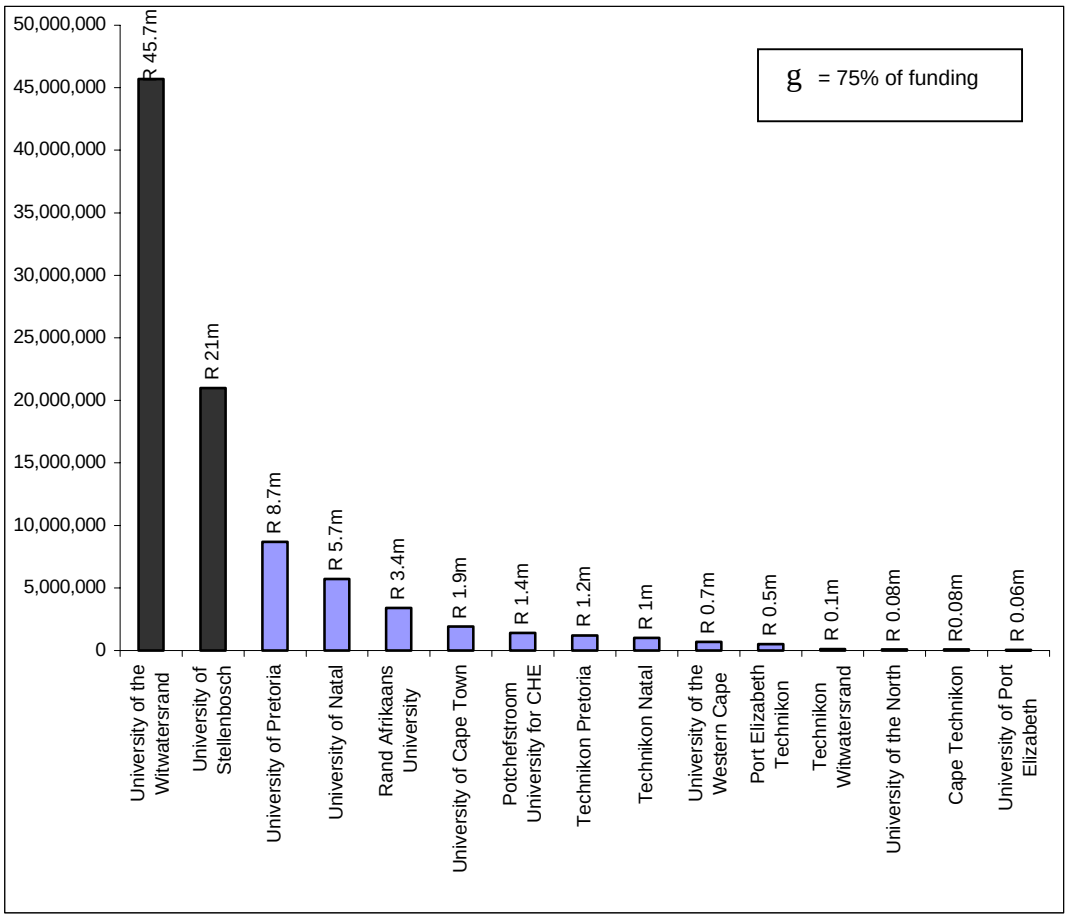
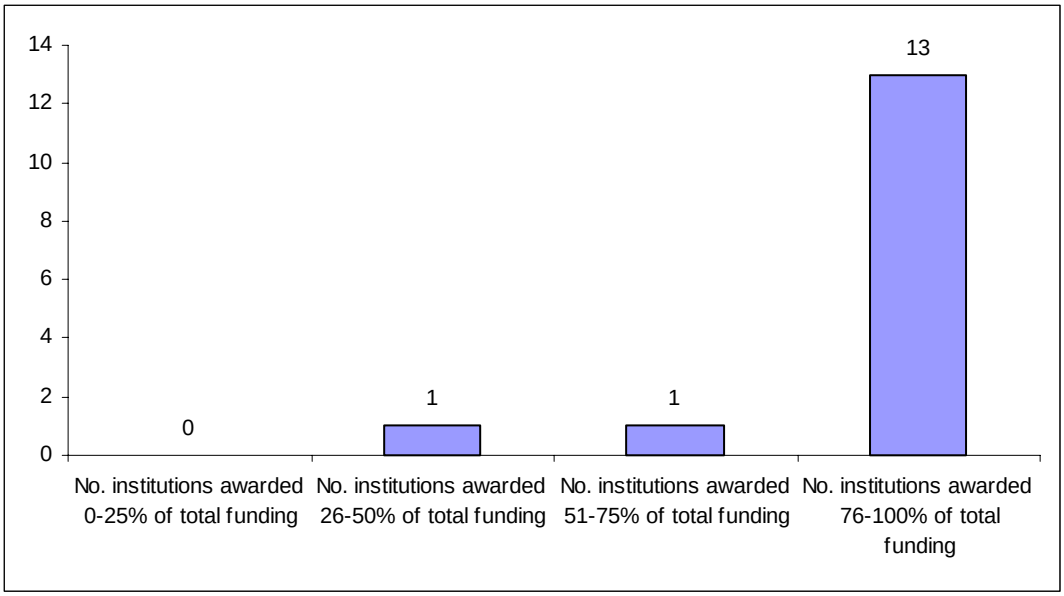


Figure 39a: Distribution of funds by technological areas across institutions



6.5 CONCLUSION

This chapter has shown that THRIP and the Innovation Fund make a marked financial contribution to incentivising higher education-industry linkages in the three technological bands, as well as in other technological areas. The degree and extent of this contribution should be measured against the total expenditure on HE institution-industry partnerships in South Africa.

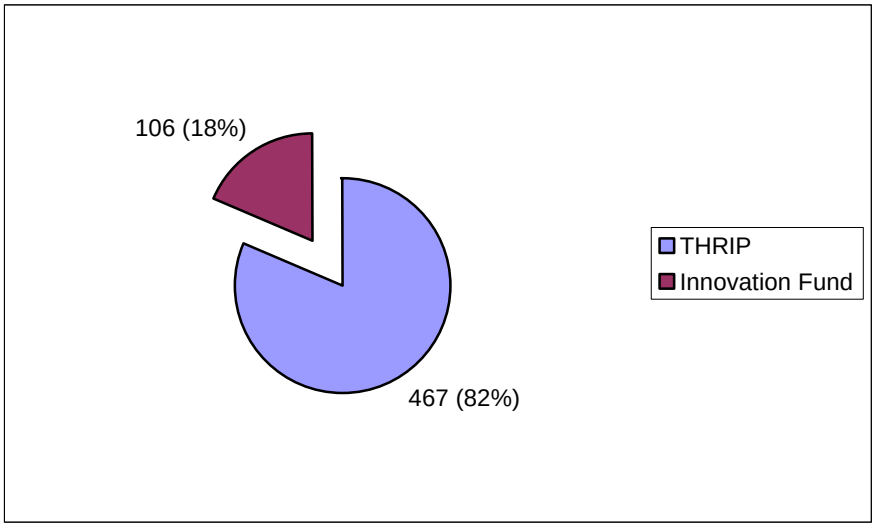
Furthermore, the chapter indicates that the financial contribution to research and development in the three critical technological bands is considerable. The degree and extent of this contribution should ideally be measured against the total research and development (R&D) expenditure in these three bands. While such analysis is not part of the scope of the study, it could serve as an important area of further investigation. The total industry contribution of R308.6 million to THRIP partnerships illustrates the large investment being made by industry into these projects. It also provides an indicator of the contribution of industry to R&D in the three technological bands.

7

THE INDUSTRY PARTNERS

The 423 THRIP and Innovation Fund projects involve 573 industry partners. Of this total, 82% (467) are linked to THRIP projects and 18% (106) to Innovation Fund projects (Fig 40). It must be noted that THRIP requires industry partner participation on each project as part of its project criteria, possibly accounting for the high number of industry partners for THRIP projects.

Figure 40: Total industry partners[11]



7.1 INDUSTRY PARTNERS IN THE THREE TECHNOLOGICAL BANDS

For THRIP and the Innovation Fund combined, 49% of the partners are located in the three bands and 51% in areas not the subject of investigation in this study. Approximately 18% of the industry partners participate in the biotechnology band; 18% in new materials development band and 13% in ICT (Fig 41).

[11] Note that THRIP defines 'industry partner' as a company that is registered. Holding companies and subsidiary companies were counted (applying this principle) as individual companies in their own right. For example, Mondi Forests and Mondi Ltd were considered as two separate companies. Three companies were involved in both THRIP and Innovation Fund projects. For the purposes of this analysis the three companies were double counted. It is important to note that in some instances there are more than one partner per partnership/project.

Of the total number of partners (including those not in the three bands) involved in THRIP projects, 18% are located in the field of new materials development, 14% in biotechnology and 10% in ICT (Fig 42). For the Innovation Fund, 41% of the industry partners are involved in biotechnology projects, 28% in ICT projects and 19% in the field of new materials development (Fig 43).

Figure 41: Total industry partners by industry technological bands[12]

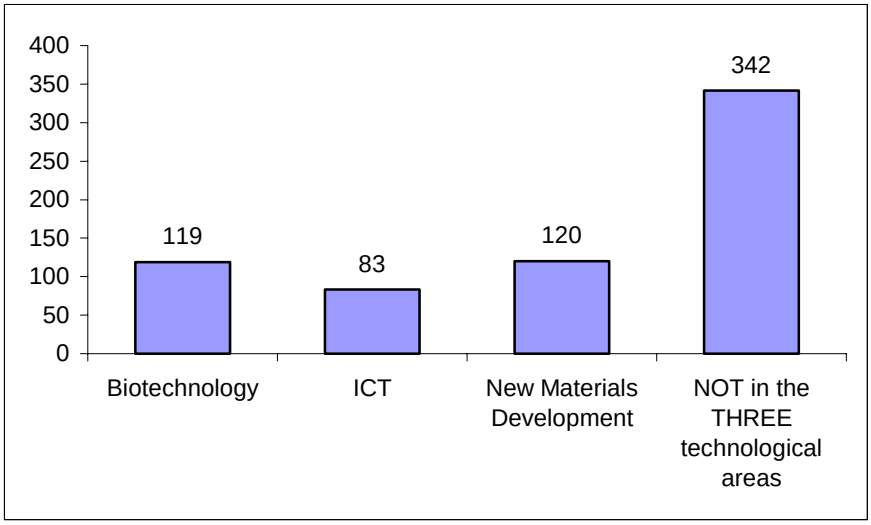
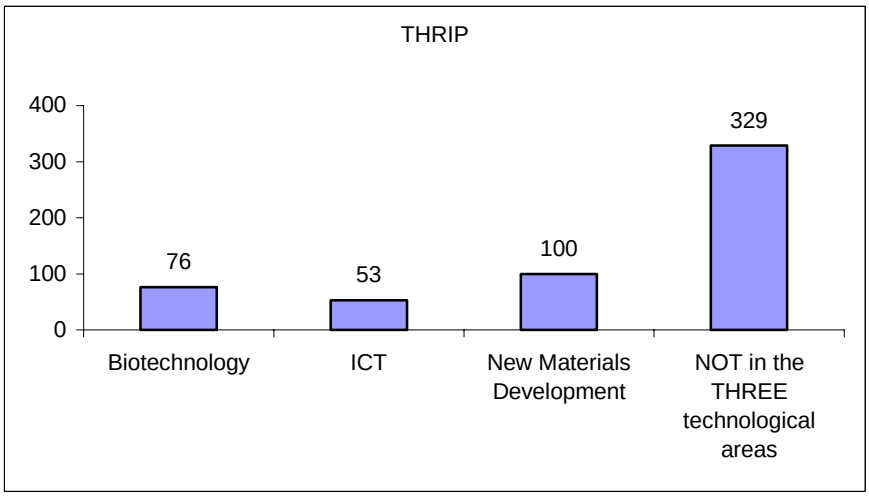
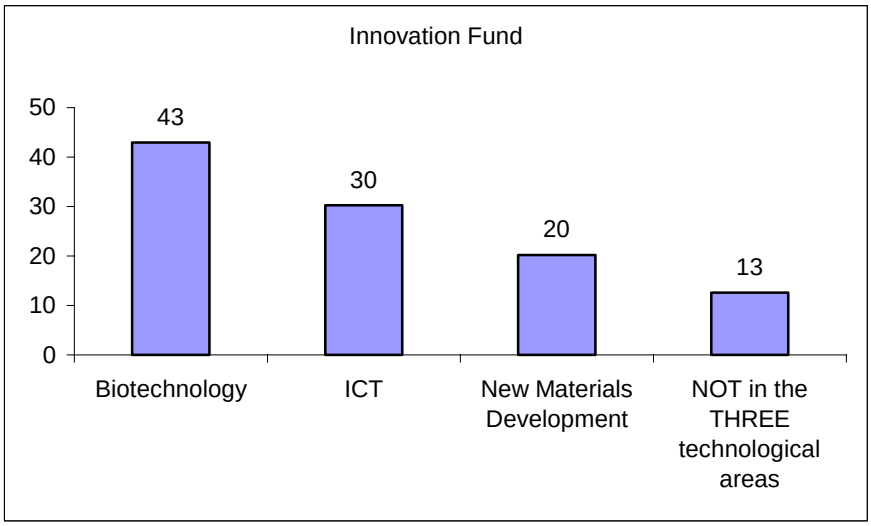


Figure 42: Total industry partners by industry technological bands for THRIP



[12] Note that some companies were involved in more than one technological area. Therefore, the total for this graph does not add up to 573 partners. This is especially the case for companies participating in THRIP projects.

Figure 43: Total industry partners by industry technological bands for the Innovation Fund

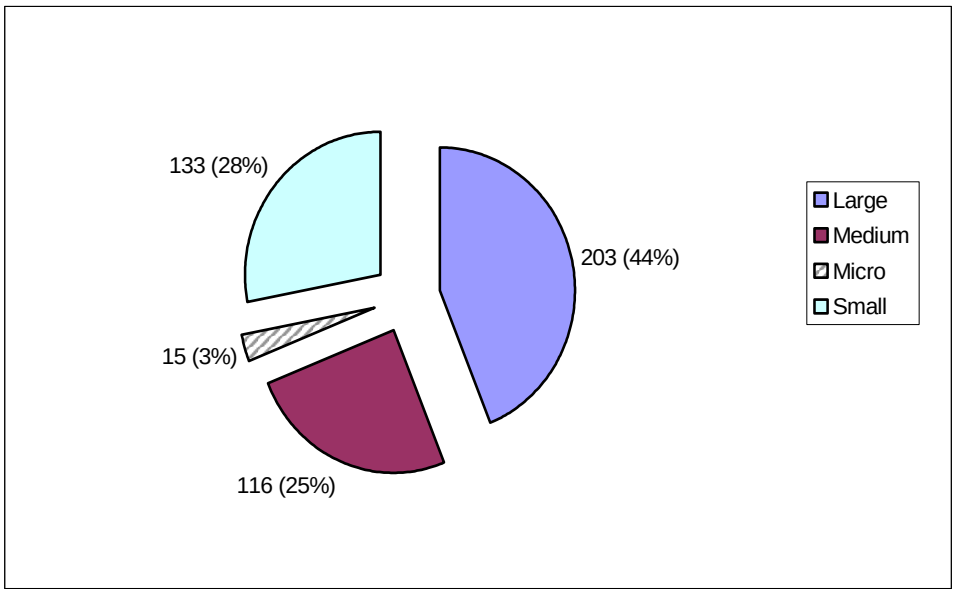


7.2 INDUSTRY PARTNERS BY SIZE[13]

The highest proportion of industry partners for THRIP are large enterprises (44%), followed by small enterprises (28%) and medium enterprises (25%). Only 3% are micro enterprises (Fig 44). These figures must be seen against the backdrop of THRIP placing significant emphasis on promoting SMME participation in partnerships and contributing R1:R1 (instead of R1:R2) in projects where only SMMEs invest financially. These figures suggest high SMME participation in research and development programmes with South African HE institutions. While the highest proportion of enterprises are large, the high number of small and medium enterprises needs to be acknowledged. Closer analysis indicates that most of the small and micro enterprises (with the exception of two cases) are involved in collaborative relationships with large enterprises in establishing and managing these higher education-industry partnerships.

[13] Industry size was provided by the THRIP database and by Innovation Fund Higher Education beneficiaries surveyed.

Figure 44: Industry partners by size[14]



The majority of industry partners in the biotechnology band are medium enterprises (49%), followed by large enterprises (34%) and a significantly smaller proportion of small (12%) and micro (5%) enterprises (Fig 44a). ICT industry partners are predominantly either large (42%) or small (40%) enterprises, followed by a smaller proportion of medium enterprises (18%) and no micro enterprises (Fig 44b). This mirrors enterprise size across the ICT sector, characterised by large national and multi-national enterprises and large numbers of smaller local enterprises. Almost half of the partner enterprises involved in new materials development projects are large enterprises. Medium and small enterprises are also represented (21% and 23% respectively) and a relatively high percentage (7%) of micro enterprises are involved (Figure 44c).

[14] These graphs exclude enterprises participating in Innovation Fund programmes as the numbers were too small to disaggregate with any degree of validity to this level.

Figure 44a: Industry partners by size – biotechnology

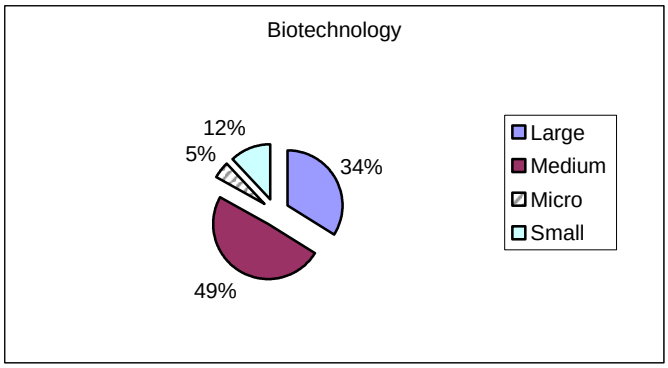


Figure 44b: Industry partners by size – ICT

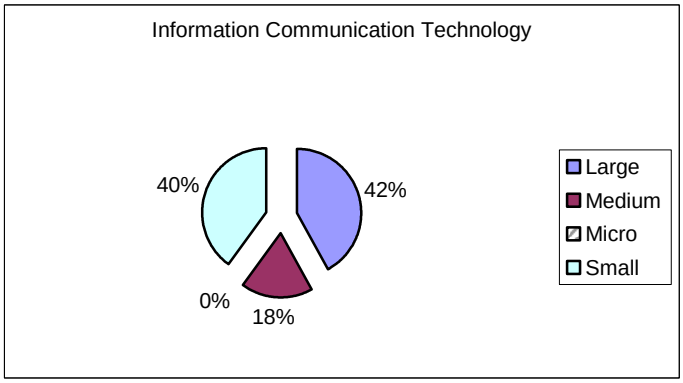
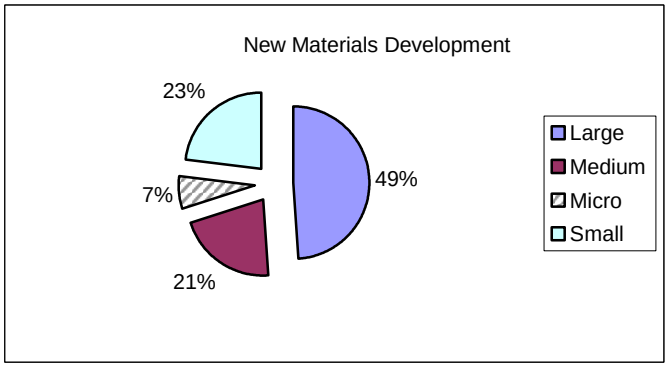


Figure 44c: Industry partners by size – new materials development



7.3 REASONS WHY INDUSTRY HAS PARTNERSHIPS WITH HE INSTITUTIONS

Industry respondents surveyed indicated (against a set of prescribed options) the reasons why their enterprise developed a partnership or partnerships with HE institutions. Contrary to expectations, items relating to financial gain and increased

profitability did not rank as the top two motivations for the relationship with HE institutions. The top two priorities relate to the issues of accessing research technology and research expertise not available within the company/industry but available at HE institutions.

Financial gain only ranks third, at the same level as ensuring equity in the enterprise's workforce through the training of black and female students in technological areas. Added technological value, sustained technological innovation and human resource development also rank highly. Factors appearing at the lower end of the ranking include the factors relating to direct industry gain such as tax rebates, company marketing and improved understanding amongst staff (Fig 45).

Industry respondents were then asked (in an open question) to indicate the perceived benefits of the relationship with HE institutions to their own enterprises and to the HE institutions. Industry perceptions of the benefits of the relationship to their own enterprises may be summed up in terms of three reasons, and are best illustrated in the following quotations:

Competitiveness and technological gain through research and development

'We have become a leader in our technology in South Africa within four years. Our product is of a high standard and we have gained international visibility through publications and exports';

'It permits increased capacity for industry related research and human resource development. It results in a broadening of research expertise, collaborations and synergy';

'It increases finance available for research, more competitive research and a better chance of products coming out of research';

'The linkage with higher education is important for our reputation and the development of advantage in our own particular market';

'Joint research links company strength with HE institution research expertise in biotechnology. As a technically oriented company, we wish to interact with HE institutions understanding leading-edge technology'.

Human resource development and employment opportunities

'[Company X] has limited R&D capacity and needs all the help it can get to advance technologically. We would like there to be a good pool of competent mining practitioners that we can employ or use as consultants';

'The relationship results in the development of specific skills that would otherwise have not been possible or would have been too costly. It helps gain access to suitably qualified previously disadvantaged personnel';

'[It exposes us] to top quality students for possible future employment at the enterprise. We have the knowledge to make an informed decision about students' abilities';

‘It permits growth in terms of offering a service to South African industry, which would normally be sought abroad. It helps us to train and educate manpower at a high level, especially trainees from technikons’.

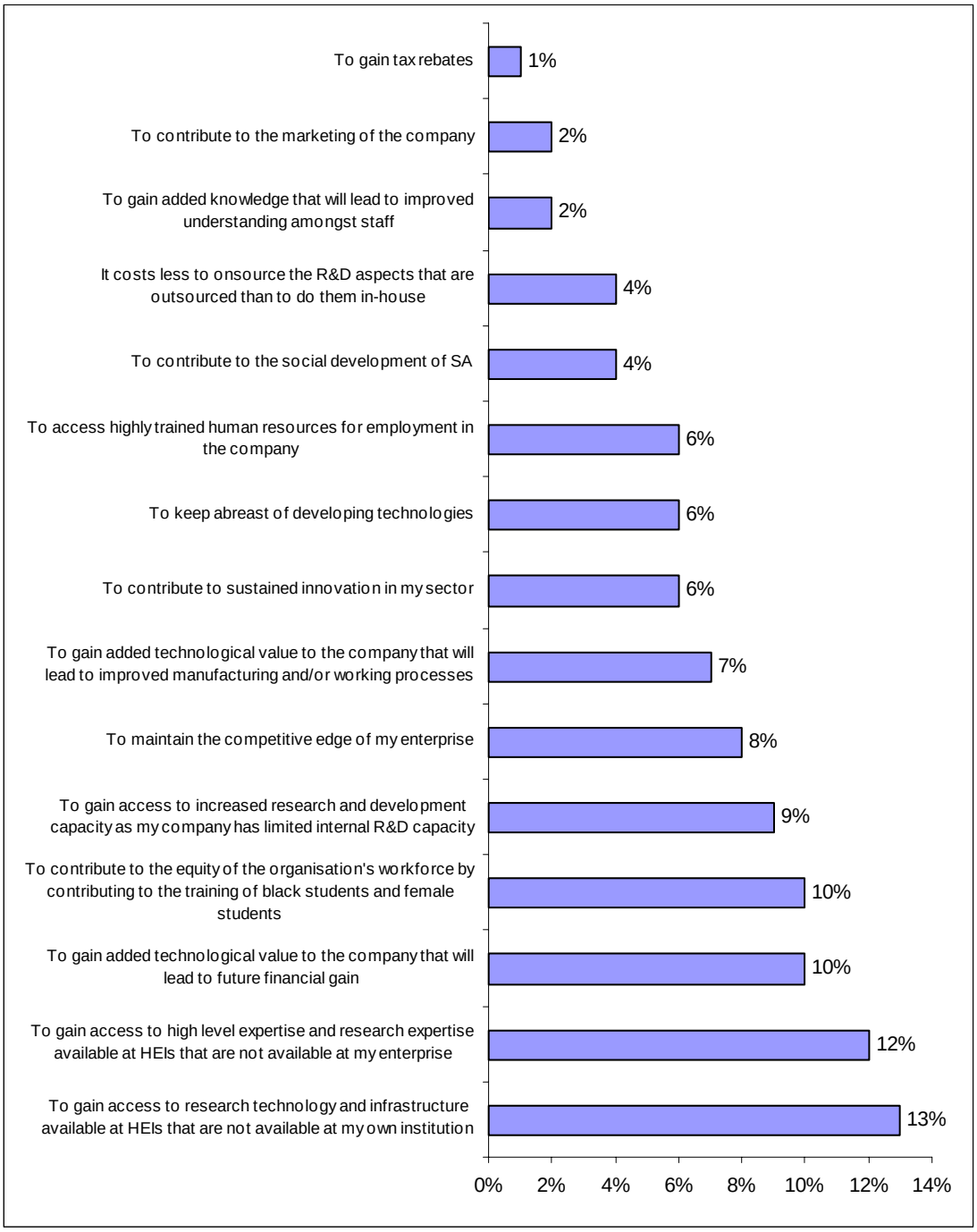
Benefits in terms of outputs of the relationship

‘Around 150 000 South Africans will be able to participate in gene therapy for retinal blinding conditions such as *Retinitis Pigmentosa*. [The research will] ensure that the genetic mutations causing retinal disease in all South African sufferers is identified timeously and that all have access to therapy’;

‘Crucial information on the safety of the potable water that my enterprise produces is obtained. It also fills a gap in our monitoring programme, as this type of technical expertise is not locally available’.

These perceptions suggest that industry beneficiaries have a strategic understanding of the possibilities of partnering and networks.

Figure 45: Reasons why industry has relationships with HEIs



7.4 NUMBER OF ENTERPRISES INVOLVED IN PROJECTS

The majority of THRIP and Innovation Fund projects involve more than one company and there are at least two projects where a total of 20 or more companies are involved (Fig 46).

THRIP has more companies involved per project than the Innovation Fund, probably as a result of the fact that THRIP places special emphasis on encouraging numerous partners to participate on each project and is willing to fund projects R1:R1 in cases where more than one industry partner is involved and where the second highest industry contribution is at least 10% of the highest industry contribution (Fig 47). All Innovation Fund projects have at least one or more industry partners per project, but there are no instances in which more than five industry partners are involved in any one project (Fig 48).

Figure 46: Number of companies involved in each project

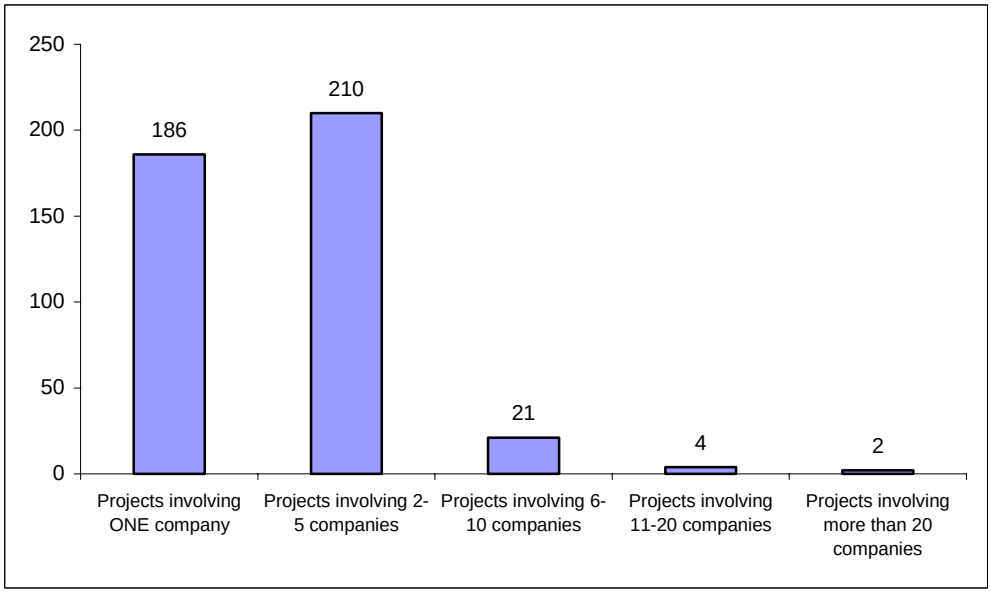


Figure 47: Number of companies involved in each project for THRIP

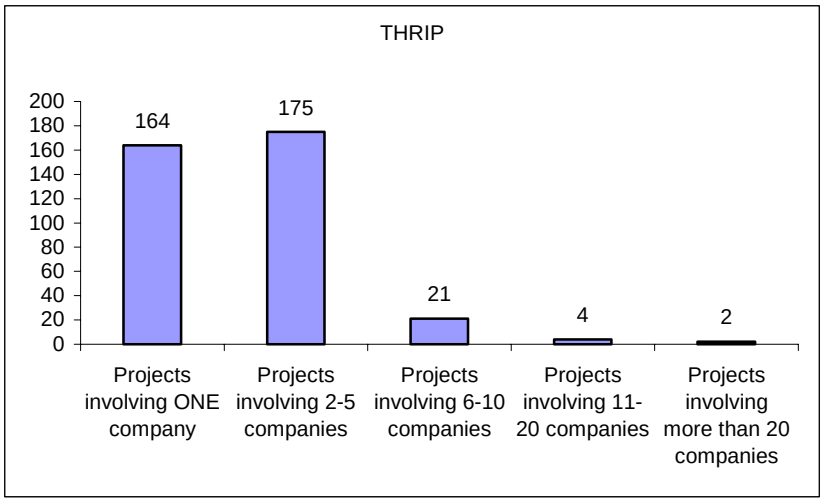
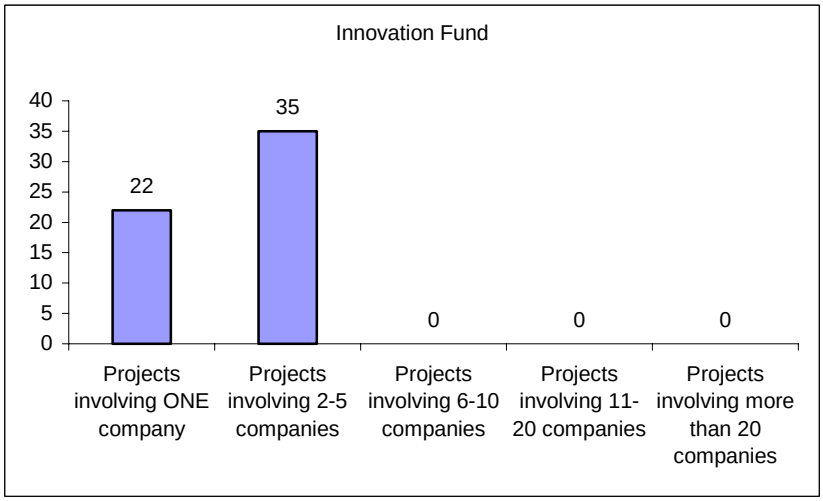


Figure 48: Number of companies involved in each project for the Innovation Fund



These findings provide strong evidence of Castells' (1996) notion of firms collaborating together to contribute to future competitiveness. Figure 52 provides an analysis of the type of companies that industry partners, in THRIP and Innovation Fund projects, are collaborating with. It shows that 46% of the industry partners reported that they had a previous relationship with the enterprise/s concerned and 42% reported that the relationship was based on the partner being involved in the same technological field (Fig 52). Only 12% of the respondents reported that they selected the partners specifically on the basis that they were not in the same technological field, so as to avoid direct competition. Data suggests that firms are collaborating, even with their competitors. It also suggests that firms have recognised that working in partnership with other enterprises can enhance rather than detract from the development of much needed cutting-edge technology.

7.5 NUMBER OF PROJECTS PER ENTERPRISE

The majority of enterprises are involved in one project and a high proportion are involved in between 2 and 5 projects. At least two enterprises are involved in a high total of 20 or more projects (Fig 49).

As with the total figures, most THRIP-industry partners are involved in one project but a high proportion are also involved in 2 to 5 projects at any one time. At least five enterprises are involved in up to 20 projects and 2 enterprises in even more than 20 projects (Fig 50). In the case of the Innovation Fund, almost all of the industry partners are linked to one project, with only two enterprises involved in between 2 and 5 projects (Fig 51).

This points to interesting questions about why certain companies have such a high level of participation in THRIP and Innovation Fund projects.

7.6 TOTAL NUMBER OF INDIVIDUALS INVOLVED FROM INDUSTRY PARTNERS

A total of 982 industry-based individuals are involved as either researchers/subject matter experts or as non-research staff in the 423 projects discussed here (Fig 53). This is an indicator of the high level of commitment to the partnerships on the part of industry.

A total of 841 of these are researchers or subject matter experts involved in the THRIP and Innovation Fund projects. Only seven companies (10%) indicated that there were no staff contributing at this level. Three companies indicated that they have at least 50 or more research/subject matter expert staff members involved in a partnership, indicating a high commitment of human resources to the project. At least 46% (32) of the companies have between two and five staff members working on the partnership project (Fig 54).

A total of 141 individuals are involved in THRIP or Innovation Fund partnerships at an administrative or non-research level from industry. This is also a significant indicator of commitment to the success of the projects outside of the research process itself and implies industry contributions to project management and communication (Fig 55).

Figure 49: Number of projects that companies are involved with

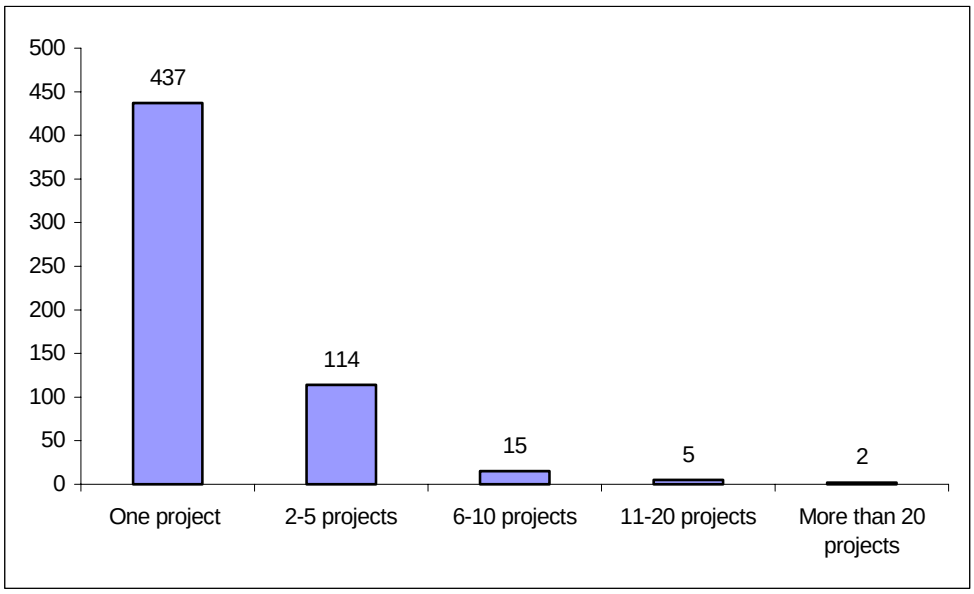


Figure 50: Number of projects that companies are involved with for THRIP

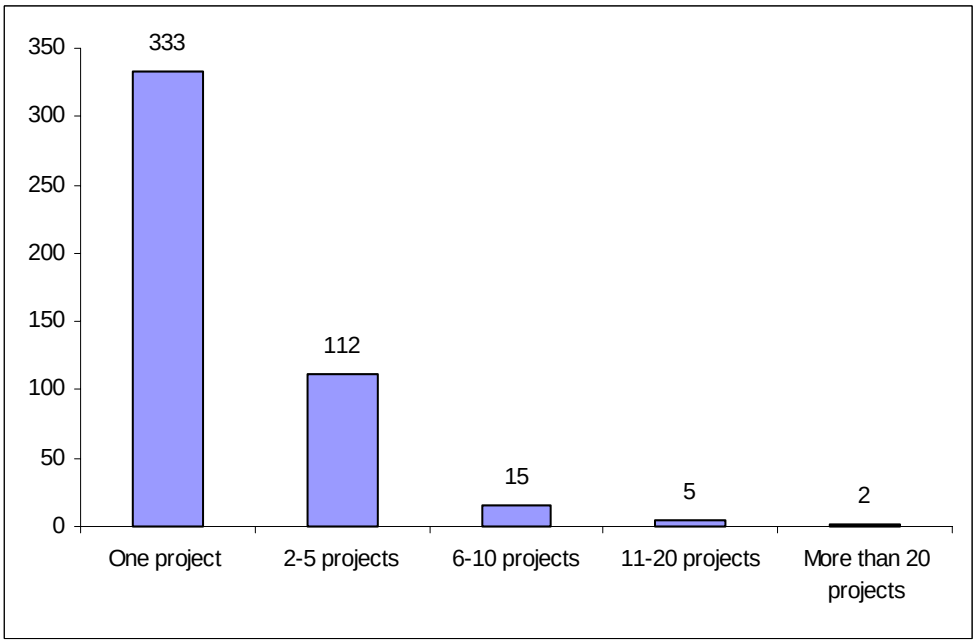


Figure 51: Number of projects that companies are involved with for the Innovation Fund

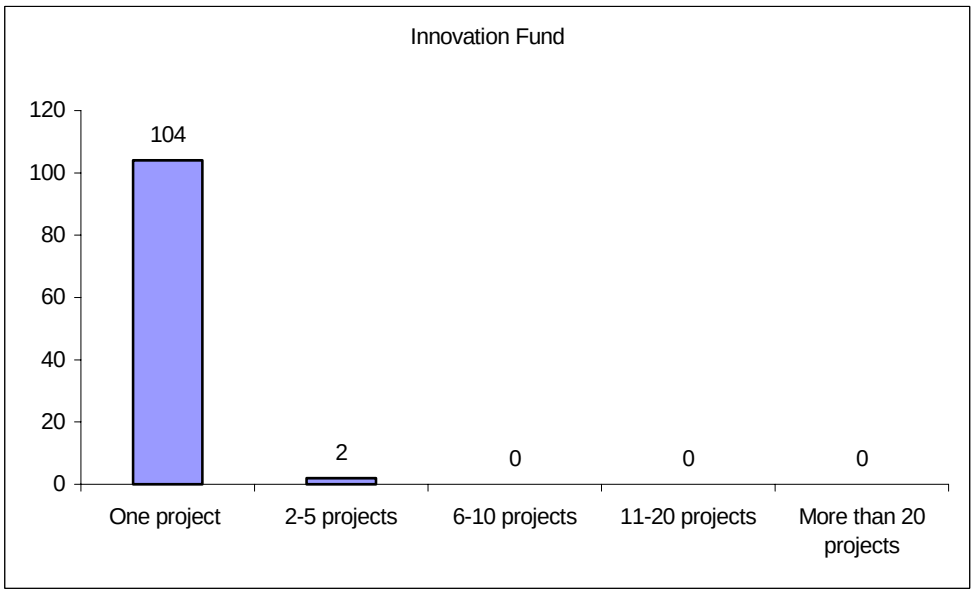
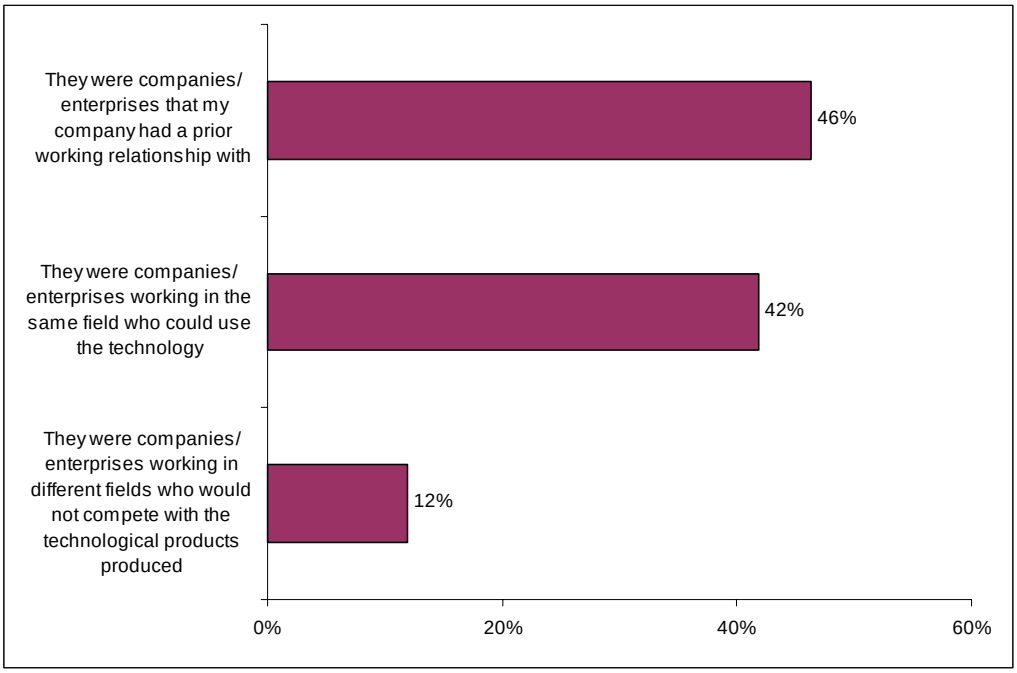


Figure 52: Motives for selecting the companies that they work with[15]



[15] Note that this data relates to the 49% of returned questionnaires that indicated they did select other industry partners. The remaining 51% indicated that they did not select other industry partners. In these instances, the HEI was most probably responsible for the selection of the participating partners.

Figure 53: Staff from industry involved in partnerships

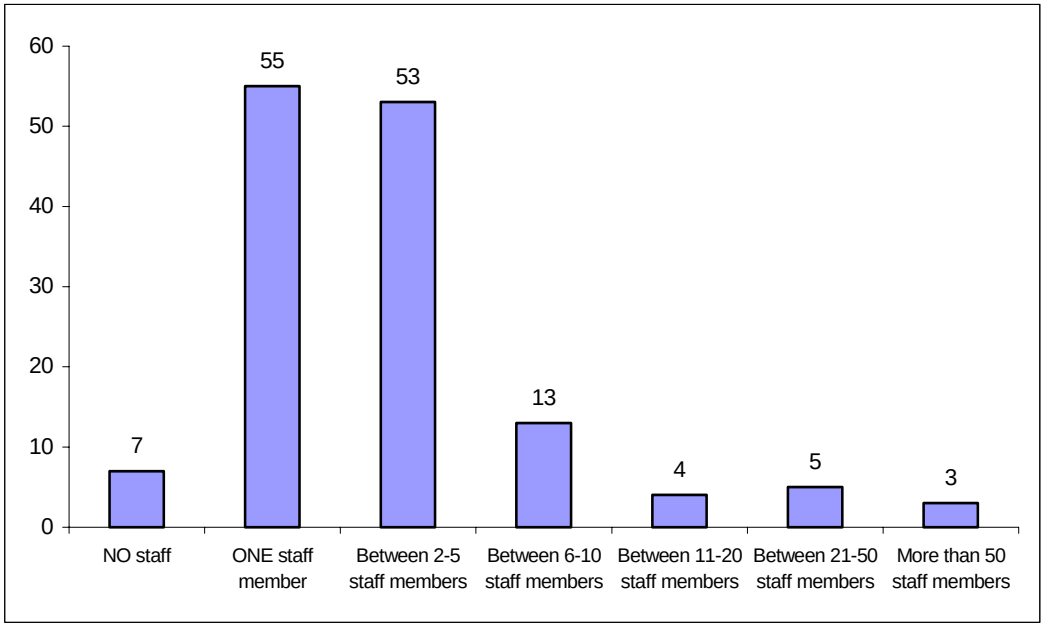


Figure 54: Researchers/subject matter experts from industry involved in partnerships

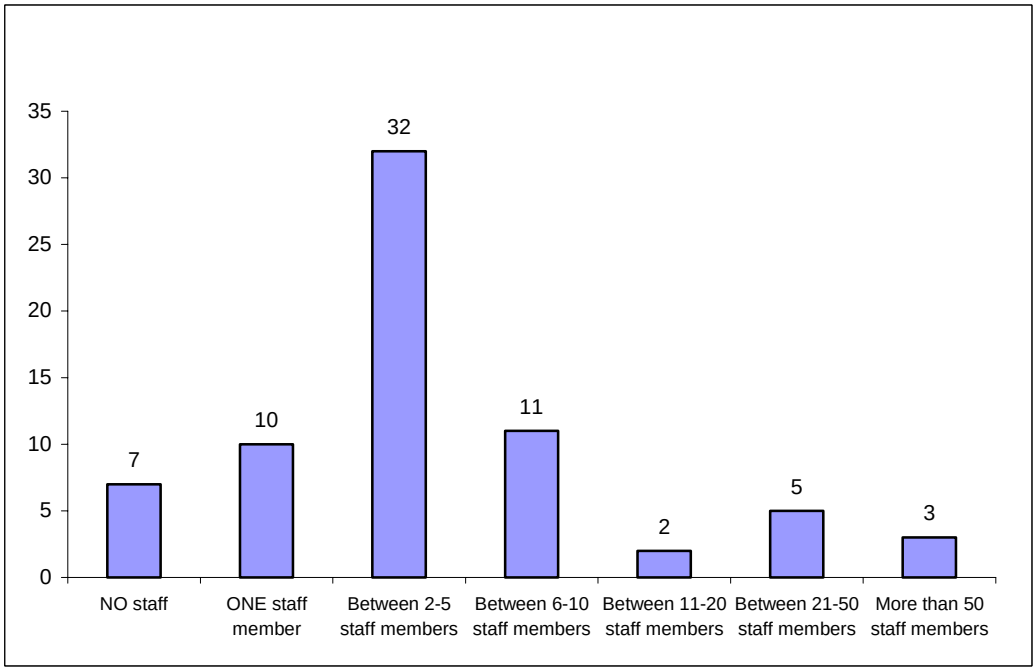
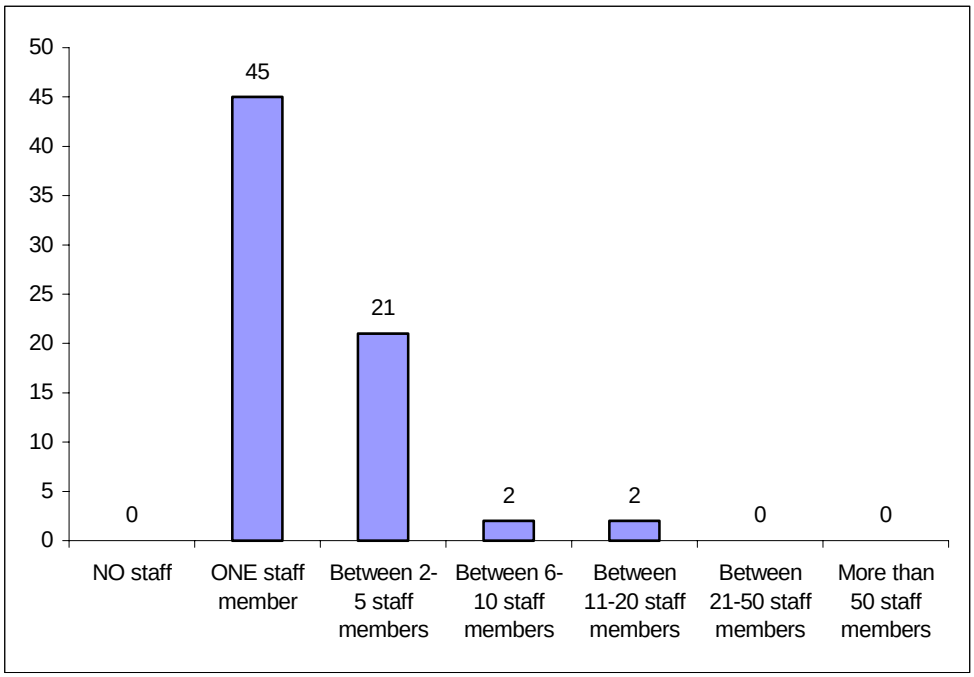


Figure 55: Non-research staff from industry involved in partnerships



7.7 CONCLUSION

This section illustrates that industry partners on THRIP and Innovation Fund projects show a high level of commitment to HE-industry partnerships in terms of the dedication of human resources (both subject matter experts and administrative staff) to these initiatives.

Moreover, industry motives for engaging in these partnerships are directly linked to issues such as access to research facilities and expertise and human resource development, rather than simply the narrower motives of financial gain and increased competitiveness. That the motives are understood in a complex manner suggests an appreciation of the benefits of networks, partnership and collaboration.

8

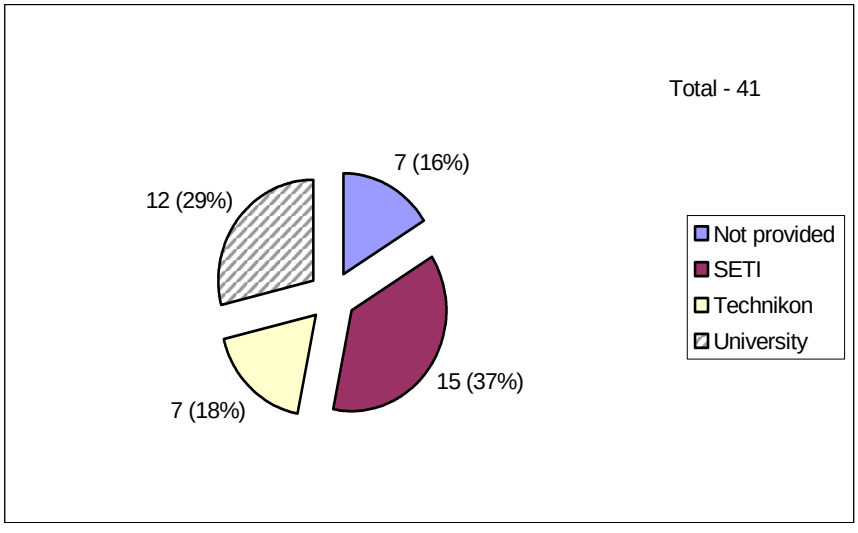
THE HIGHER EDUCATION PARTNERS

8.1 HE INSTITUTION PARTNERS IN THRIP AND INNOVATION FUND PROJECTS

A total of 41 HEIs/ SETIs are the primary beneficiaries of THRIP and Innovation Fund funding. Of these 37% are SETIs, 29% universities and 18% technikons (Fig 56). THRIP funds a total of 32 HEI/SETI beneficiaries. Of these, 50% are universities, 30% technikons and only 17% SETIs (Fig 57). In contrast to THRIP, the 15 Innovation Fund beneficiaries are largely SETIs (47%), followed by universities (20%) and no technikons (Fig 58).

Figure 59 illustrates the total number of partnerships by institutional type. As indicated, 309 (73%) of the projects are located in universities; 16% are located in SETIs; 9% are located in technikons and 2% have not been specified.

Figure 56: The HEI/SETI partners[16]



[16] The analysis is based on the HEI/SETI that are primary beneficiaries rather than HE institutions that are involved as part of the research team. The methodology section indicated that the primary beneficiary is the HEI/SETI with which the contract with THRIP or the Innovation Fund has been signed. Note that the term SETIs used in this report includes predominantly SETIs but also a small number of research units located in the NGO and in the private sectors.

Figure 57: The HE/SETI partners for THRIP[17]

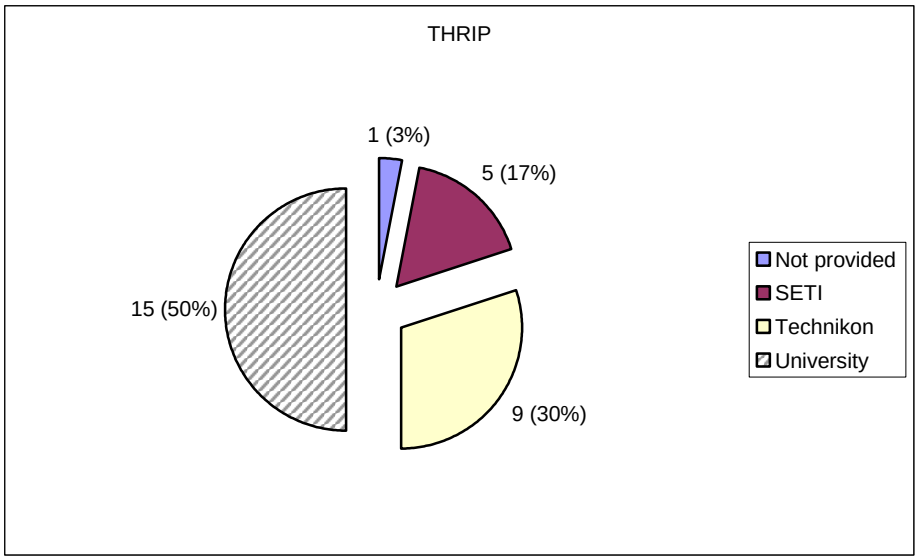
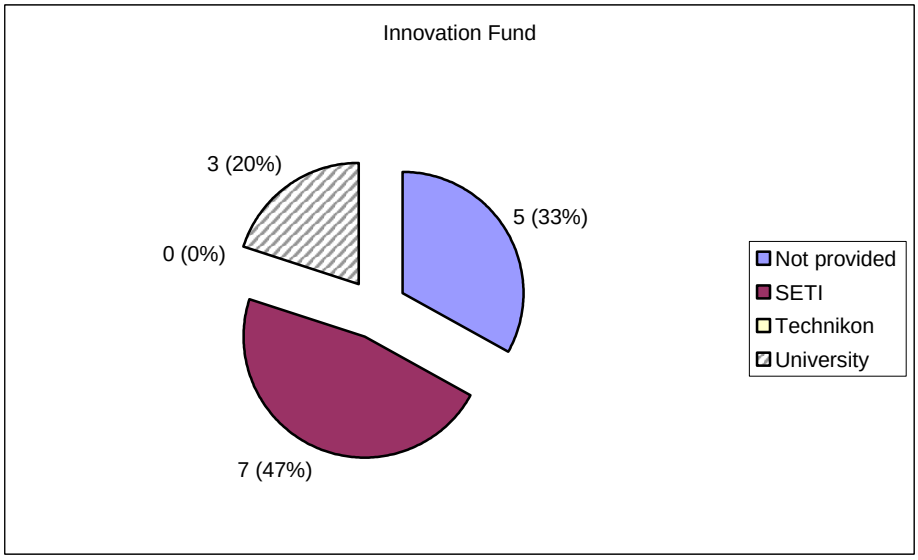
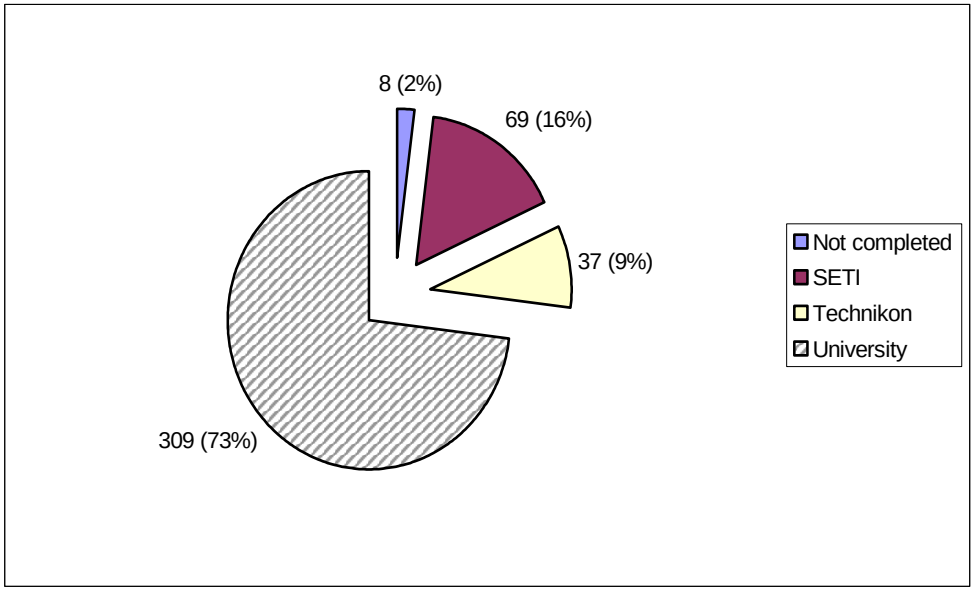


Figure 58: The HEI/SETI partners for the Innovation Fund



[17] Note that this section discusses a total of 41 HEI/ SETIs. When the primary institutions for THRIP and the Innovation Fund are added they total 46, which is greater than the total number of institutions. This is due to THRIP and the Innovation Fund funding the same HEIs/SETIs.

Figure 59: Total partnerships by institutional type[18]



8.2 HE INSTITUTION GRANT HOLDERS IN THRIP AND INNOVATION FUND PROJECTS

Figure 60 illustrates the total number of partnerships for which each institution is a grant holder. The University of Pretoria is a grant holder for 21% (72) of the total THRIP and Innovation Fund partnerships, followed by the University of Stellenbosch, which is grant holder for 19% (66) of the total number of projects, and the University of Cape Town, which is grant holder for 13% (45) of the total projects. Technikons are grant holders for 11% of the projects (this includes HWIs and HBIs). Historically black institutions (both universities and technikons) are grant holders for a total of 6% of the projects.

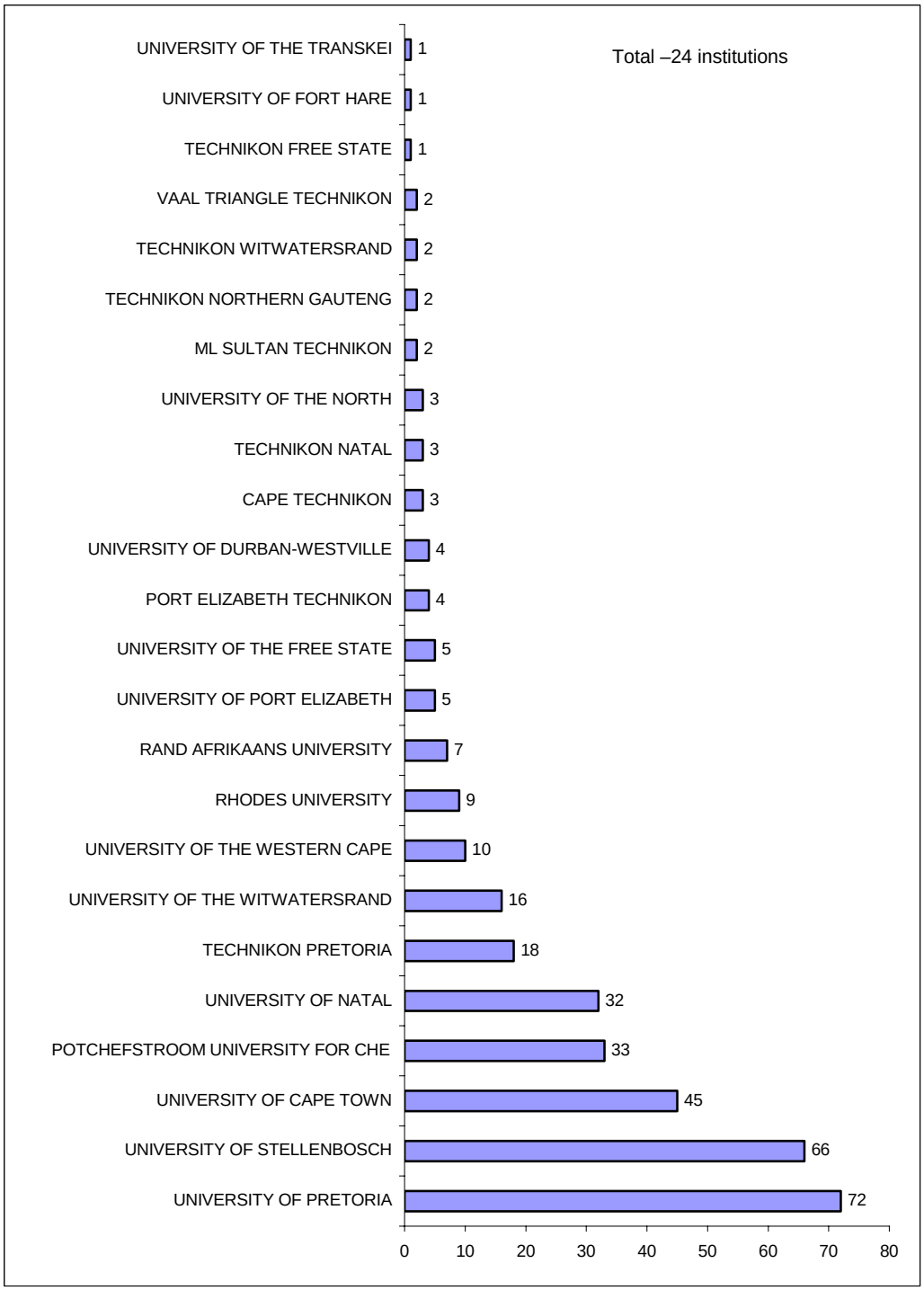
Figure 61 illustrates the number of projects that HE institutions are involved in either as grant holders or as research team members. The University of Stellenbosch is involved in the largest number of projects (23% of the total), followed by the University of Cape Town (16%) and the University of Pretoria (13%). Technikons are involved in 9% of the projects and historically black universities are involved in 5% of the projects.

Figures 62, 63 and 64 illustrate the grant holders for THRIP and Innovation Fund projects by the three technological bands. In the field of biotechnology, the majority of THRIP grant holders are universities, whilst for the Innovation Fund, the majority are SETIs. For both organisations combined, 56% of the grant holders are universities, 38% are SETIs and 6% are technikons (Fig 62). For ICT, the distribution is similar, with THRIP grant holders being mainly universities and Innovation Fund grant holders mainly SETIs. For both THRIP and the Innovation Fund combined, 55% of the ICT

[18] This figure includes all partnership projects, not only just those in the three technological bands.

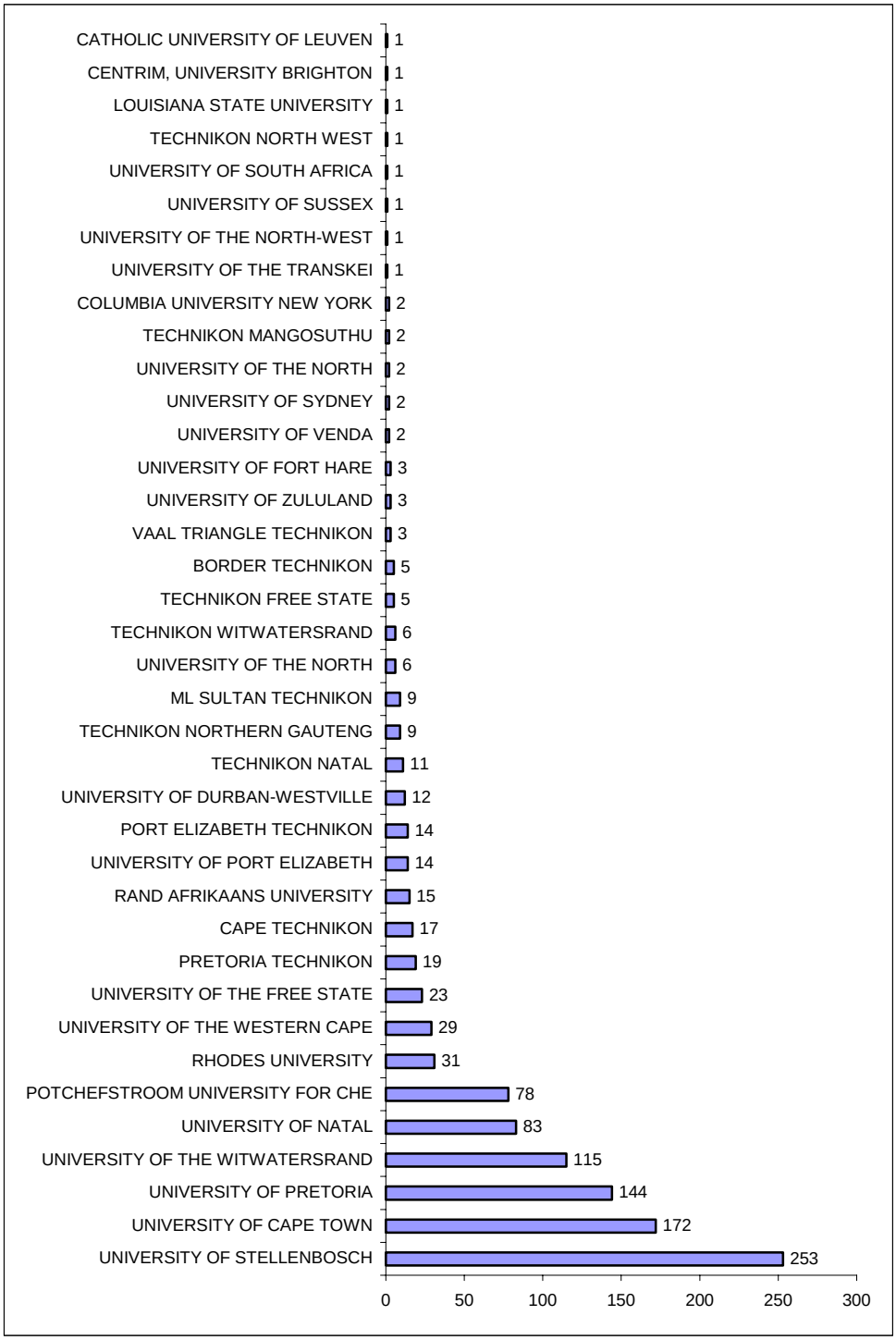
grant holders are universities, 35% SETIs and 10% technikons (Fig 63). In new materials development, universities once again dominate for THRIP projects and SETIs for Innovation Fund projects. For both THRIP and the Innovation Fund combined, 55% of the ICT grant holders are universities, 35% SETIs and 10% technikons (Fig 64).

Figure 60: Primary HEI funded by total number of projects for which HEIs are primary beneficiaries[19]



[19] This analysis is based on HEIs that are primary beneficiaries, in that they are the primary grant holder of the THRIP/ Innovation Fund project, and excludes the HEI of research team members.

Figure 61: The number of projects that HEIs are involved in (both grant holders and research team members)[20]

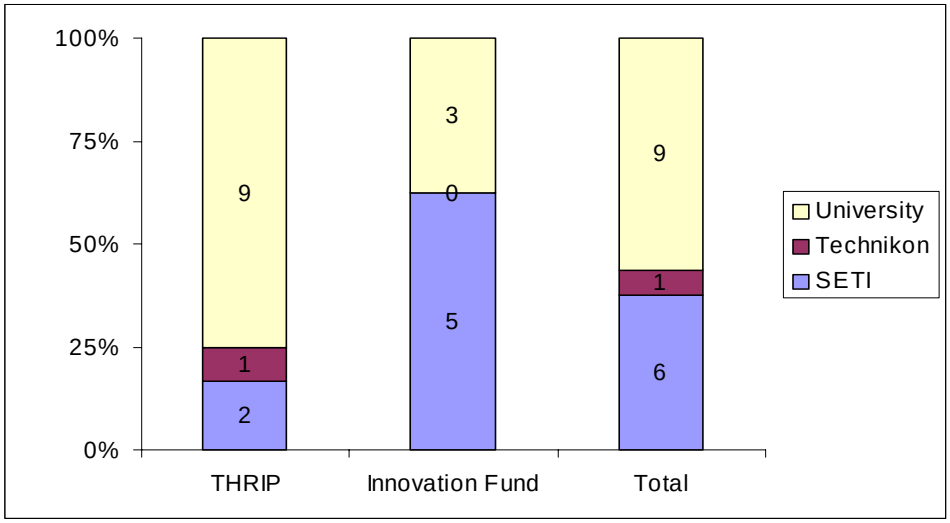


[20] This analysis is based on HEIs that are both primary and auxiliary beneficiaries, in that they are the primary grant holder of the THRIP/Innovation Fund project as well as involved in research projects for which they are not the grant holder. Please note that this analysis undercounts the Innovation Fund team members that were not located at the grant holders institution as this information was not available.

Figure 61a: Analysis of the HEIs involved as either grant holders and/or research team members

HAI / HDI	Technikons	Universities	Grand total
Historically advantaged institutions	12	11	**23**
Historically disadvantaged institutions	2	10	**12**
International universities	-	6	**6**
Grand total	**14**	**27**	**41**

Figure 62: The HE partners in biotechnology[21]



[21] Note that some higher education (or SETI and other type) institutions have partnerships in more than one of the three technological areas. As such, the institutions do not total a count of 50, but rather more than 50 because institutions are counted twice or more in the different technological areas. This applies to Figures 63, 64, 65, 66 and 67.

Figure 63: The HE partners in ICT

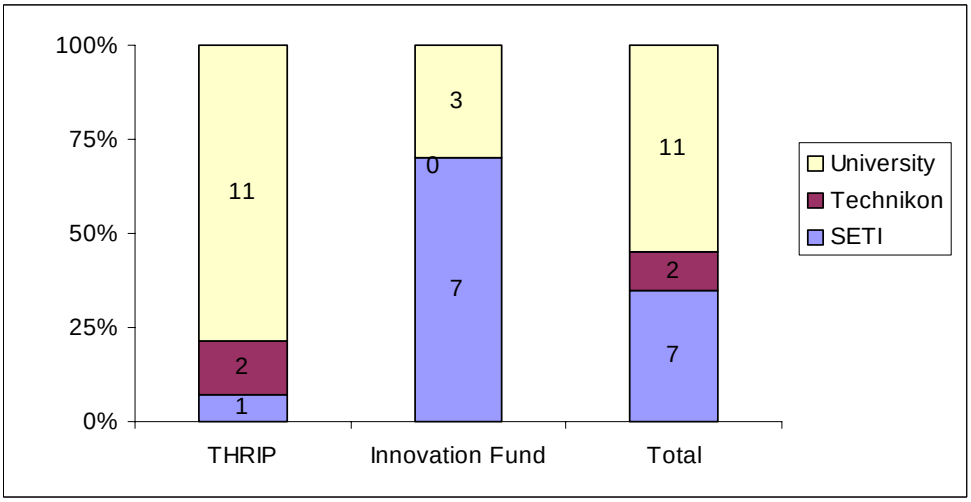
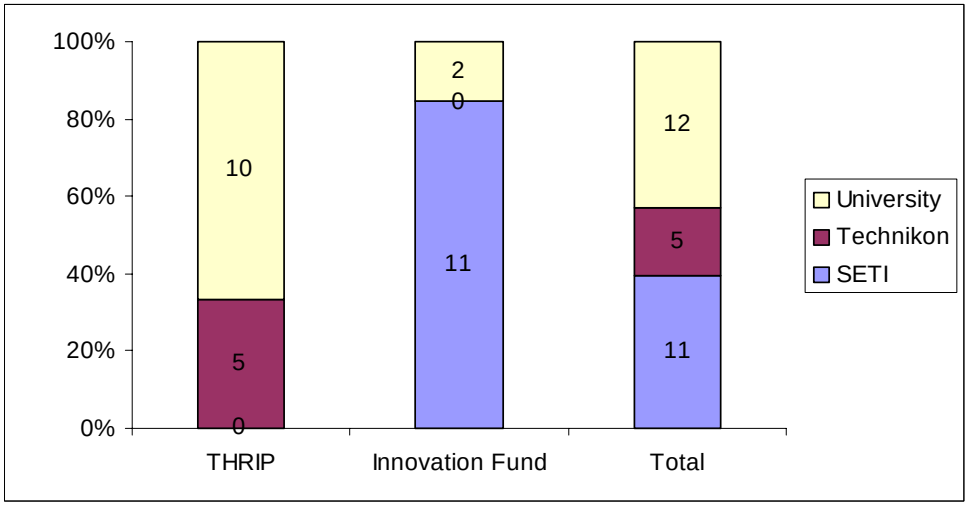


Figure 64: The HE partners in new materials development[1]



8.3 HEIs/SETIs BY THREE TECHNOLOGICAL BANDS

Figures 65, 66 and 67 illustrate the higher education partnerships by the three technological fields. As shown in Figure 65, the University of Pretoria is involved in a total of 17 biotechnology projects as the primary beneficiary and the University of Stellenbosch follows closely behind with 13 biotechnology projects. The University of the Western Cape, the only historically black institution, is the beneficiary of three biotechnology projects.

Figure 66 illustrates that the University of Cape Town leads as the beneficiary of ICT projects, followed by the Universities of Stellenbosch, Pretoria and Potchefstroom. The University of the Western Cape, the University of Fort Hare and the University of Durban-Westville, all historically disadvantaged institutions, are involved in a total of

four ICT projects. Three technikons, i.e., Pretoria, Witwatersrand and ML Sultan are also involved in ICT projects.

Figure 67 illustrates that the University of Pretoria leads as the beneficiary of materials development projects, as is the case with biotechnology projects. This is followed by the University of Cape Town and the University of Natal. The University of the Western Cape and the University of the North (HBUs) are involved in a total of three projects and technikons are involved in a total of six new materials development projects.

Figure 65: Higher education institutions by total number of projects in biotechnology

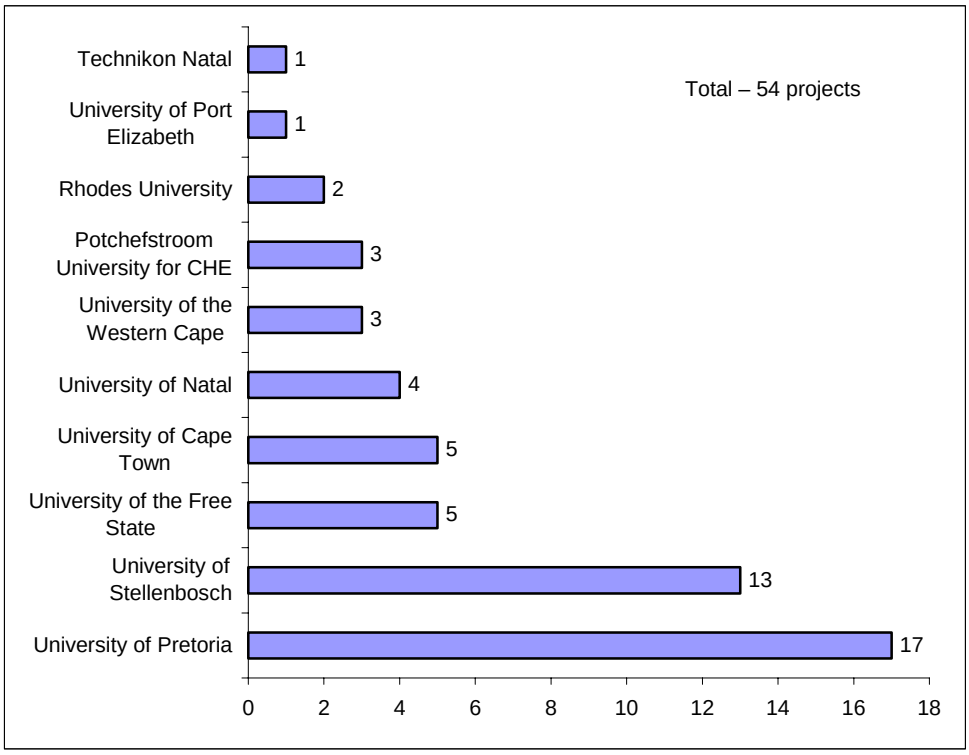


Figure 66: Higher education institutions by total number of projects in ICT

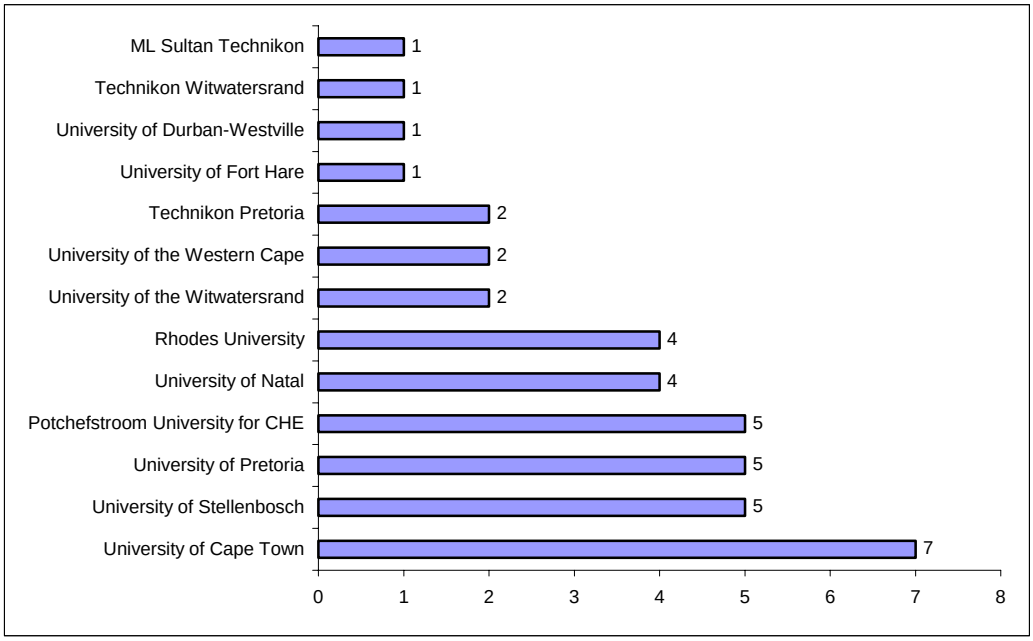
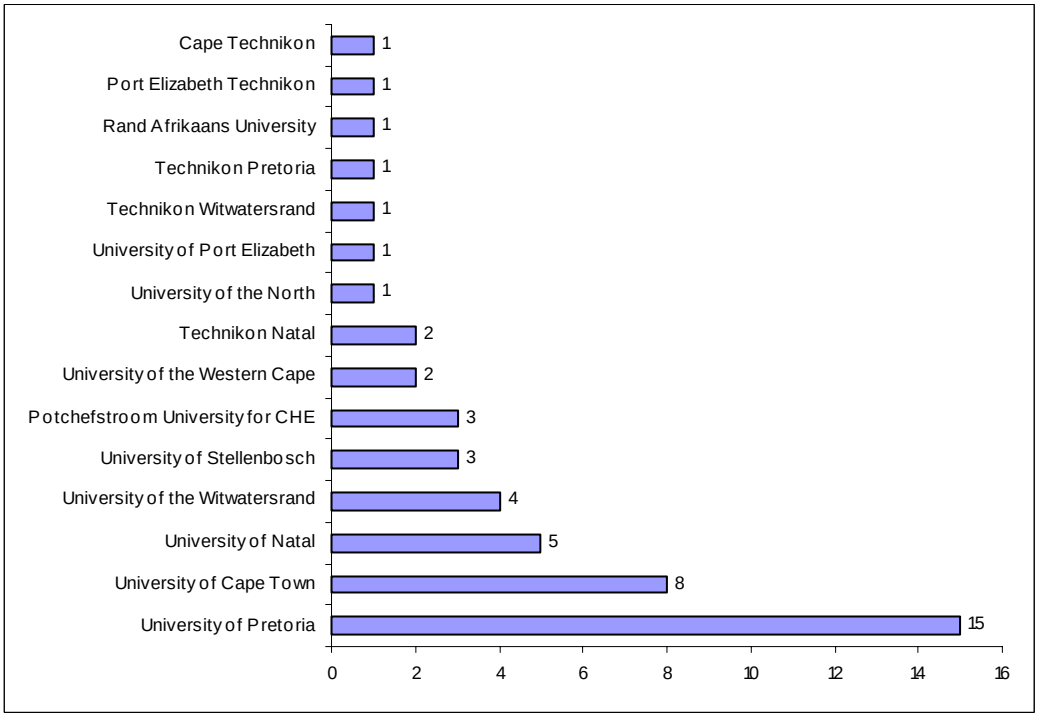


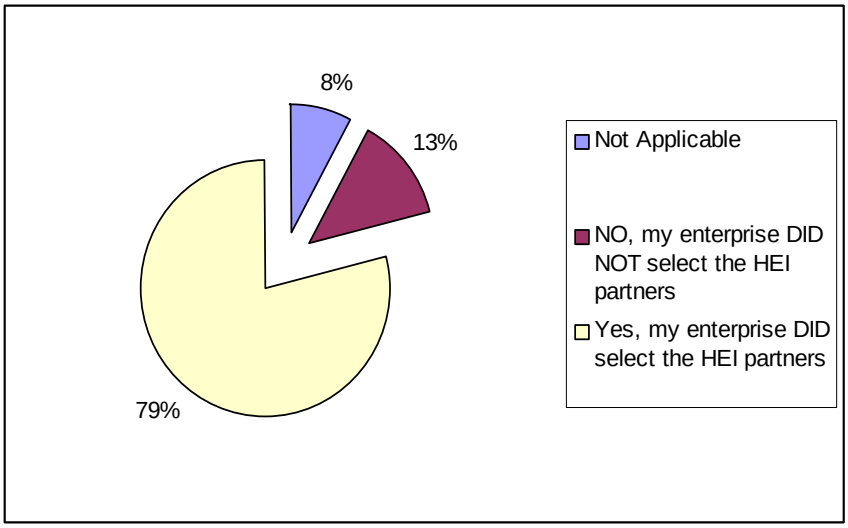
Figure 67: Higher education institutions by total number of projects in new materials development



8.4 INDUSTRY CRITERIA FOR SELECTING HE INSTITUTIONS

The industry survey requested respondents to indicate whether or not they selected their HE partners and, if so, the reasons for selecting those particular HE institutions as partners. The results indicate that 79% of the industry partners selected their HE partners (Fig 68).

Figure 68: Selection of HE partners



Of those that did select their industry partner, 52% indicated that this related specifically to the institution's research expertise; 17% said that the enterprise had a previous relationship with the institution; 13% indicated that the selection was due to the HE institution's physical and infrastructural resources; 6% selected the institution on the basis of their reputation; 4% based the decision on the appropriate cost of services or geographic location; 2% reported that the HE institution approached industry and 1% selected institutions on the basis that they were historically disadvantaged institutions (Fig 69).

It is interesting to note from the above that 17% of the enterprises selected HE institutions on the basis of a previous relationship. Figure 70 focuses specifically on the number of enterprises that either did have or did not have a previous relationship with the HE institution partner. As illustrated, 60% indicated that they had a prior relationship, whereas 40% indicated that they did not have a prior relationship. This is interesting in two respects. Firstly, the figure suggests that prior relationships are an indicator of the development of partnership relationships. Secondly, the figure indicates that THRIP and Innovation Fund projects are responsible for the generation of several new partnership relationships.

Figure 69: Those who did select HE partner, provided the following reasons for selecting HE institution

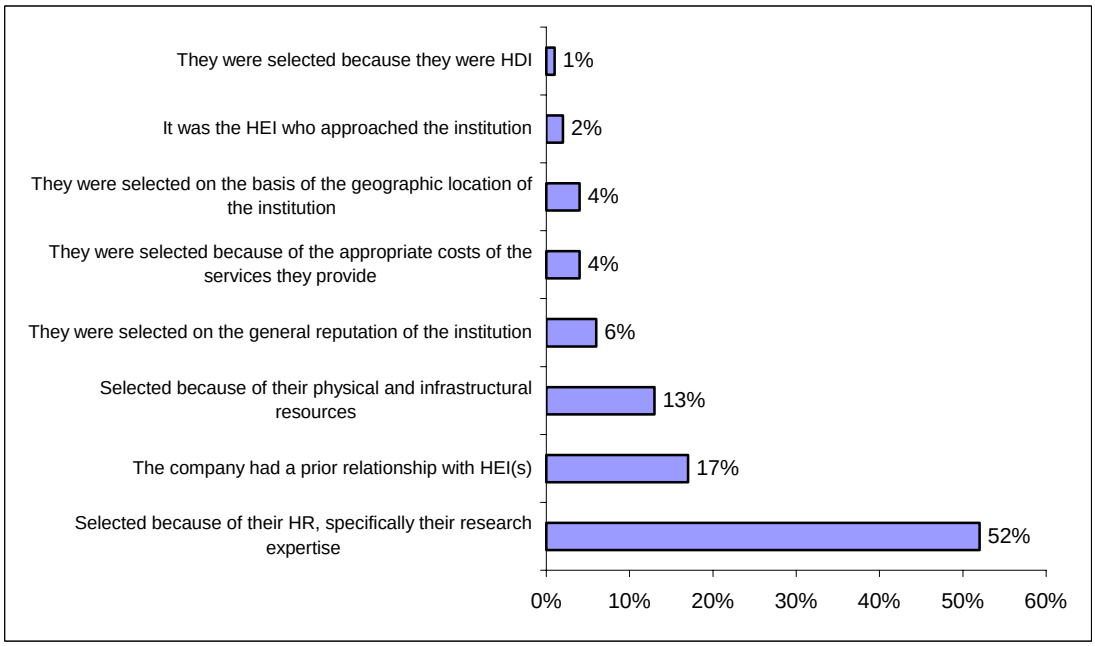
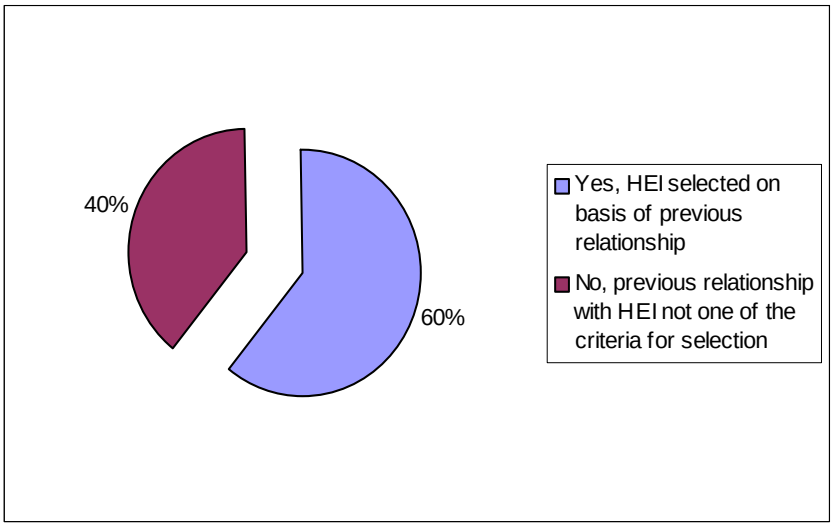


Figure 70: Prior relationships with HEIs



8.5 INDUSTRY MOTIVES FOR PARTNERSHIPS

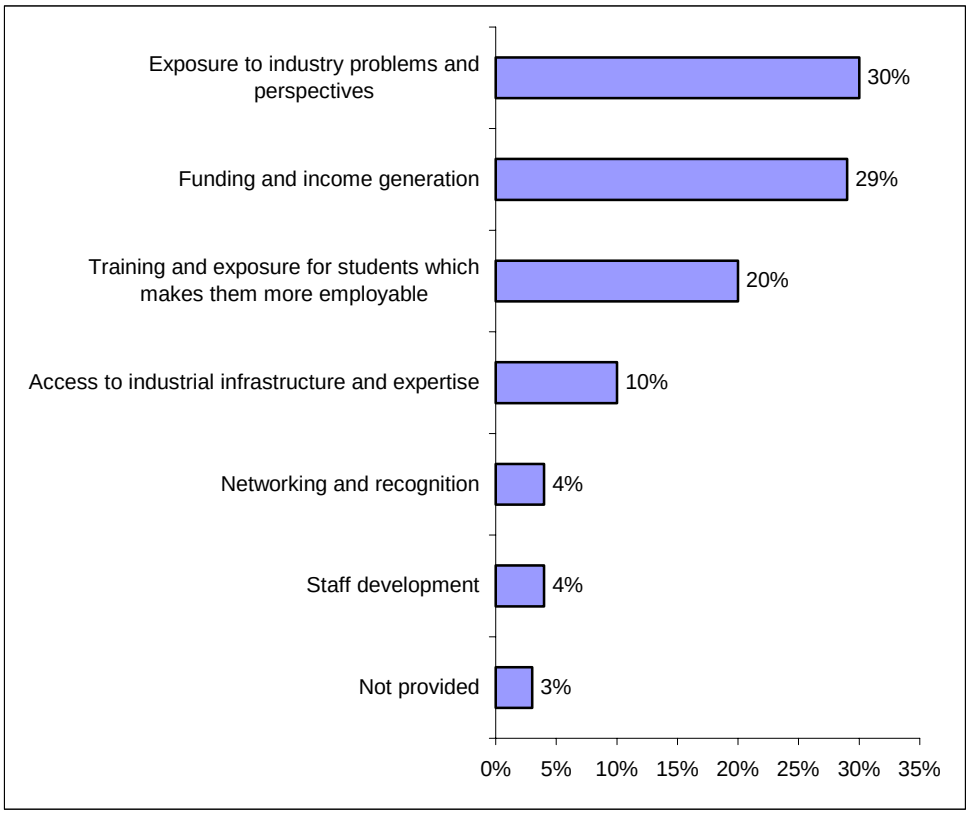
In the industry survey, respondents were requested to indicate their perceptions of the benefits of HE-industry partnerships to industry and to HE institutions. In the previous section, industry's perceptions of the benefits to their own enterprises were discussed. Figure 71 indicates industry's perceptions of the benefits of HE-industry partnerships to HE institutions. As illustrated, 30% of the respondents indicated that HE institutions benefit from such partnerships by being exposed to industry problems and perspectives in relation to technological developments. As one respondent commented,

'it allows academia to test the relevance of theories and to realise the extreme practical limitations encountered by industry. It provides academia with real world problems'.

A further 29% indicated that HE institutions benefit as a consequence of the funding allocated to the projects and the income generated by the projects. Twenty per cent indicated that HE institutions benefit by exposing students to different technological issues in industry, thus better preparing them for employment after graduation. As one respondent commented, linkages 'make the research undertaken by students more market-related and make science students more marketable in the private sector'.

Ten per cent stated that HE institutions benefit by gaining access to industry-based technological expertise and infrastructure. Just over 4% indicated that HE institutions benefit by being exposed to broader networks in the industrial sector and just under 4% argued that HE-industry partnerships result in HE staff development. 3% of the respondents did not provide information in this regard.

Figure 71: Industry perceptions of the benefits of partnerships for HE institutions

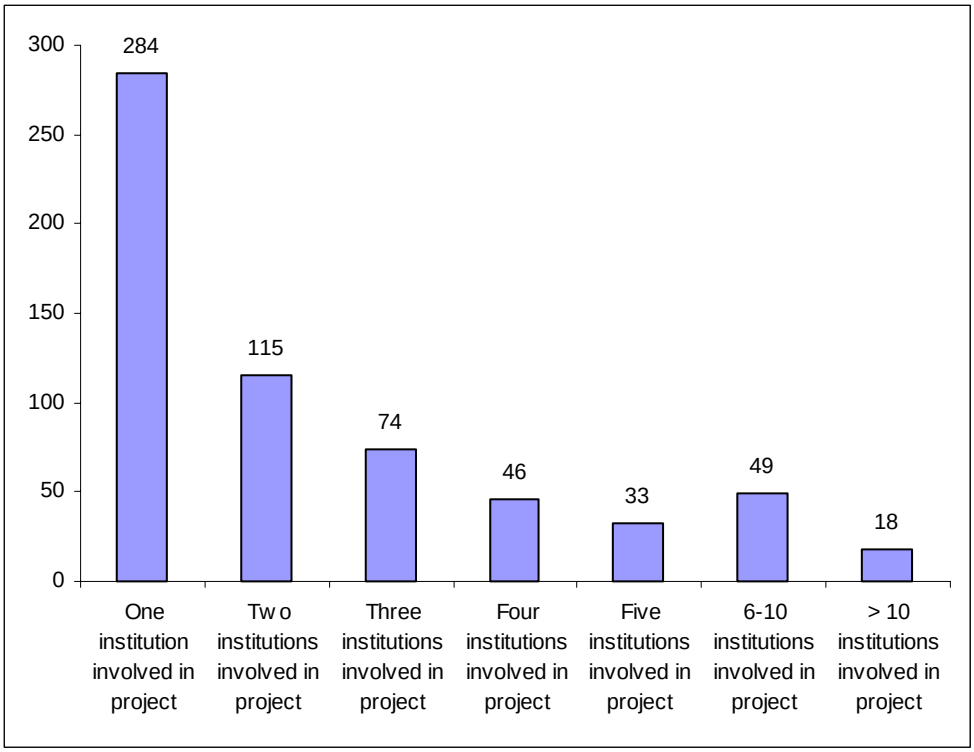


8.6 NUMBER OF HE INSTITUTIONS WORKING ON PROJECTS

Figure 72 illustrates the number of HE institutions working on THRIP and Innovation Fund partnerships. The graph provides some indication of networking between institutions within the framework of paradoxical relationships based on co-operation and competition or 'competitive collaboration' (see Castells 1996). The figure also points at the production of 'Mode 2' or transdisciplinary knowledge, wherein existing

knowledge is 'generated in the context of application' rather than in separate academic and application contexts (Gibbons et al 1994). The figure shows that in 33% of the cases, more than one HE institution is involved with individual THRIP or Innovation Fund projects. In 67% of the cases, only one HE institution is involved in each project. The data points to the emergence of collaboration between HE institutions, in their relationship with industry.

Figure 72: Number of HEI/SETI working on projects



8.7 CONCLUSION

This section indicates that universities, followed by SETIs, are the primary grant holders for the majority of THRIP and Innovation Fund partnerships. Technikons are the grant holders for only a few select partnership projects.

Industry motives for partnerships with HE institutions largely relate to the institution's research expertise and physical and infrastructural resources available at HE institutions. Significantly, many industry partners indicated that they had a previous relationship with the partnering HE institution, which formed the basis of their selection of particular institutions for THRIP and Innovation Fund projects.

Industry respondents indicated that HE institutions benefit from HE-industry partnerships by being exposed to industry problems and perspectives in relation to technological developments. In addition, HE institutions benefit from the funding generated through such partnerships and students benefit by being placed in industrial contexts for research and work experience.

9

THE RESEARCHERS

The data reveals that there are a total of 1 561 higher education-based researchers working on THRIP or Innovation Fund projects. These researchers are HE staff linked to HE institutions that are either higher education grant holders or auxiliary higher education beneficiaries.[22]

The total of 1 561 researchers does not double count those researchers who work in more than one capacity and those who work in multiple projects. The total of 1 561 researchers does not include Innovation Fund auxiliary researchers who are located at an institution other than the grant holders. Nor does it include industry-based researchers and higher education students who work either directly on the partnership projects or who are granted research funding through these projects.

As Table 2 illustrates, the Innovation Fund has 52 grant holders, one for each project. THRIP has 235 grant holders. These grant holders form the total body of grant holders for the 423 partnership projects funded by Innovation Fund and THRIP projects presented in Chapter 5.

Table 2: The researchers[23]

Type	Innovation Fund	THRIP	Grand total
Grant holders	52	235	287
Research team member	180	1 094	1 274
Grand total	232	1 329	1 561

9.1 RESEARCHERS BY RACE AND GENDER

An analysis of all researchers by race, indicates that 79% are white; 7% African; 4% Indian; 3% coloured and 0.1% Asian (Fig 73a). When a similar analysis is conducted for grant holders (rather than researchers), findings show that 75% of the grant holders are white and only 3% African (this data is shown in Table 1 in Appendix E).

[22] For definitions of primary, secondary and auxiliary beneficiaries, see the sample section in the methodology.
[23] Note that while there are 423 projects that there are only 287 grant holders. This is because some institutions are grant holders for more than one project. In such cases researchers involved in the projects have been counted only once.

An analysis of researchers by gender (Fig 73b) shows that 23% of the researchers are female and 72% are male. When analysed by grant holders (rather than researchers), the findings reveal that only 13% of the grant holders are female and 87% male (this data is attached in Appendix E).

9.2 RESEARCHERS IN THE THREE TECHNOLOGICAL BANDS

A total of 57% of the researchers are involved with projects that do not fall within the three bands. The remaining 43% are distributed across the three bands (Fig 74). Of these, 294 researchers (19%) are involved in projects in the field of biotechnology. A further 211 researchers (14%) are involved in the field of ICT and 159 researchers (10%) are involved in the field of new materials development (Fig 74).

Figure 73a: The researchers by race

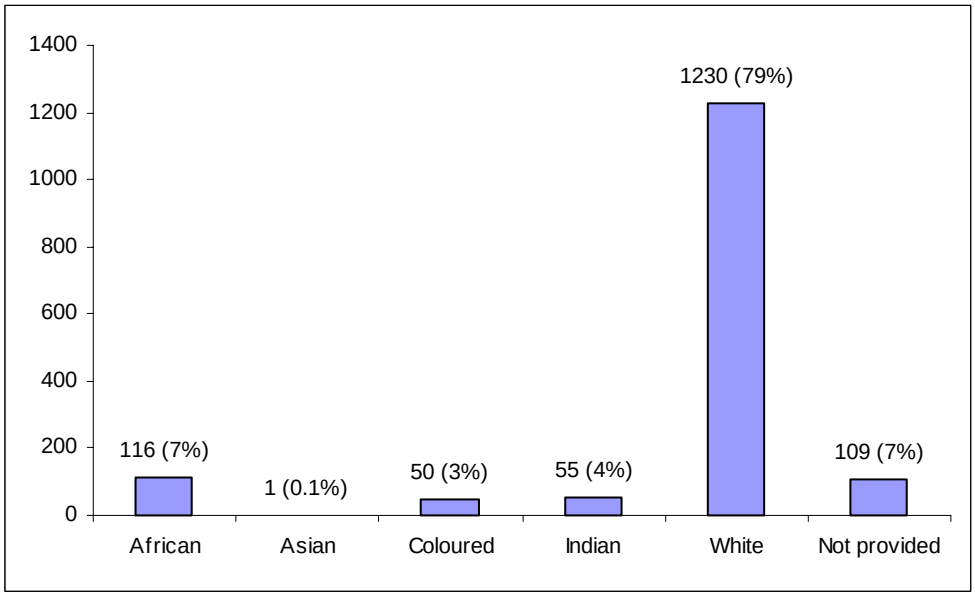


Figure 73b: The researchers by gender

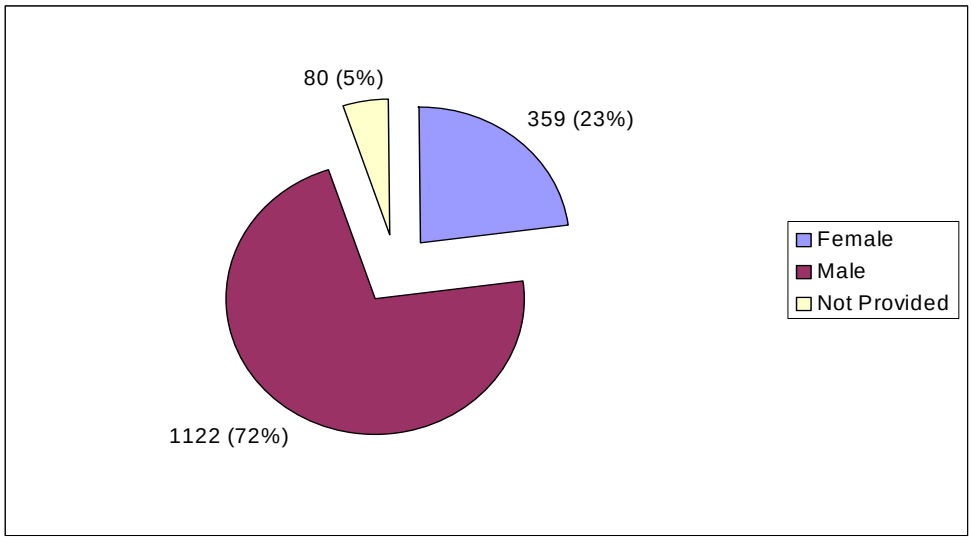
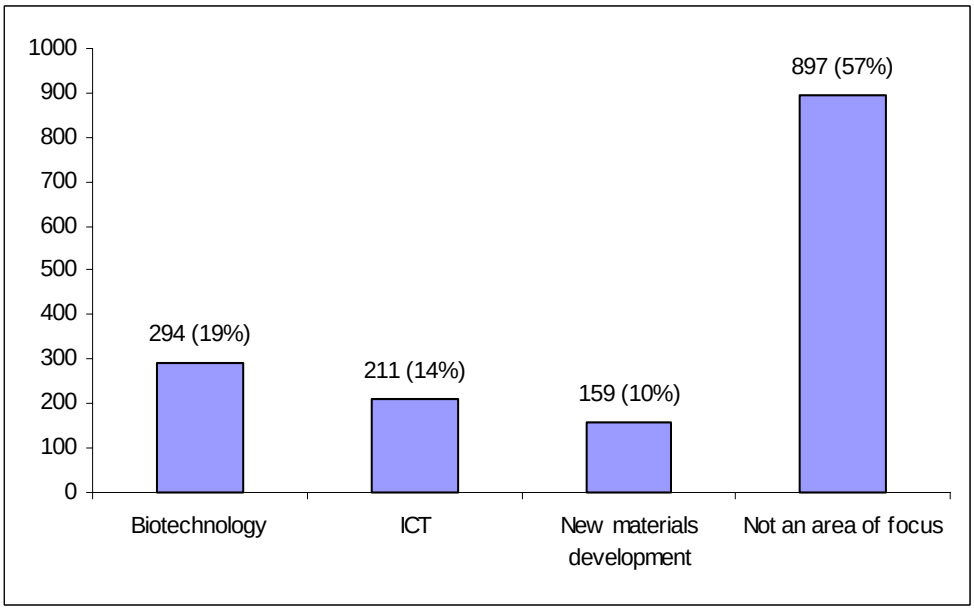


Figure 74: The researchers by three technological bands



9.3 NUMBERS OF RESEARCHERS WORKING ON PROJECTS

For the majority of THRIP and Innovation Fund projects (53%), between two and five researchers are involved in each project. Twenty-three per cent of the projects involve only one researcher (this refers only to either grand holder researchers and auxiliary researchers, and does not include industry-based and student researchers). Up to five projects have more than 20 researchers involved (Fig 75).

Figure 75: Number of researchers working on research projects (includes all three technological bands)

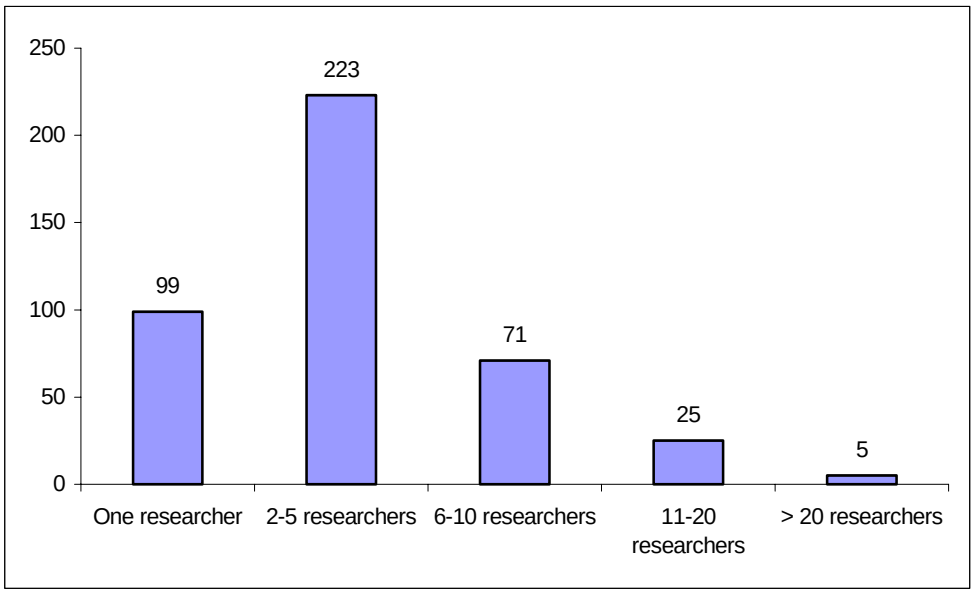


Figure 76 illustrates that the majority of projects in the field of biotechnology involve more than one researcher, with 47% of the projects involving at least between 2 and 5 researchers and 24% involving between 6 and 10 researchers. The researcher distribution for ICT projects is similar to that in the field of biotechnology. 24% of the projects involve only one researcher, 47% involve between 2 and 5 researchers and an additional 17% involve between 6 and 10 researchers (Fig 77). For new materials development, 40% of the projects involve only one researcher, which is a higher proportion than in the fields of biotechnology and ICT. A further 54% of new materials development projects involve between 2 and 5 researchers and a smaller percentage more than five researchers (Fig 78).

These findings suggest the emergence of research networks in the three technological bands as well as in other bands. It shows researchers working together in teams to provide, as Gibbons et al (1994) state, knowledge solutions to our economic and social problems. The complexity of the relationships between the researchers precluded further analysis of the research networks in this study. A detailed study of the networks that exist may further illuminate the nature and extent of such researcher networks.

Figure 76: Number of researchers working on research projects – biotechnology

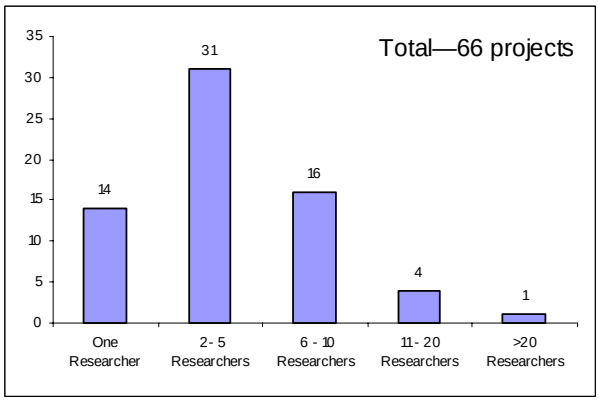


Figure 77: Number of researchers working on research projects – ICT

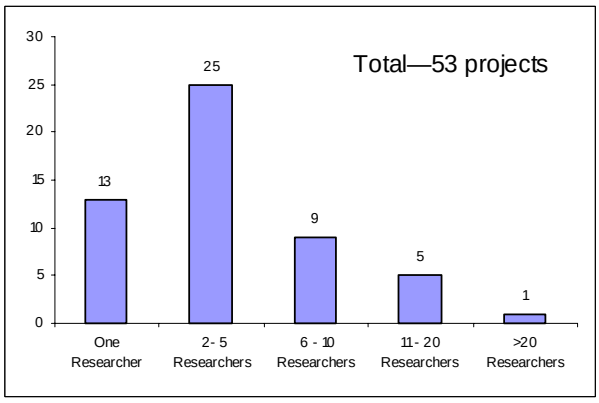
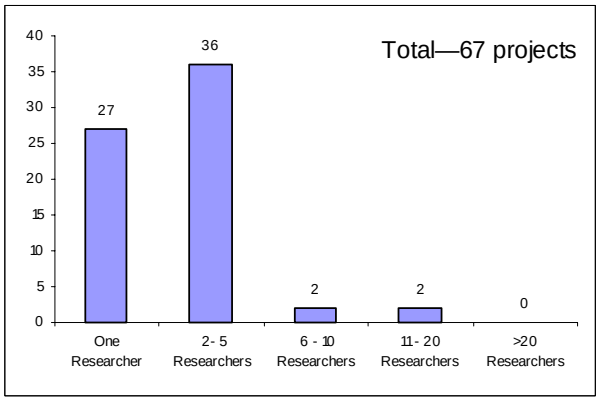


Figure 78: Number of researchers working on research projects – new materials development

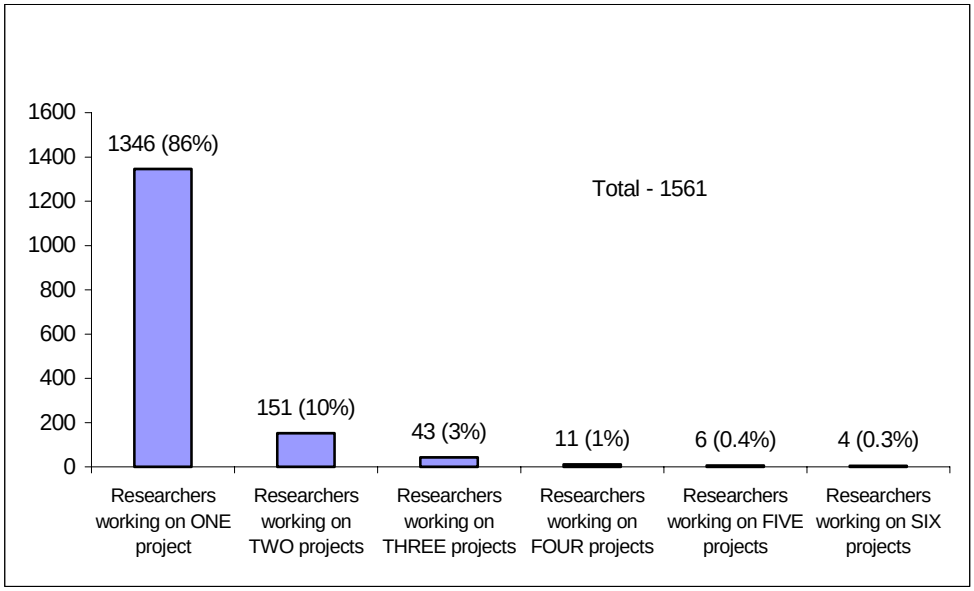


9.4 NUMBER OF PROJECTS THAT RESEARCHERS WORK ON

The vast majority of researchers (86%) are working on one Innovation Fund or THRIP project (Fig 79). 10% of the total number of researchers are working on two projects, 3% on 3 projects, 1% on 4 projects and even smaller numbers on more than 4 projects.

These findings suggest the possibility that a small number of researchers specialise in consulting to a wide number of partnership projects.

Figure 79: Number of projects that researchers are working on



While most researchers involved in partnership projects funded by THRIP and the Innovation Fund work on only one project, in biotechnology 26 researchers work on more than one project with 8 researchers working on three and more projects. In new materials development 12 researchers work on more than one project and in ICT 17 researchers work on more than one project (Table 3). These findings may suggest a layer of researchers who have a high level of expertise in either research area, or in the skill of networking itself. Few researchers in the three bands work on more than four projects.

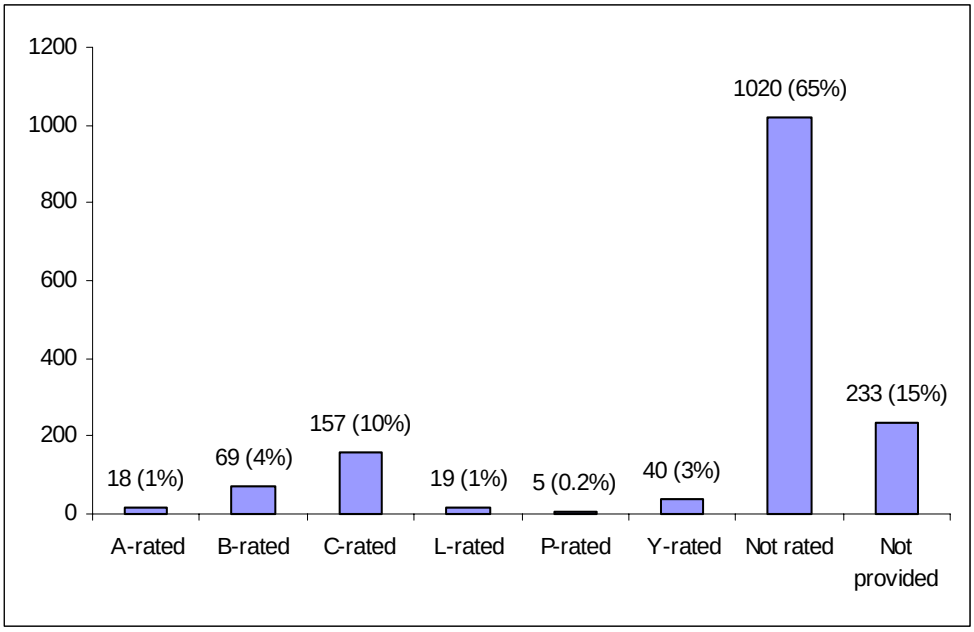
Table 3: Number of projects that researchers are working on – by technological bands

Number of projects being worked on by researcher	Technological bands			Total for 3 technological bands
	Biotechnology	ICT	New materials development	
TWO	18	14	9	41
THREE	6	1	1	8
FOUR	1	2	1	4
FIVE	1	0	0	1
SIX	0	0	1	1

9.5 RESEARCHERS BY NRF RATING

Figure 80 reviews THRIP researchers by the NRF ratings. This rating scale is provided in Table 4. As illustrated, the majority of researchers have not been rated but for those who have been, 10% are C-rated, 4% B-rated, 3% Y-rated and only 1% A-rated. Only 1% are L-rated, suggesting that few previously disadvantaged researchers are involved currently in research projects. These findings raise a number of questions about the research status of the researchers involved in the partnership projects. Specific questions include: (i) Are the researchers who are involved in the partnership projects the researchers who are the most frequently published in their discipline? (ii) Do the researchers who are working in the partnership projects have a specific expertise in networking and/or establishing partnerships? (iii) Do the researchers have status as well-known and reputable researchers in their area? Figure 81, by illustrating that the majority of researchers working on three or more projects are B- or C-rated researchers, i.e. researchers who have substantial expertise in their fields, begins to suggest answers to these questions. Only very small numbers of A- (top experts) and no Y-rated (young researchers) work on more than three projects.

Figure 80: The THRIP researchers by NRF rating[24]



[24] THRIP projects include a field on NRF rating of researchers. While the information was gathered for Innovation Fund projects, the data proved unreliable and has not been included in Figure 80. Lists of researchers by rating and by three technological bands are available on request.

Figure 81: Researchers working on three or more projects – analysed by NRF rating

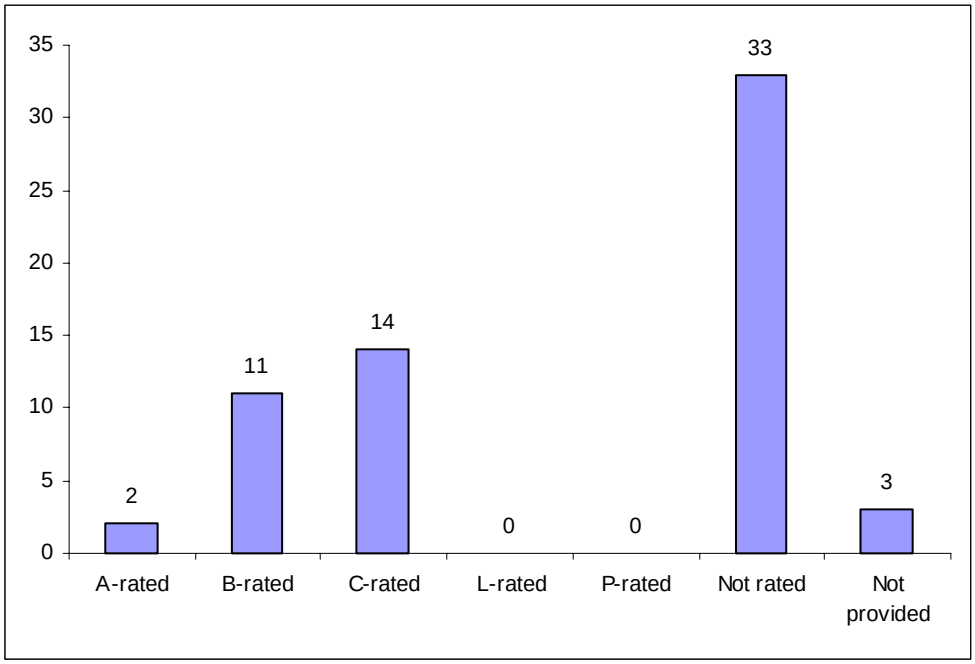


Table 4: NRF researcher rating scale

A	Researchers who are unequivocally recognised by their peers as leading international scholars in their field for the high quality and impact of the recent research outputs
B	Researchers who enjoy considerable international recognition by their peers for their recent research output
C	Established researchers with a sustained recent record of productivity in the field who are recognised by their peers as having * produced a body of quality work, the core of which has coherence and assets to ongoing engagement with the field * demonstrated the ability to conceptualise problems and apply research methods to investigating them
P	Young researchers (normally younger than 35 years of age), who have held the doctorate or equivalent qualification for less than five years at the time of application and who, on the basis of exceptional potential demonstrated in their published doctoral work and their research outputs in their early post-doctoral careers are considered likely to become future leaders in their field
Y	Young researchers (normally younger than 35 years of age), who have held the doctorate or equivalent qualification for less than five years at the time of application, and who are recognised as having the potential to establish themselves as researchers within a five-year period after evaluation, based on their performance and productivity as researchers during their doctoral studies and/or early post-doctoral careers
L	Persons (normally younger that 55 years) who were previously established as researchers or who previously demonstrated their potential through their own research products, and who are considered capable of fully established or re-establishing themselves as researchers within a five-year period after evaluation. Candidates should be South African citizens or foreign nationals who have been resident in South Africa for five years during which time they have been unable for practical reasons to realise potential as researchers. Candidates in this category include: * black researchers * female researchers * those employed in higher education institution that lacked a research enrolment * those who were previously established as researchers and have returned to the research environment

9.6 CONCLUSION

This chapter shows that a large number of researchers are involved in the partnership projects and that this involvement is frequently in the form of teams, rather than as single researchers. In the majority of THRIP and Innovation Fund projects, more than one HE institution-based researcher is involved in each research team (for all three technological bands). In a small number of cases, more than 20 HE institution-based researchers are involved in individual projects. The majority of researchers, however, are involved in only one project at a time.

The data illustrates that on current THRIP and Innovation Fund projects, the vast majority of HE institution-based research staff are white and male.

Section D

THE CONTRIBUTION OF GOVERNMENT-INCENTIVISED PARTNERSHIP PROJECTS

10

RESEARCH NETWORKS

One of the indicators of the development of 'Mode 2' knowledge, is the extent to which knowledge production is transdisciplinary, rather than multidisciplinary in nature (Gibbons et al 1994). This section aims to raise questions about the potential transdisciplinary interaction in THRIP and Innovation Fund projects, by reviewing the number of different academic departments involved in partnership projects and by reviewing the number of different institutions involved in partnerships projects.

It must be noted, however, that departments working together do not necessarily reflect transdisciplinary activities. As such, this section represents an attempt to raise questions about the extent and direction of the disciplinary links that exist.

10.1 NUMBER OF DEPARTMENTS INVOLVED IN PROJECTS

Out of a total of 38 higher education institutions,[25] 389 different departments are involved in THRIP and Innovation Fund partnerships or projects.[26] A total of 16 institutions (42%) have only one department involved in projects; 26% have at least 2 to 5 departments involved; 18% have between 6 and 10 departments involved, 3% have between 11 and 20 departments involved and 4 institutions (11%) have between 20 and 40 different departments involved in THRIP and Innovation Fund projects. Overall, 58% have more than one department involved, indicating high levels of involvement across departments (and therefore across disciplines) (Fig 82).

A total of 52% of the projects are attached to only one department. 48%, however, are attached to more than one department with 23% linked to 2 departments; 20% linked to between 3 and 5 departments and 3% linked to between 6 and 10 departments (Fig 83).

[25] This analysis is based on HEIs that are both primary and auxiliary beneficiaries, in that they are the primary grant holder of the THRIP/Innovation Fund project as well as involved in research projects for which they are not the grant holder. Please note that this analysis undercounts the Innovation Fund team members that were not located at the grant-holders' institution as this information was not available.

[26] Note that this analysis was taken off ALL the institutions involved, not only the primary institutions, and includes those involved as part of research teams.

10.2 NUMBER OF DEPARTMENTS BY THE THREE TECHNOLOGICAL BANDS

A total of 53% of projects in the field of biotechnology are linked to two or more departments; 47% are linked to only one department (Fig 84a). The ICT field shows a similar distribution, with a slightly lower percentage (49%) of projects linked to two or more departments and 51% linked to only one department (Fig 84b). A different distribution is evident for new materials development, where the majority of projects (68%) are linked with only one department and 32% with two or more departments (Fig 84c). These findings suggest that new materials development appears to be more specialised whilst ICT and biotechnology appear, in terms of working with other disciplines, to be more cross-cutting.

These figures are suggestive of potential transdisciplinary co-operation on THRIP projects.

Figure 82: Number of departments by institution

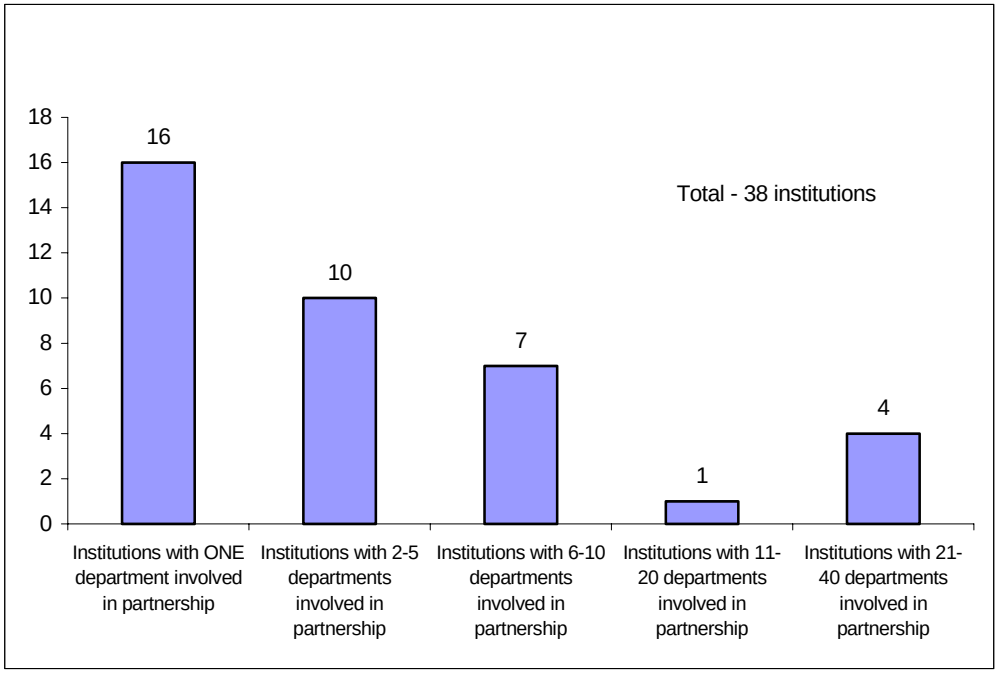


Figure 83: Total number of departments per project[27]

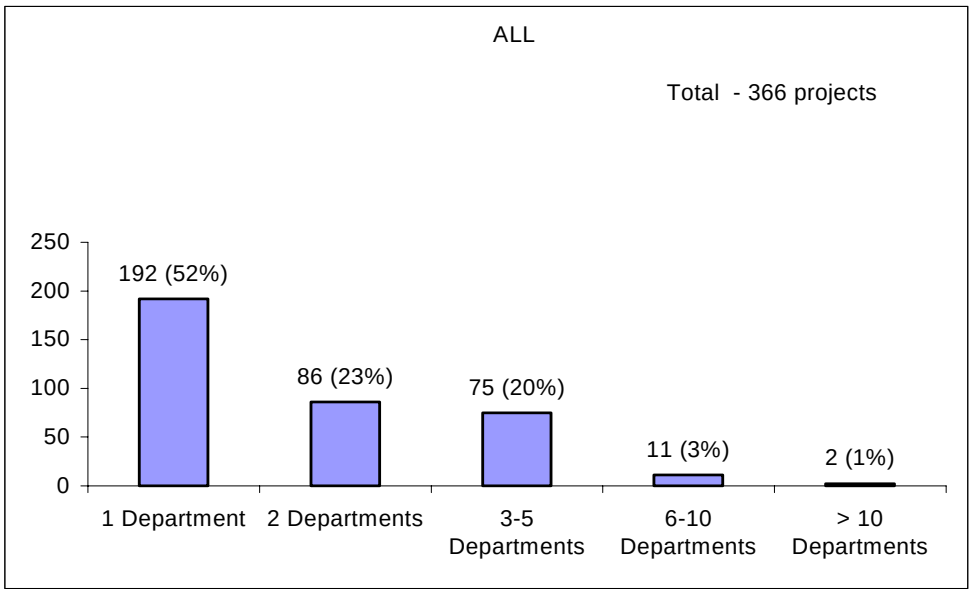
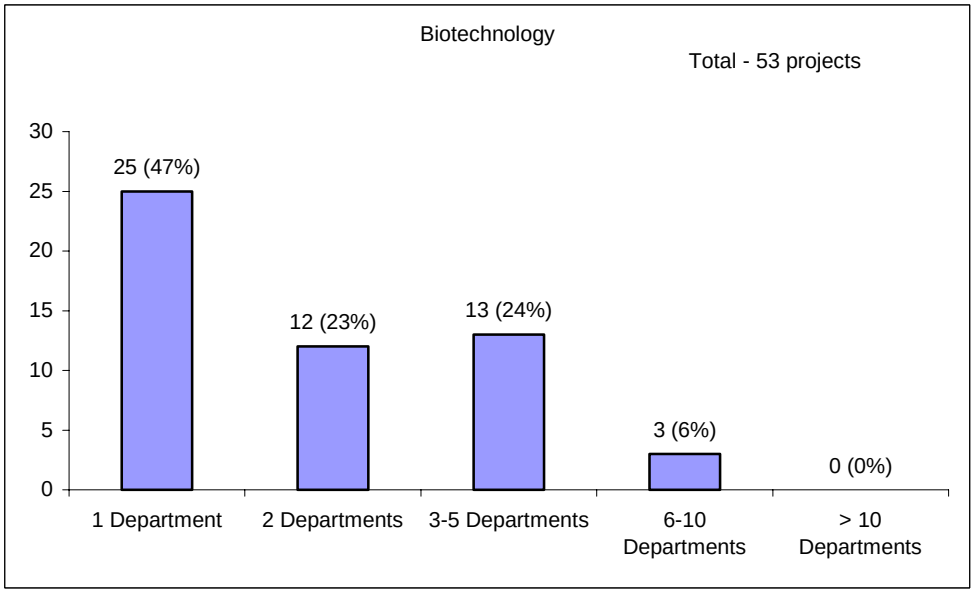


Figure 84a: Total number of departments per project in biotechnology



[27] Note that the analysis here refers only to THRIP projects.

Figure 84b: Total number of departments per project in ICT

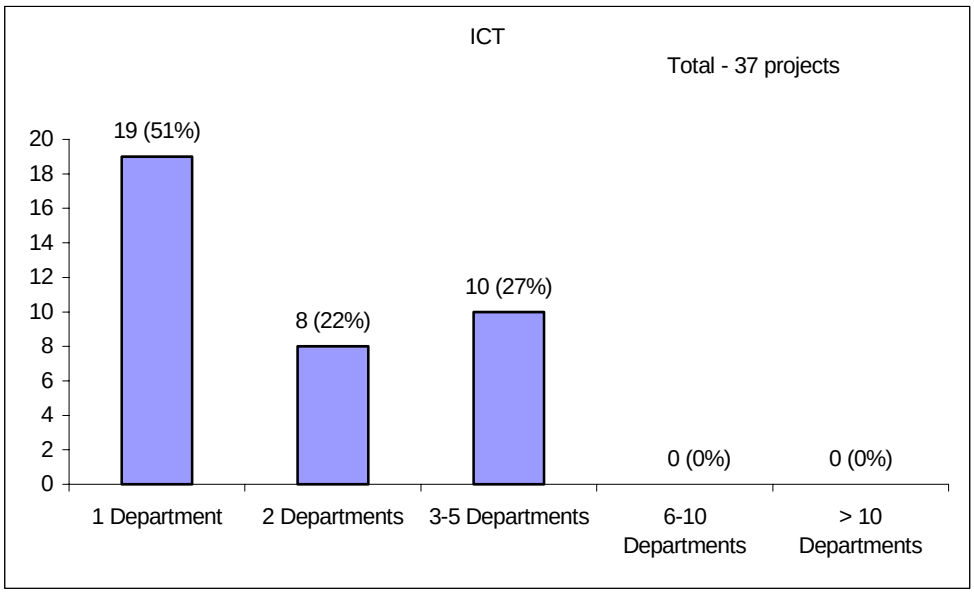
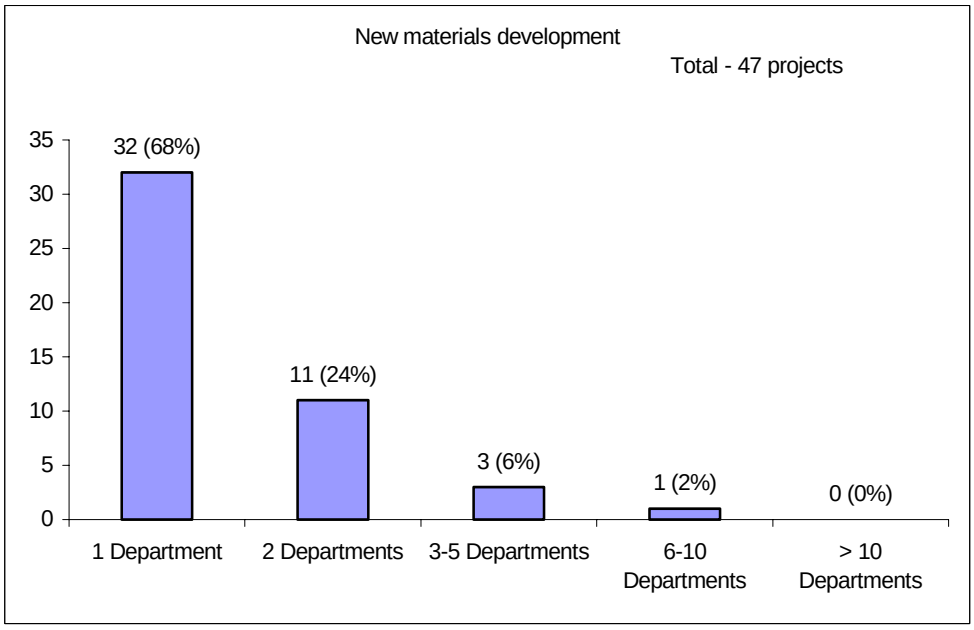


Figure 84c: Total number of departments per project in new materials development



10.3 INSTITUTIONAL LINKAGES

This section, building on the previous analysis, reviews the extent to which grant holders (primary beneficiaries) are working with researchers in departments and institutions other than their own. It does so in an attempt to further illustrate the number of links existing. It is important to note that linkages between researchers, institutions and departments are complex and interwoven. Whilst this section portrays

some of these linkages in as simplified a manner as possible, in many ways, it does so at the cost of showing the real complexity that exists.

These linkages are worth further and more in-depth study and analysis. The space and time of this study does not permit a more elaborate analysis. Nonetheless, it is clear that THRIP and Innovation Fund partnerships have enabled a myriad of networks between researchers, departments, institutions and industrial enterprises to emerge.

Table 5 refers to the researcher links within a department (i.e. between different individuals within a department), between different departments in the same institution and between different institutions. It shows that grant holders have a total of 312 links to other researchers. Of these total links, 157 (50%) are researchers in their own department; 80 (26%) are researchers in departments other than their own but in the same institution and 75 (24%) are researchers at different institutions. This shows that a total of 76% of the researcher links are in their own institution, and 24% in different institutions (Table 5a).

A similar distribution exists for all three technological bands. A review of biotechnology (Table 5b) shows, for example, that grant holders have a total of 25 (51%) researcher links within their own departments, 12 (24%) are researchers in departments other than their own but in the same institution and 12 (24%) are researchers at different institutions.

These findings suggest that a myriad of linkages have been formed but that these have, for the most part, been quite uneven with 76% of these links remaining in the researchers' own institution.

Table 5: Total departmental links by grant holder/primary beneficiary's department in THRIP projects[28]

Table 5a: For all projects

	No links	Links	Missing	Total
Own department	96	157	18	271
Other department	164	80	27	271
Other institution	167	75	29	271
TOTAL	427	312	74	813

Table 5b: For projects in biotechnology

	No links	Links	Missing	Total
Own department	10	25	1	36
Other department	21	12	3	36
Other institution	22	12	2	36
TOTAL	53	49	6	108

Table 5c: For projects in ICT

	No links	Links	Missing	Total
Own department	9	17	2	28
Other department	17	8	3	28
Other institution	17	8	3	28
TOTAL	43	33	8	84

Table 5d: For projects in new materials development

	No links	Links	Missing	Total
Own department	14	20	3	37
Other department	25	9	3	37
Other institution	25	6	6	37
TOTAL	64	35	12	111

Table 6[29] provides an analysis of directional researcher links. These links are considered '*directional'* in that it shows the number of links that grant-holder institutions have with other research institutions. As such, the *direction* of the analysis flows from the grant-holding institution outward. On the horizontal axis of this table is a list of grant-holder institutions and on the vertical axis a list of researcher institutions. The table is a subset of a bigger table and excludes weak linkages between grant-holder institutions and research institutions.

[28] Table 5 is based on only THRIP data. It totals 271 rather than 366 as in some cases departmental data was missing.
[29] The full analysis is indexed in Table 10 in Appendix E.

Table 6: Directional relationships between HEIs/SETIs

	UNIVERSITY OF STELLENBOSCH	UNIVERSITY OF CAPE TOWN	UNIVERSITY OF PRETORIA	UNIVERSITY OF THE WITWATERSRAND	POTCHEFSTROOM UNIVERSITY FOR CHE	UNIVERSITY OF NATAL Dbn.	ARC - Stellenbosch	CSIR - MININGTEK	UNIVERSITY OF THE WESTERN CAPE	UNIVERSITY OF THE FREE STATE	CSIR - FOODTEK	RHODES UNIVERSITY	CAPE TECHNIKON	CSIR - ENVIRONTEK	RAND AFRIKAANS UNIVERSITY	TECHNIKON PRETORIA	PORT ELIZABETH TECHNIKON	UNIVERSITY OF NATAL Pmb.	TECHNIKON NATAL	UNIVERSITY OF DURBAN-WESTVILLE	ML SULTAN TECHNIKON	UNIVERSITY OF PORT ELIZABETH	MEDICAL RESEARCH COUNCIL	TECHNIKON WITWATERSRAND	Total excluding researchers at own institution	Grand total
UNIVERSITY OF STELLENBOSCH	**165**	6	2			2	5	3	3					1									12		34	199
UNIVERSITY OF CAPE TOWN	4	**124**		1		1						1	1								1		1		10	134
UNIVERSITY OF PRETORIA			**99**					14						2											17	116
UNIVERSITY OF THE WITWATERSRAND		7	3	**87**				8	1															1	20	107
POTCHEFSTROOM UNIVERSITY FOR CHE					**62**		1	2						1											4	66
UNIVERSITY OF NATAL Dbn.			1			**38**								1	2						3				7	45
ARC - Stellenbosch	4						**20**	7	4							1								1	18	38
CSIR - MININGTEK								**29**					1												1	30
UNIVERSITY OF THE WESTERN CAPE							2		**20**															2	4	24
UNIVERSITY OF THE FREE STATE			1						3	**15**															5	20
CSIR - FOODTEK			2								**16**														2	18
RHODES UNIVERSITY					1	3					1	**12**													6	18
CAPE TECHNIKON	13												**4**												13	17
CSIR - ENVIRONTEK								7						**8**											7	15
RAND AFRIKAANS UNIVERSITY		1	1					1							**11**										3	14
TECHNIKON PRETORIA	1															**13**									1	14
PORT ELIZABETH TECHNIKON															2		**11**								2	13
UNIVERSITY OF NATAL Pmb.				1				5										**6**			1				7	13
TECHNIKON NATAL						1													**9**	1					2	11
UNIVERSITY OF DURBAN-WESTVILLE						5														**5**					5	10
ML SULTAN TECHNIKON						3															**5**				4	9
UNIVERSITY OF PORT ELIZABETH	1	1		1																		**5**			3	8
MEDICAL RESEARCH COUNCIL			1				1		1														**3**		3	6
TECHNIKON WITWATERSRAND		1		1	1										1									**2**	4	6
BORDER TECHNIKON								5																	5	5
TECHNIKON FREE STATE	1																								1	5
TECHNIKON NORTHERN GAUTENG						1																			1	5
CSIR - AEROTEK						1																			1	4
ARC - Roodeplaat			3																						3	3
ARC - PPRI	1		1			1																			3	3
CSIR	1											2													3	3
MINTEK								2												1					3	3
UNIVERSITY OF THE NORTH	1		2																						3	3
VAAL TRIANGLE TECHNIKON				1	2																				3	3
CSIR - MATTEK						1																			2	2
TECHNIKON MANGOSUTH						2																			2	2
UNIVERSITY OF FORT HARE						1																			2	2
UNIVERSITY OF SYDNEY	1	1																							2	2
(blank)	22	6	16	6	9	2		24				3		1	1	1	9		2	5						107
Total excluding researchers at own institution	**28**	**17**	**17**	**5**	**4**	**22**	**9**	**57**	**9**	**0**	**1**	**3**	**2**	**5**	**5**	**1**	**0**	**0**	**0**	**2**	**5**	**0**	**17**	**0**		**996**
Grand total	216	147	134	98	76	64	30	112	29	16	17	18	6	16	17	15	20	7	11	13	10	5	20	2		1117

Table 6 shows that CSIR-Miningtek, in instances where they function as the primary institution or grant holder, is dominant in establishing research networks with researchers elsewhere. In total they have research links with 57 researchers outside of CSIR-Miningtek. These research links are in 11 HEIs/SETIs. The researchers are from the following South African universities: University of Stellenbosch, University of Pretoria, University of the Witwatersrand, Free State University, University of Natal, RAU and Potchefstroom University for CHE. International universities include Louisiana State University. Only one technikon is involved with CSIR-Miningtek, i.e. Border Technikon.

The University of Stellenbosch is second dominant and in instances where they function as the primary institution or grant holders, they have research links to 28 researchers. These researchers are located at ten different institutions. The researchers are from the following South African universities: The University of Cape Town, the University of Port Elizabeth and the University of the North. International universities include the University of Sydney. Technikons include Cape Technikon, Technikon Pretoria and Free State Technikon. There are also links to researchers at Elsenburg Agricultural College.

The University of Pretoria is third dominant in that it has 17 researcher links at other institutions. These research links are in ten HEIs/SETIs. The researchers are from the following South African universities: University of Stellenbosch, University of the Witwatersrand and the Free State University, RAU, University of the North and the University of Natal. No international universities or technikons are involved in these links.

This analysis could continue for all the remaining institutions reflected in Table 6. The analysis provides an example of how such networks can be disaggregated and how the data in Table 6 should be interpreted and understood.

The University of Stellenbosch is dominant as an institution included as a research link in instances where other institutions function as the primary institution or grant holders. They have 34 auxiliary researcher links (these exclude cases where researchers operate as auxiliaries on projects where the University of Stellenbosch is the primary grant holder). These researchers work on projects at eight grant-holder institutions. The grant-holder institutions include the following HE institutions: The University of Cape Town, the University of Pretoria, the University of Natal and the University of the Western Cape.

The University of the Witwatersrand is second dominant as an institution included as a research link in instances where other institutions function as the primary institution or grant holders. They have 20 auxiliary researcher links (these exclude cases where researchers operate as auxiliaries on projects where the University of Witwatersrand is the primary grant holder). These researchers work on projects at five grant-holder institutions. The grant-holder institutions include the following HE institutions: The

University of Cape Town, the University of Pretoria and University of the Western Cape.

Again, this analysis could continue for all the remaining institutions reflected in Table 6. The analysis provides an example of how such networks can be disaggregated and how the data in Table 6 can be interpreted and understood.

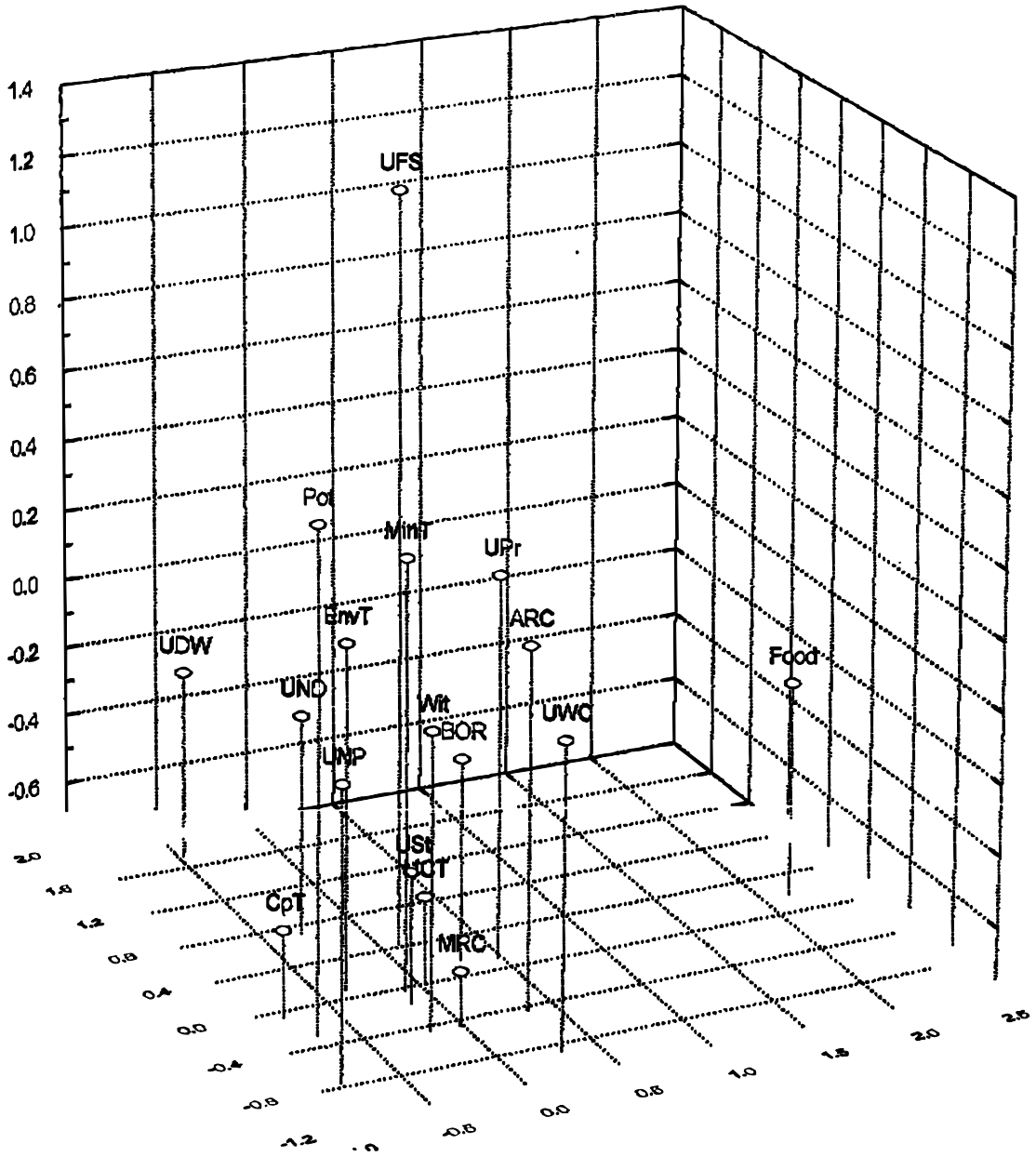
Table 7 represents non-directional researcher links between institutions. In this regard, Table 7 differs from Table 6. While Table 6 provides an analysis of '*directional*' researcher links in that it shows the number of links that grant-holder institutions have with other research institutions, Table 7 provides an analysis of all links between institutions. This means that it looks at which institutions are linked together based on a 'similarity matrix'. Unlike the findings presented in Table 6, this analysis does not move directionally from the grant holder, but rather simply focuses on linking institutions that have worked together on THRIP and/or IF partnerships. Such matrices are based on the assumption that institutions that are the most similar are the most likely to be linked. Whilst this figure is difficult to read, it cannot be mapped on two dimensions, as the relationships represented in this manner show too many linkages resulting in a visually messy spaghetti that, besides highlighting the density of networks and their complexity, remains for the most part quite unreadable.

According to the figure then, Mintek and the University of Stellenbosch are dominant in terms of linkages between themselves and other organisations. All of the organisations close to Mintek indicate a similarity to Mintek and those further away from Mintek, less similar. Those institutions close to Mintek include the University of Pretoria, University of the Witwatersrand, Agricultural Research Council (ARC), CSIR-Environtek, Border Technikon and the University of Natal (Pietermaritzburg).

The University of Stellenbosch, on the other hand, is grouped closely to the Medical Research Council (MRC), University of Cape Town, the University of the Western Cape and Cape Technikon.

Those institutions on the periphery of the figure (i.e. lying outside of the 'similarity groupings' and therefore having few strong linkages to other institutions) include the University of Durban-Westville, the University of the Free State and CSIR-Foodtek (now called CSIR-Bio/Chemtek).

Table 7: Non-directional relationships between HEIs/SETIs



CONCLUSION

This section merely provides a taste of the kind of statistical analysis of networks and linkages that can be undertaken and the value of the findings that could result. The analysis presented here suggests complex and interwoven networks existing in the partnerships funded by THRIP and the Innovation Fund. These would benefit from more in-depth study.

11

THE OUTPUTS

The outputs presented in this section were determined from the THRIP database and from the surveys of higher education beneficiaries of IF projects. The survey results were weighted in order that the totals provided in this section may approximate as closely as possible the reality.

In terms of THRIP and Innovation Fund partnership projects in the three technological areas, the total outputs are 8% (202) for products or artefacts; 4% (93) take the form of patents/artefacts; 36% (885) are research publications and 52% (1,293) of the outputs were students involved to gain experience in one of the three bands (Fig 85a and b). A comparison of the outputs produced by projects funded by THRIP and Innovation Fund outputs is provided in Figure 85b. It shows that while THRIP has more students involved and more publications, IF partnership projects have resulted in more patents.

Figure 85a: The outputs for all partnership projects in the three technological bands by THRIP and IF

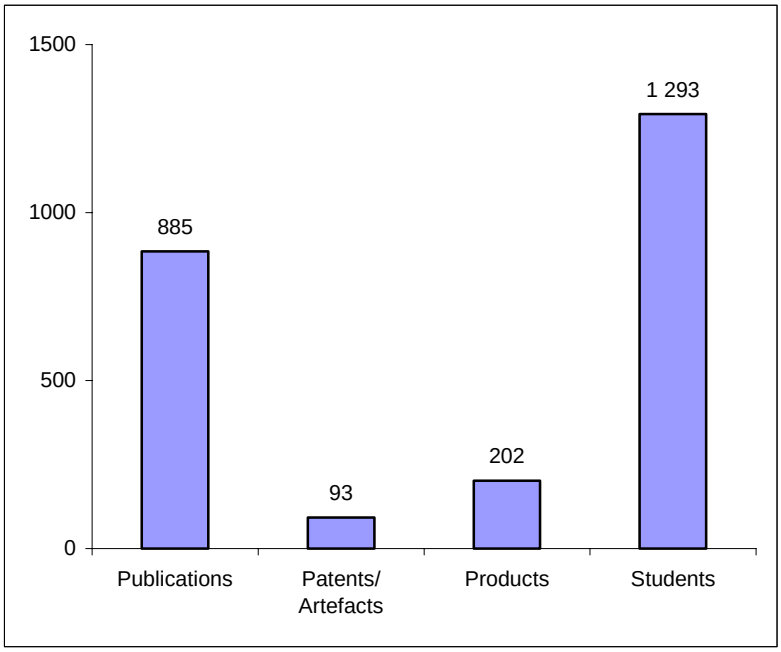
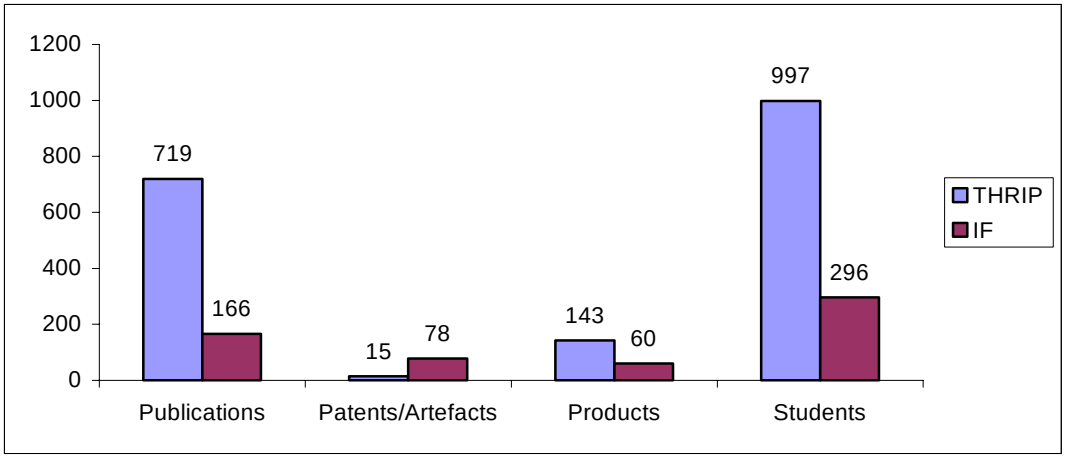


Figure 85b: The outputs for all partnership projects in the three technological bands for THRIP and IF



11.1 OUTPUTS BY TECHNOLOGICAL BAND

In the field of biotechnology (Figure 86a), the greatest output (61% of the total outputs) is that of student involvement. A further 34% of the outputs are research publications, 3.3% products or artefacts and 1% patents.

Outputs in the field of ICT show a similar distribution to the outputs for biotechnology. 52% of the outputs relate to student placements, 37% are research publications, 9.7% are products and artefacts and 1% are patents (Fig 86b). The outputs for new materials development also follow a similar distribution, the only exception being a marked increase in the total number of patents. In new materials development, 69 patents are produced.

The distribution of THRIP's TIPTOP candidates (see the section on THRIP's funding options for more detail) across the three bands is such that 45% of the candidates are placed in projects not within the three fields discussed here. 27% of the candidates are placed in the field of ICT, 22% in the field of new materials development and only 6% in the field of biotechnology (Fig 87).

Figure 86a: The outputs in biotechnology[30]

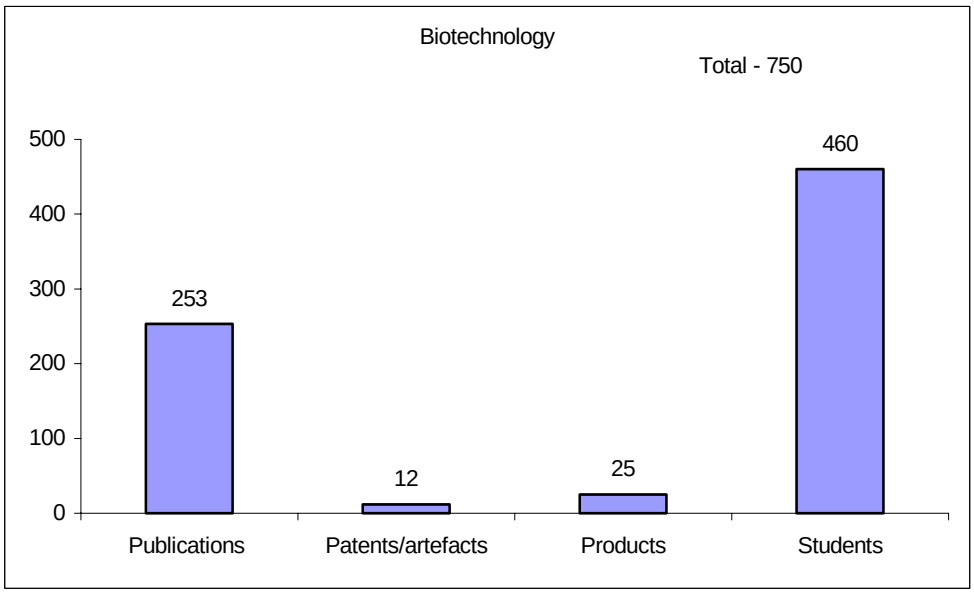
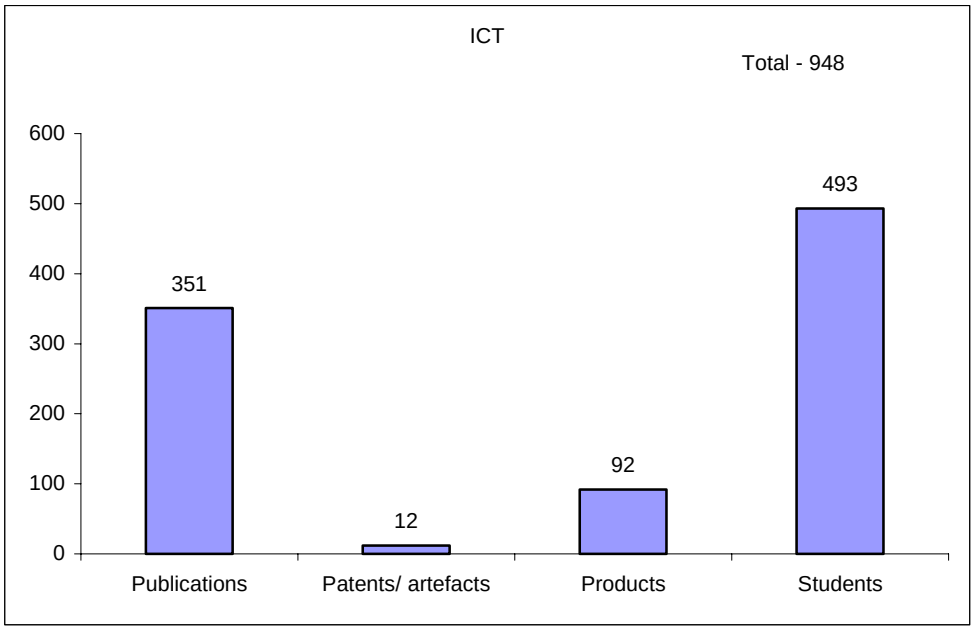


Figure 86b: The outputs in ICT[30]



[30] Note that the totals provided in this graph, particularly for Innovation Fund totals, may not (due to differences in the weightings applied for the total population and for each subfield), equal that provided in Figure 85b.

Figure 86c: The outputs in new materials development[30]

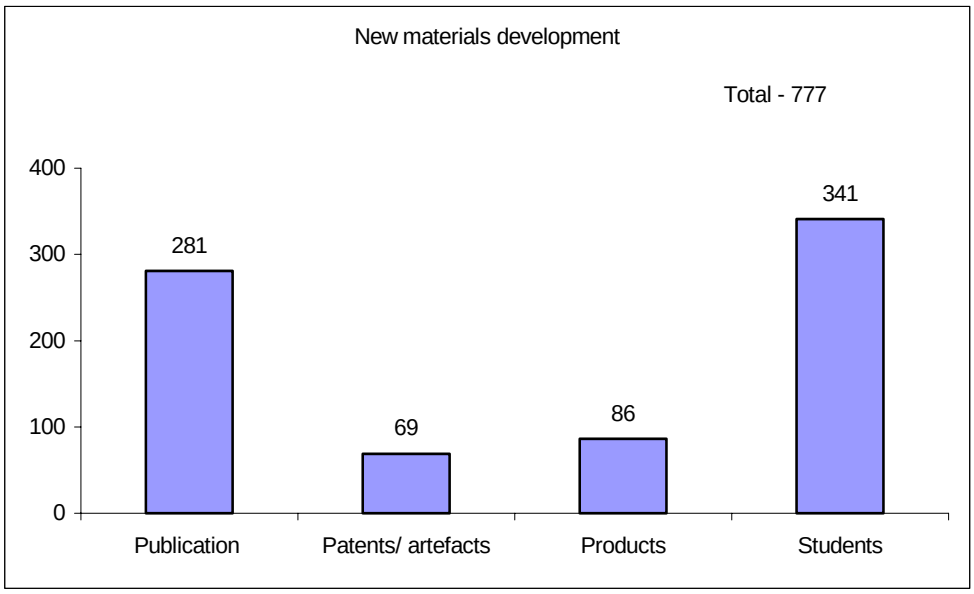
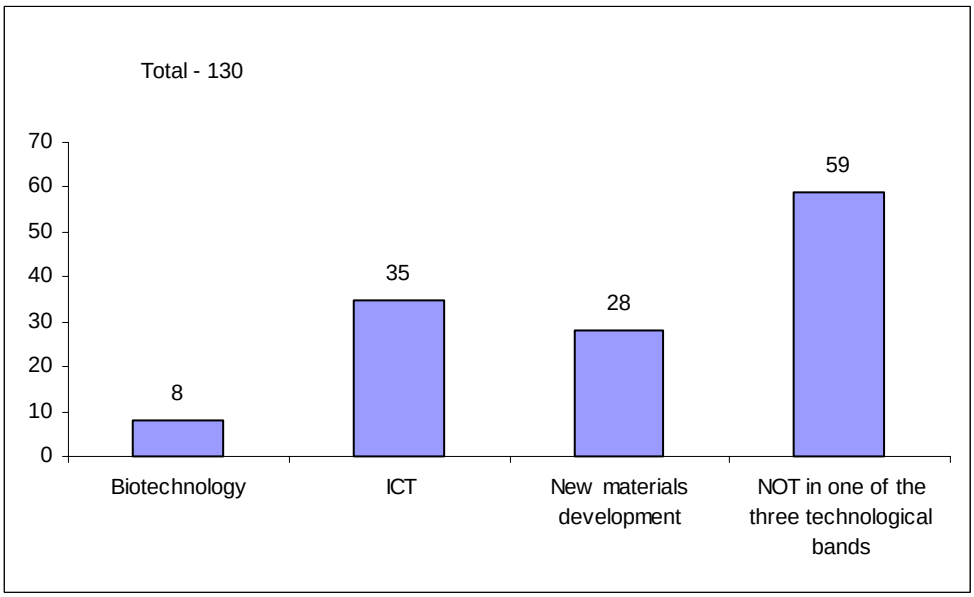


Figure 87: TIPTOP candidates by technological band



11.2 OUTPUTS BY INSTITUTIONAL TYPE

The following table represents the outputs by institutional type and by technological band. Universities are involved in the development of 79% of the outputs, while technikons are involved in 4% of the outputs (Table 8).

Universities are solely responsible for the total products/artefacts both in the fields of biotechnology and ICT and technikons are responsible for two products in the field of

new materials development. Overall, universities account for 85% of the products and technikons 1% (Table 8a).

Table 8b illustrates a similar distribution for the production of patents, with no patents being produced by a technikon. Overall, universities are involved in 23% of the patents produced and SETIs 77%.

In terms of the publication outputs (Table 8c), universities are responsible for the overwhelming majority of publications compared with technikons and SETIs. Nonetheless, the table does show that technikons are involved in the production of at least 31 publications linked to THRIP and Innovation Fund projects.

Table 8d reviews project outputs in terms of student placements and illustrates that the universities account for 78% of the student involvement, SETIs 17% and technikons for 7%.

Table 8: The outputs – by HEI type and by three technological bands

HSRC focus area	SETI	Technikon	University	Total
Biotechnology	133	32	584	749
Information communication technology	82	29	836	946
New materials development	185	38	554	777
Grand total	**400**	**99**	**1974**	**2473**

Table 8a: Outputs by institutional type and technological band for products/artefacts

HSRC focus area	SETI	Technikon	University	Total
Biotechnology	3	0	22	25
Information communication technology	14	0	78	92
New materials development	12	2	72	86
Grand total	**28**	**2**	**172**	**202**

Table 8b: Outputs by institutional type and technological band for patents

HSRC focus area	SETI	Technikon	University	Total
Biotechnology	2	0	10	12
Information communication technology	8	0	4	12
New materials development	62	0	7	69
Grand total	**72**	**0**	**21**	**93**

Table 8c: Outputs by institutional type and technological band for publications

HSRC focus area	SETI	Technikon	University	Total
Biotechnology	16	15	222	253
Information communication technology	30	9	311	351
New materials development	33	7	241	281
Grand total	**79**	**31**	**774**	**885**

Table 8d: Outputs by institutional type and technological band for students

HSRC focus area	SETI	Technikon	University	Total
Biotechnology	113	17	330	460
Information communication technology	30	20	443	493
New materials development	78	29	234	341
Grand total	**221**	**66**	**1007**	**1293**

11.3 INDUSTRY'S EXPECTATIONS IN RELATION TO PROJECT OUTPUTS

In the industry survey, a considerably high percentage of respondents (90%) commented that direct outputs were anticipated. Five per cent responded that no direct outputs were anticipated from the projects (Fig 88). These respondents indicated, however, that the reasons for the partnership with the HE institution were not based on direct outputs, but rather on more indirect or less tangible benefits. According to the respondents, these indirect benefits included knowledge gain, the use of HE research facilities, research inputs into technological development and improved efficiency in the research process.

In terms of industry's perceptions of what the intended project outputs will be (or have been), 22% anticipate new technological innovations and products; 19% anticipate improved human resource capacity within the enterprise; 18% anticipate the same improved HR capacity within HE institutions; 16% anticipate the output of commercially exploitable knowledge; 15% the production of increased public knowledge and 11% the increased stock of scientific knowledge (Fig 89). Data on already completed outputs (see Fig 85a) suggests that the production of products or artefacts is not yet aligned with industry's expectations and is presently at 4% of the total outputs. However, the development of human resource capacity (42%) has outstripped expectations. In addition, the production of public, scientific and commercially exploitable knowledge, in the form of publications, is also high in terms of current outputs (52%) and exceeds industry's expectations expressed here.

Figure 88: Industry expectation that there will be DIRECT products/outputs from research

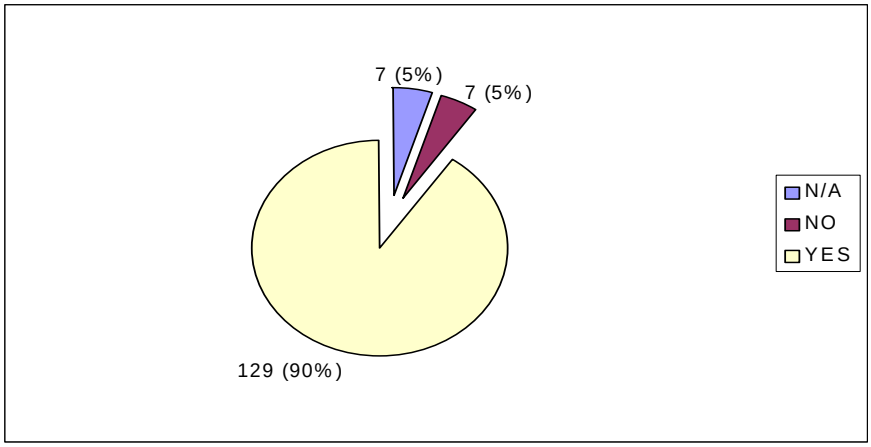
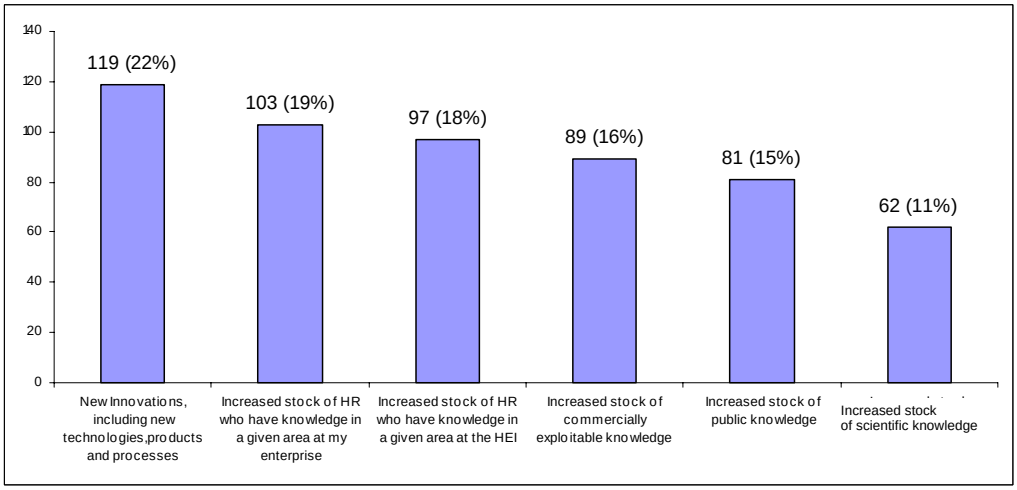


Figure 89: From industry's perspective, intended products



A full 93% of the industry respondents anticipate that the project outputs will be met and only 4% expect that the outputs will not be met (Fig 90). This illustrates a high level of confidence on the part of industry in the ability of HE-industry partnerships to deliver according to targets and expectations.

Figure 91 probes further into whether or not any additional applications, not initially envisaged as outcomes of the project, have been or are likely to emerge. As indicated, 57% of the respondents reported that they anticipate additional applications to result as part of the partnership projects. And 41% indicated that no additional outputs are likely.

Figure 90: From industry's perspective will the outputs be met?

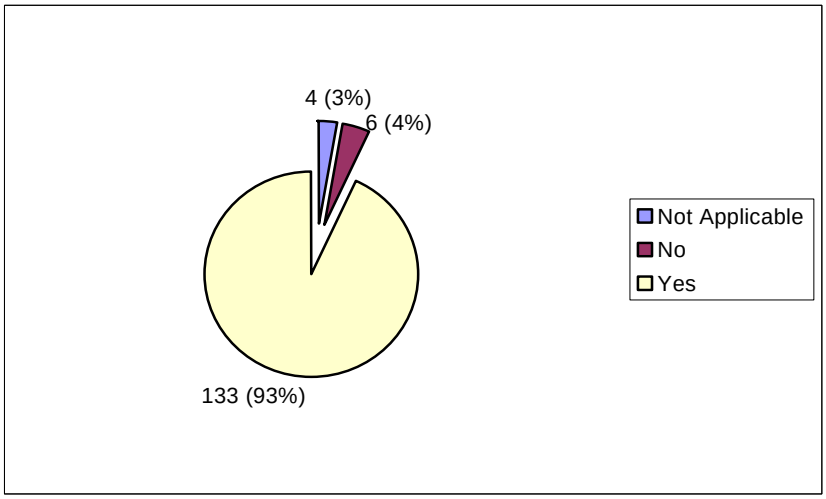
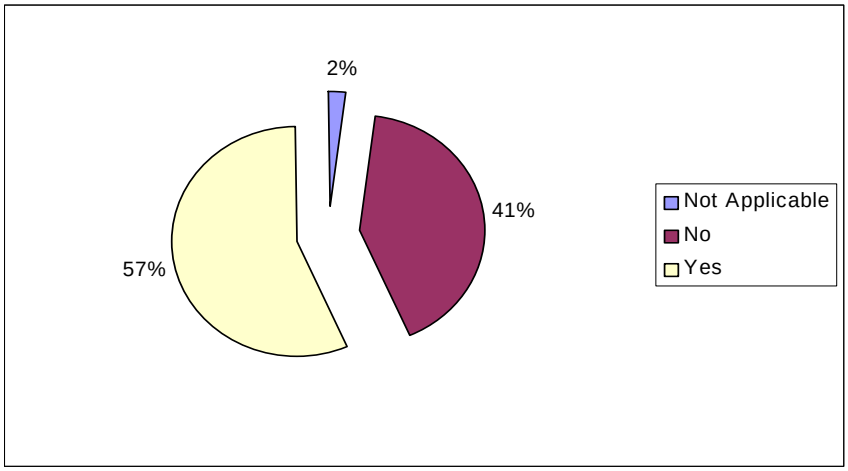


Figure 91: Are there new applications which were developed (or are being developed) that were not initially envisaged? –- industry's perspective



11.4 CONCLUSION

This section indicates that the primary outputs of THRIP and Innovation Fund projects remain the traditional forms of publications and the placement of students. Outputs in relation to publications and students currently outstrip industry's expectations but product or artefact outputs, indicative of innovation, are yet to be aligned with these expectations.

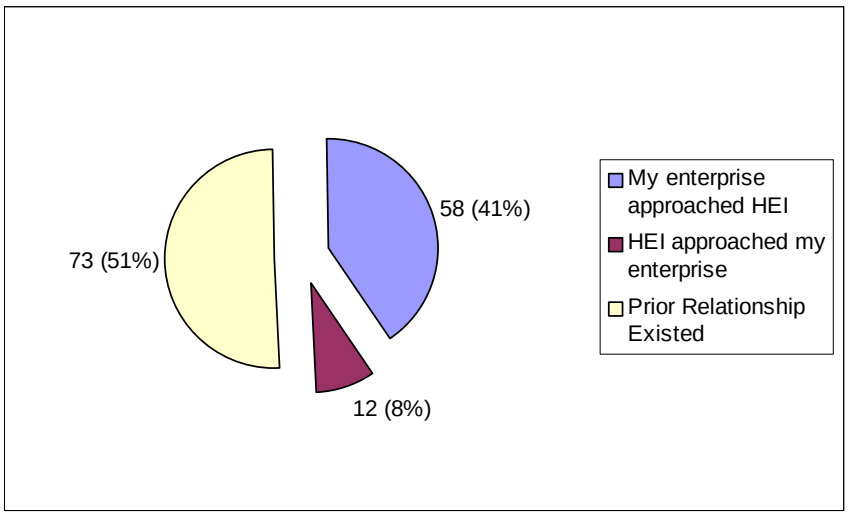
It is clear, however, that industry has a high level of confidence in the ability of HE-industry partnerships to deliver in accordance with project targets. In some instances, additional applications and products and targets, outside of those originally envisioned have resulted from the partnership project.

12

GOVERNMENT-FUNDED PROJECTS

Figure 92 reviews the manner in which industry's relationships with HE institutions were formed in relation to THRIP and Innovation Fund projects. The data was extracted from information obtained from the industry survey. As indicated, 51% of the respondents reported that their enterprise's relationship with the HE institution was based on a prior relationship. In 41% of the instances, the enterprise approached the HE institution and in only 8% of the cases, the HE institution approached industry. This indicates the extent to which previous relationships facilitate the development of HE-industry partnerships.

Figure 92: How the relationship with HEI that exists through THRIP/Innovation Fund project was initiated

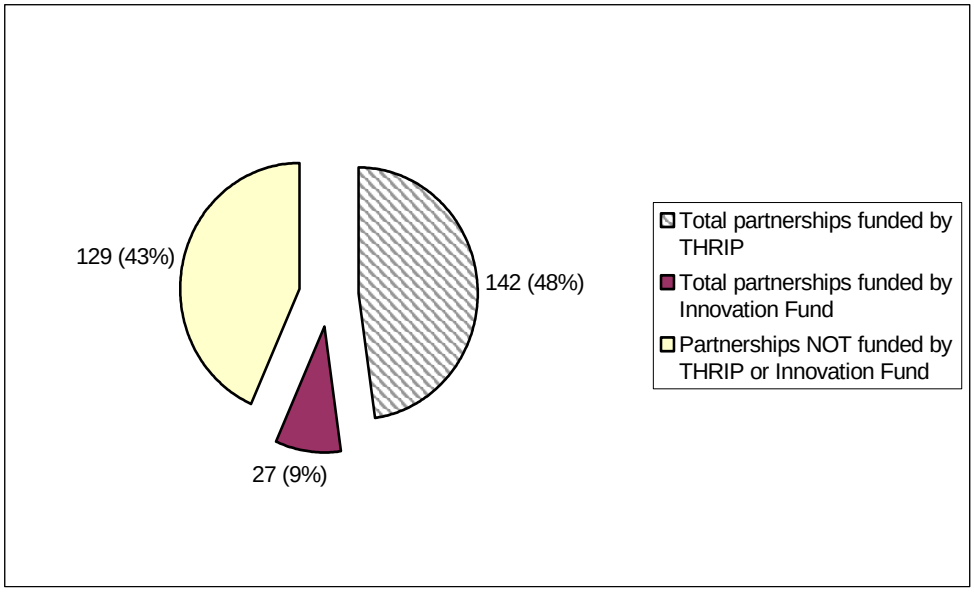


12.1 NUMBER OF PARTNERSHIPS INDUSTRY HAS WITH HE INSTITUTIONS

Figure 93 reviews the total number of partnerships that industry enterprises have with HE institutions, including THRIP and Innovation Fund partnerships, as well as other partnerships not funded by these organisations. The figure illustrates that slightly more than half of HE-industry partnerships are currently THRIP and Innovation Fund partnerships, with only 43% not funded by one of these two organisations. This

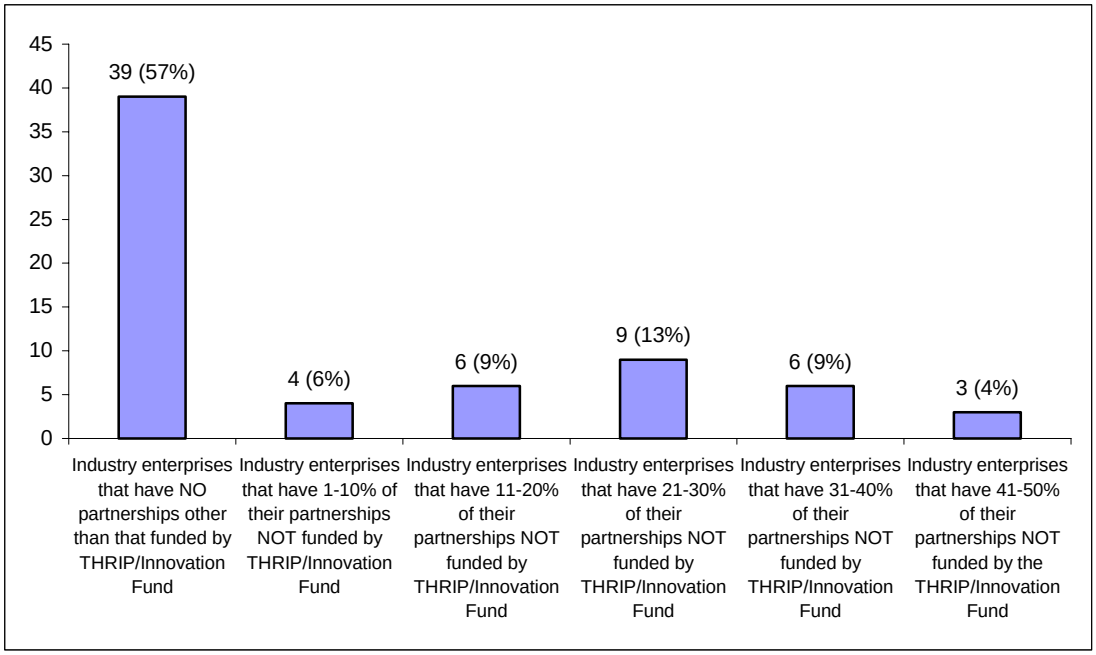
suggests that government funding is currently a critical contributor to the development of HE-industry partnerships in South Africa.

Figure 93: Total partnerships with HEIs: THRIP and IF-funded partnerships compared with total



In terms of the degree to which industry enterprises have partnerships that are not funded by THRIP or the Innovation Fund, 57% have no additional partnerships. A total of 43% of the enterprises have partnerships that are not funded by the Innovation Fund or by THRIP. Of these, 6% have non-THRIP and Innovation Fund funding for between 1% and 10% of their partnerships; 9% have non-THRIP and Innovation Fund funding for between 11% and 20% of their partnerships; 13% have non-THRIP and Innovation Fund funding for between 21% and 30% of their partnerships; 9% have non-THRIP and Innovation Fund funding for between 31% and 40% of their partnerships and only 4% have non-THRIP and Innovation Fund funding for between 41% and 50% of their partnerships (Fig 94).

Figure 94: The degree to which industry enterprises have partnerships that are or are not funded by THRIP/Innovation Fund



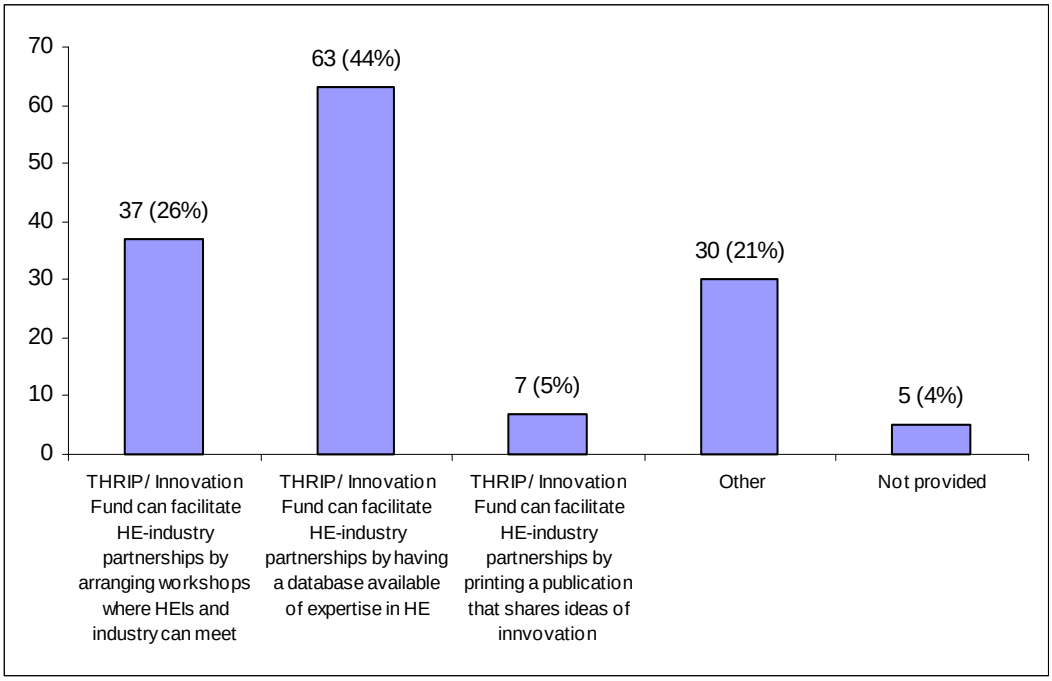
12.2 HOW TO IMPROVE HE-INDUSTRY PARTNERSHIPS

Industry respondents' perceptions of how the Innovation Fund and THRIP could take steps to improve relationships between industry and HE institutions shows that 26% believe that relationships could be improved by the provision of workshops where potential industry and HE partners could meet and review the possible benefits of such a relationship. 44% indicated that relationships could be improved by access to data which indicates what expertise is available in HE institutions. 5% indicated that relationships could be improved by an increased sharing of published information on technological innovation (Fig 95). 21% indicated other possibilities, which include the following:

- Longer-term financial commitment from the funding agencies—current year-by-year funding is seen to prevent longer-term planning and increased project outputs;
- Increased funding of projects to facilitate increased collaboration;
- Permitting greater flexibility in the administration of funds—it is commented that in-house industry-based research and development is not adequately recognised or supported;
- Increased emphasis on assisting HE institutions to focus on product development rather than just research outputs; and

- Matching specific industry requirements with corresponding expertise at HE institution.

Figure 95: Steps that THRIP and the Innovation Fund can take to improve the relationship between industry and HEI

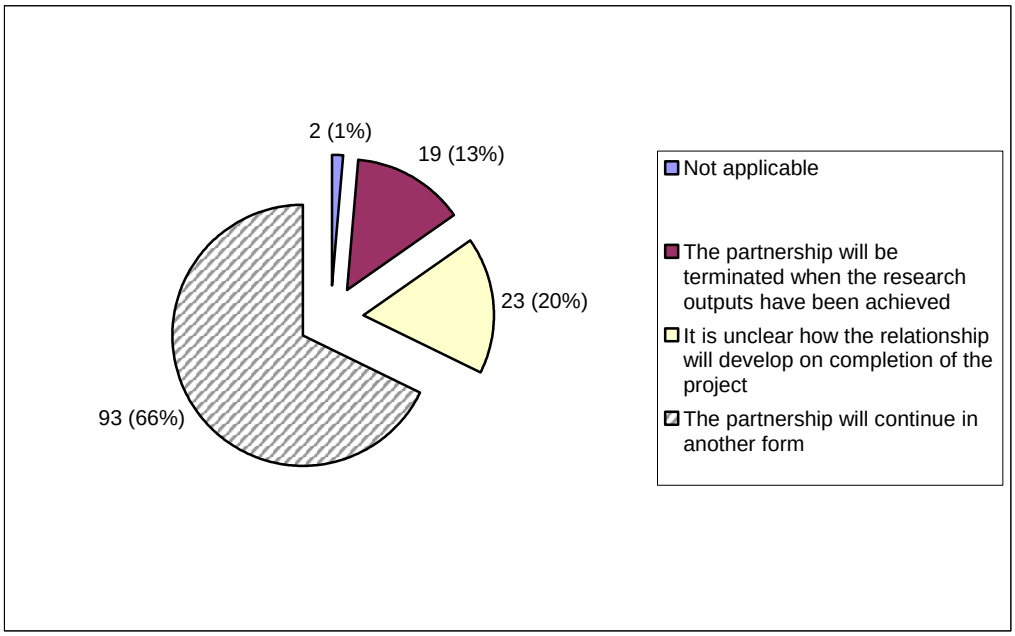


12.3 TERMINATION OF THRIP AND INNOVATION FUND PARTNERSHIPS

In the industry survey, respondents were requested to indicate if current HE-industry partnerships would be terminated on project completion, and if so, how this termination would be performed.

A full 93% of the respondents indicated that the relationship with HE institutions will continue on project completion in another form. This is an extremely positive indicator of the durability and sustainability of partnerships where the benefits of the relationship are perceived as mutually beneficial and the outputs are both innovative and successful. This finding suggests that industry's experience on THRIP and/or Innovation Fund projects has led to a new way of viewing research and development as a form of synergistic collaboration, where academia and industry are brought together within the framework of a mutually reinforcing relationship. A further 20% indicated that the future of the relationship has yet to be determined or is currently not clear. Only 13% of the respondents indicated that the relationship would be terminated on completion of the project (Fig 96).

Figure 96: Indications of how/if the relationship will be terminated



Section E

CONCLUSION

13

CONCLUSION

This study shows that THRIP and the Innovation Fund have made a marked contribution to incentivising higher education-industry linkages in the three technological bands as well as in other technological areas. In this regard, it has shown that:

- THRIP and the Innovation Fund incentivised a large number of partnerships between industry and higher education. A total of 423 projects were incentivised, with 366 of these in the three technological fields of biotechnology, ICT, new materials development, identified as priorities for innovation.
- THRIP and the Innovation Fund make a marked financial contribution to incentivising higher education-industry linkages in the three technological bands, as well as in other technological areas. THRIP and the Innovation Fund have resulted in a total of R869.1 million being spent on HE/SET-industry linkages and a total of R309.6m on projects in the three technological bands. In this respect, THRIP's strategy of providing matching funding for projects resulted in a large investment being made by industry into these projects. In total, industry invested R308.6m during 2001 to 2002 for research.
- THRIP and the Innovation Fund have impacted on the number of industry partners involved in higher education partnerships. The findings show that THRIP and Innovation Fund projects involve 573 industry partners and that many of these partners are involved in two or more projects, with some involved in as many as eleven projects.
- Equally, THRIP and the Innovation Fund have impacted on the HEI/SETIs in that their projects have involved 41 HE/SET institutions as primary beneficiaries in the partnership. The study has highlighted partnerships that build complex and intensive networks between HE institutions and between departments both within and across institutions.
- One of the most marked achievements is highlighted in the attitude of industry. The study shows that industry views the relationship with HEI/SETIs as a collaborative relationship or a partnership in which there is a commitment

to a common set of goals and overall objectives, rather than a 'business arrangement'. Generally, the research has shown that industry partners on THRIP and Innovation Fund projects show a high level of commitment to HE-industry partnerships in terms of the dedication of human resources to these initiatives. Moreover, industry motives for engaging in these partnerships are linked to issues such as access to research facilities and expertise and to human resource development, rather than just to narrow motives of financial gain and increased competitiveness.

- It shows that these projects have resulted in 1 293 students being involved in research teams and a total of 885 publications being produced. Contrary to concerns raised in the literature that the traditional role of higher education may be jeopardised, these partnerships have resulted in increased publications; that basic rather than applied research is supported and that in many cases a sharing of intellectual property between the industry enterprise and the HE institution(s) takes place.
- In terms of technological advancement, the projects funded by THRIP and the Innovation Fund resulted in a total of 35 patents and 296 artefacts being produced, suggesting that these projects have made a significant contribution both to research but also to industrial innovation in South Africa.
- The study, through the network analysis undertaken and presented in Chapter 10, indicates that a myriad of networks exist in the partnership projects funded by THRIP and the Innovation Fund. An important finding highlighted in this chapter is that biotechnology and ICT appear, on the whole, to consistently show patterns of partnership with other disciplines and other institutions while new materials development consistently differs from this pattern. This may suggest marked differences between the knowledge fields and the way in which they operate.

Together, these findings provide the basis for re-assessing concerns that HE-industry partnerships may impact negatively on the traditional role of higher education. They suggest that the partnerships have resulted in tangible benefits with advantages being gained on both sides. This does not attempt to suggest that all HE-industry partnerships are inherently beneficial, but rather that THRIP and Innovation Fund partnerships do appear to have rested on a formula where mutual benefit is obtainable and which represent exemplars of how HE-industry partnerships can be used to develop science, technology and innovation in South Africa.

GLOSSARY

Responsiveness: As first used in the South African higher education policy context, the term implies that higher education should take seriously the problems and challenges presented by the societal context in which it operates.

Networking: A feature of the new global economy is the seemingly paradoxical rise of relations of both competition and co-operation in the form of networking between firms in related product markets. Constant product market innovations, technological breakthroughs, access to expertise and a skilled workforce are often beyond the means of a single firm, but are feasible through co-operation amongst a number of firms. By collaborating around research and development (R&D), training, marketing and producer-supplier relations, firms gain access to the knowledge and expertise of other firms, reduce the cost of R&D, and through joint innovation are able to design new products and processes.

The networking society: Improving the nation state's competitiveness is increasingly dependent on the complex interaction between historically-rooted political institutions and increasingly globalised economic agents. For Castells, what becomes crucial for competitiveness in the 'new' global economy is dependent on the political capacity of national institutions to steer growth strategies.

Three technological bands: Biotechnology, information and communication technology, and new materials development.

Black is used in this publication to refer to African, Indian and coloured students and staff.

Higher Education: Refers to Higher Education as defined in the Higher Education Act 1997 (Act No. 101 of 1997).

Primary beneficiary: This term has been adopted by THRIP and refers to the main beneficiary or higher education grant holder of each project. The main THRIP contract is a document signed between THRIP and the grant holder at the higher education institution.

Secondary beneficiary: Secondary beneficiaries are defined as the industry partners on a project.

Auxiliary beneficiary: These are research staff at HEIs or SETIs who form part of the project research team.

Students: This includes students who work on or are funded through the project.

Primary institution: This refers to the HE institution or SETI that holds the research contract.

Auxiliary institution: This refers to the HEIs/SETIs at which auxiliary researchers are located.

Transdisciplinary: Term coined by Gibbons et al that refers to transdisciplinary, rather than multidisciplinary forms of knowledge. In this mode of knowledge production, the applied context becomes the primary locus, rather than the traditional realms of academic institutions, departments and disciplines.

Mode 2 knowledge: Coined by Gibbons et al refers to 'Mode 2' knowledge, where knowledge and information, traditionally produced in the academic realm, is increasingly linked to forms of application required in the economic and development sectors. 'Mode 2' knowledge is viewed by Gibbons et al as a 'transdisciplinary', rather than multidisciplinary form of knowledge. In this mode of knowledge production, the applied context becomes the primary locus, rather than the traditional realms of academic institutions, departments and disciplines. As such, research teams that bridge the traditional disciplinary and institutional boundaries are established around the locus of an economic or social problem.

Threefolding: This is a concept towards understanding the 'new social landscape'. It recognises that the forces, capacities and resources to change the world are clustered in the hands of business, government and global civil society. It acknowledges that government, business and civil society will naturally emphasise different aspects of society as a whole, nevertheless, the boundaries between these three realms are fluid and actions of key institutions are bound to have an impact beyond their own natural habitat and realm. When key institutions of social life are aware of their institutional powers they can make a big difference in societal transformation through 'autonomous interaction' that can advocate for and achieve genuine or comprehensive sustainable development.

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APPENDIX A – INTERVIEW SCHEDULE FOR THE INTRODUCTORY MEETING*

1. **Can you tell us a little about THRIP?**
    a. History of THRIP
    b. Mission of THRIP
    c. Success of THRIP

2. **Which partnerships have been forged by THRIP?**
    a. Total Number of Partnerships
    b. Nature of partnerships
    c. Industry and higher education institutions involved (Universities and/or technikons. Public and/or private)
    d. Overall impact of THRIP on innovation and knowledge production in these areas? Which Indicators have been used: Patents, Publications, Students Graduated, Any others?

3. **Which Partnerships have been forged in THRIP in the area of biotechnology, materials development and ICT?**
    a. Does THRIP have a policy of encouraging partnerships in scarce skills areas?
    b. Total partnerships forged in these three areas?
    c. Nature of the partnerships?
    d. Industry and higher education institutions involved (Universities and/or technikons. Public and/or private)

    Overall impact of THRIP on Innovation and knowledge production in these areas? Which Indicators have been used: Patents, Publications, Students Graduated, Any others?

* The Appendices that follow are facsimile copies of the original research instruments.

APPENDIX B – THRIP PROJECT DATA ISSUES

File format

Format

The original data were presented on request by the research team, in the form of five Excel worksheets:

- Industry Partners
- Institution
- Grant Holders
- Budgets
- Teams

Issues

There are two issues with this flat file format:

- there is much duplication of information which:
  - wastes space
  - allows for inconsistent entries in different worksheets
- extracting related information from more than one worksheet is fairly cumbersome and therefore error prone.

Examples

Duplication

- duplicate records exist for Grant Holders and Researchers who are involved in more than one project. This duplication makes the counting and summarizing of so-called "warm bodies" as distinct from "research links" a lot more difficult to do in a consistent way.
- Institution appears in Institution, Grant Holders and Teams worksheets
- Department appears in Grant Holders and Teams worksheets

Inconsistencies

- Botany, Department of Botany, Phychology Unit Botany Department…

Related information

- Establishing whether the Grant Holder, in one worksheet, and the Team member, in another, belong to the same Institution and Department involves a lookup based on project ID, which can be automated, but the comparison of "Botany"with "Phychology Unit Botany Department" cannot. I generated short Department names by stripping out "Department of" etc. but the final cleaning of the "Phychology Unit" and spelling mistake inconsistencies was manual and time-consuming.

Missing data

Missing Department and/or Institution names limited the networking analysis to some extent.

A relational database

A relational database will be required for this data and analysis. An appropriately designed relational database minimises duplication and inconsistencies as well as dealing with the inter-relationships between the different "areas" of the data.

The data could be arranged in the following *tables*:

1. **Project** containing
   - Project ID
   - Title
   - Focus
   - Grant Holder

   with links to:
   - **Annual Record**
   - **Person**

2. **Annual Record** to deal with project details that may change from year to year:
   - Funding
   - Outcomes

   with links to:
   - **Person** via **Researcher** *junction table* to deal with the possible many-to-many relationships. A single researcher may work on many projects in a year and a single project may involve many researchers in a year.
   - **Industry Partner** via **Partner** *junction table* (as above).

3. **Person** containing Grant Holder and Researcher details because a single person may fulfil both roles.

4. **Institution-Department** combination – with links to:
   - **Person**

5. **Industry Partner**

6. An **Institution** *lookup table* would reduce duplication and ensure consistency.

APPENDIX C – COPY OF QUESTIONNAIRE SENT TO INNOVATION FUND HIGHER EDUCATION BENEFICIARIES

THE NETWORK SOCIETY – AN AUDIT OF INDUSTRY BENEFICIARIES

HSRC

QUESTIONNAIRE

To be completed by the higher education beneficiaries of Innovation Fund Project

THE INNOVATION FUND

Human Sciences Research Council

INSTRUCTIONS

1. Please answer all the questions as fully as possible.
2. Please **keep copies** of all returned questionnaires.
3. Before posting the questionnaire, please use the checklist on the back cover to check that you have completed all the requirements.
4. Please return the questionnaires to L. Powell Consultancy by the **XXX of XXXMonth 2002** to enable researchers to process the information as quickly as possible.
5. Return questionnaires to Lesley Powell, 29 First Avenue, Westdene, 2092 or Fax to: 011-477-3063 or email to lesleyp@worldonline.co.za.
6. If there are any queries address these to Lesley Powell at 011-673-3039 or lesleyp@worldonline.co.za

SECTION A - TELL US ABOUT YOURSELF

A1 Name _____

A2 Race (Please tick the appropriate square)

African ☐ Indian ☐ Coloured ☐ White ☐ Asian ☐

A3 Gender (Please tick the appropriate square) Female ☐ Male ☐

A4 Citizenship? (Please tick the appropriate square) South African ☐ Other ☐

A5 Department/centre/ unit _____

A6 Contact details

Physical Address (Street Address) _____

_____

Postal Address _____

_____

Telephone Number ( )_____

Fax Number ( )_____

Email Address _____

SECTION B - TELL US ABOUT THE INNOVATION FUND PROJECT

B1 **What is the Project Number?**

B2 **Name the Industry Companies and/or enterprises involved in the project and for each please provide the name and contact details of the main contact person**

Industry Enterprise or Corporation	Contact Person(s)	Phone No (W)	Cell Number	Email Address

B3 **Name any other Higher Education Institution(s) involved in the project (excluding your own institution) and for each please provide the name and contact details for the main contact person.**

Higher Education Institution	Contact Person(s)	Phone No (W)	Cell Number	Email Address

B4 **Please indicate which discipline your project falls into by ticking the appropriate square**

Biotechnology ☐

Information Communication Technology ☐

New Materials Development ☐

If Other, please indicate the discipline_____ ☐

SECTION C - TELL US ABOUT THE OTHER STAFF (INCLUDING RESEARCHERS AND STUDENTS) INVOLVED IN THE PROJECT AT YOUR UNIVERSITY

Please provide details of the researcher(s), other than yourself who are involved in the project by completing the table below. Please note that 'researchers' could include students and university staff members who are working as researchers in the project.

C1

Title	Initial	Surname Provide the surname of the researcher	Race 1=African 2=Coloured 3=Indian 4=White 5=Asian	Gender 1=Male 2=Female	Highest Qualification Please provide the highest qualification where: 1=Degree, 2=Degree+diploma, 3=Honours, 4=Masters, 5=Doctorate	Department Provide the name of the Department or Unit that the researchers is located. For example: Department of Biotechnology or Department of Forestry	Category of person involved Please indicate if the person is a student or a staff member of the university, where: 1=Student, 2=Researcher employed as a university staff member

SECTION D - INVOLVEMENT WITH INDUSTRY DURING THE PROJECT

D1	**Does your project involve higher education staff or students spending time (as staff or student placements) in industry OR vice versa?**	Yes	No

IF YES, PLEASE ANSWER THE FOLLOWING:

D2	**What is the total number of HIGHER EDUCATION STAFF that spent time in industry?**	
	What is the total number of HIGHER EDUCATION STUDENTS that spent time in industry?	
	What is the total number of INDUSTRY STAFF that spent time in higher education institutions?	

SECTION E - TELL US ABOUT THE OUTPUTS

E1 Please provide details on the outputs of your project

Project ID	Year	Students	Team Members	Research Publication(s)	Patents	Products/Artifects
		Provide total number of students who were involved	Provide total number of Higher Education team members involved	Provide total number of research publications	Provide total number of patents that resulted from the project	Provide total number of artefacts that resulted from the project.
	Round 1					
	Round 2					
	Round 3					

APPENDIX D – COPY OF THE QUESTIONNAIRE SENT TO INDUSTRY PARTNERS OF BOTH THRIP AND THE INNOVATION FUND

THE NETWORK SOCIETY: AN AUDIT OF INDUSTRY BENEFICIARIES

HSRC

QUESTIONNAIRE

To be completed by the Industry Enterprises involved in Innovation Fund and THRIP Projects

HUMAN SCIENCES RESEARCH COUNCIL

Dear Participant

Thank you for agreeing to complete this questionnaire. The questionnaire forms part of a larger study, funded by the Carnegie Corporation, that aims to investigate the phenomenon of networking and partnerships between industry and Higher Education institutions and the influence of this on the emergence of new forms of knowledge production and the development of commercial innovations.

In conjunction with the baseline data gathered from THRIP and the Innovation Fund, this specific survey, endorsed by THRIP and the Innovation Fund, aims to determine the industry perspective of higher education partnerships.

Before completing the survey, please note carefully the following:

1. This questionnaire has been designed to determine you r perspective of the higher education-industry linkage. Please complete the questionnaire yourself by providing, where requested, your personal perpectives, rather than the policy statements of the company for which you work. The data will be presented in aggregated format in the final report and the perspectives expressed by individuals will not be held as confidential.

2. Please answer all the questions as fully as possible.

3. Please **keep copies** of all returned questionnaires.

4. Abbreviations used in the questionnaire:

   - HE - Higher Education
   - THRIP - Technology and Human Resources for Industry Programme
   - N/A - Not Applicable

5. Please return the questionnaire to LPowell Consultancy by the **21st of October 2002** to enable researchers to process the information as quickly as possible. Return the questionnaires to June Knight, 29 First Avenue, Westdene, 2092 or Fax to: 011-477-3063 or email to: junek@worldonline.co.za.

6. Queries may be addressed to June Knight at 011-673-3039 or at junek@worldonline.co.za.

Please provide your contact details:

Name _____

Phone Number _____

Fax Number _____

Email Address _____

A. ABOUT THE RELATIONSHIP OF THE ENTERPRISE WITH HIGHER EDUCATION

A1

What is the total number of industry-higher education linkages that the enterprise is involved in?	Number of partnerships
Total number of THRIP partnerships	
Total number of Innovation Fund partnerships	
Total number of any other Higher Education partnerships not funded by THRIP or the Innovation Fund	
GRAND TOTAL (combined total of the above)	

A2

What are the main purpose(s) of industry- higher education linkages that ARE NOT funded by THRIP or the Innovation Fund that the enterprise may be involved in? Please tick one or more of the following

My organisation has no industry-higher education linkages other than those funded by THRIP and/or the Innovation Fund	Ä	Accreditation and/or quality assurance of education and training	Ä
Research	Ä	Learning Programmes & Curriculum Design	Ä
Human Resource Capacity Building	Ä		
Other (please specify)			

B.

B. ABOUT THE RELATIONSHIP(S) WITH HIGHER EDUCATION FUNDED BY THRIP AND THE INNOVATION FUND

B1 **Please provide the project numbers of the THRIP and/or Innovation Fund partnership that your enterprise is involved in.**

B2 **Select from the list below the top five reasons why your enterprise has relationships with higher education. You can do this by indicating in the squares provided the numbers 1 to 5, in order of priority, where 1 represents the top motivation. Please note that this question should be based on your own perspective, rather than on the mission or strategic vision of the enterprise.**

To gain added technological value to the company which will lead to future financial gain	Ä	To contribute to the equity of my organisation's workforce by contributing to the training of black students and female students	Ä
To gain added technological value which will lead to improved manufacturing and/or working processes	Ä	To gain access to research technology and infrastructure available at Higher Education institution(s) that are not available at my enterprise	Ä
To gain added knowledge which will lead to improved understanding amongst staff	Ä	To gain access to high level expertise and research expertise available at Higher Education institution(s) that are not available at my enterprise	Ä
To contribute to the marketing of your company	Ä	To contribute to sustained innovation in my sector	Ä
To gain tax rebates	Ä	To gain access to increased research and development capacity as my company has limited internal Research and Development (R&D) capacity	Ä
To maintain the competitive edge of my enterprise	Ä	To keep abreast of advancing technologies	Ä
To contribute to the social development of South Africa	Ä	To access highly trained human resources for employment in the company	Ä
It costs less to outsource the R&D aspects that are outsourced than to do them in-house	Ä		

C. SELECTING THE PARTNERS FOR THRIP AND/OR INNOVATION FUND PROJECTS

C1 **Did the enterprise select the higher education institutions involved in the THRIP and/or Innovation Fund industry-higher education linkage? (If the higher education institution approached the company indicate NO)**

Ä Yes
Ä No

C2 **If YES, what criteria were used to select the higher education institutions? Please indicate by selecting from the square. (More than one square may be ticked)**

It was the Higher Education institution/s who approached our organisation	Ä	They were selected because they have the HUMAN RESOURCES available at institution	Ä
They were institutions that the company had previous relationships with	Ä	They were selected for the general reputation of institution	Ä
They were selected for being Historically White Institutions	Ä	They were selected because of the appropriate costs of services they provide	Ä
They were selected for being Historically Black Institutions	Ä	They were selected because of their particular research expertise	Ä
They were selected because they have the physical and infrastructural resources (NOT human resources) available at institution	Ä	They were selected because they have a reputation for expertise in a needed area	Ä
They were selected on the basis of the geographical location of institution	Ä		

C3 **If there are other industry enterprises involved in the THRIP project and/or Innovation Fund projects, did your enterprise select some or all of these enterprises? (If there are no other industry enterprises involved, respond by selecting N/A)**

Ä Yes
Ä No
Ä N/A

C4 **If yes, what criteria were used to select them? Select from the list below**

Ä They were companies/ enterprises working in different fields who would not compete with the technological products produced

Ä They were companies/ enterprises working in the same field who could also use the technology

Ä They were companies/ enterprises that my company had prior or current working relations and partnerships with

Ä Other. Explain _____

_____

D. ABOUT THE BENEFITS OF THE RELATIONSHIPS FUNDED BY THRIP & THE INNOVATION FUND

D1

From your perspective, what are the benefits of the higher education-industry linkage project funded by THRIP/ Innovation Fund? Use the space provided below for your response.

BENEFITS TO YOUR ENTERPRISE	BENEFITS TO HIGHER EDUCATION INSTITUTION(s)

E. ABOUT THE MANAGEMENT OF THE PROJECT(s) FUNDED BY THRIP & THE INNOVATION FUND

E1 **What is the total number of people involved in the project funded by THRIP and/or Innovation Fund?**

Total number of researchers/subject matter experts from my enterprise	
Total number of researchers/subject matter experts from the HE institution	
Total number of non-research staff (e.g. management & administrative support) from my enterprise	
Total number of non-research staff (e.g. management and administrative support) from the Higher Education institution	

E2 **How regularly does the higher education and industry team meet? Please select one of the following.**

We work in collaboration on almost a daily basis	Ä	We meet once a quarter	Ä
We meet at least once a week	Ä	We seldom meet	Ä
We meet at least a month	Ä		

E3 **How do the members involved in the industry-HE linkage project communicate? Please select one or more of the following**

My enterprise takes responsibility for ensuring that information is communicated to partnership project members	Ä	We usually communicate only when necessary	Ä
The Higher Education institution takes responsibility for ensuring that information is communicated to partnership project members	Ä	There is a continual exchange of information between my enterprise and the HE institution	Ä
We only communicate with the HE institution to get report-backs on their progress.	Ä	We usually communicate only at our scheduled meetings	Ä

F. ABOUT THE NATURE OF THE PARTNERSHIPS FUNDED BY THRIP & THE INNOVATION FUND

F1

What is the nature of the industry-higher education linkage that your enterprise has with the higher education institution in the project(s) funded by THRIP/ Innovation Fund?			
My enterprise funds basic research that is undertaken at the Higher Education institution	Ä	My organisation is involved in technological or Innovation Parks in which higher education institutions are involved	Ä
My enterprise contracts research that the Higher Education institution then undertakes	Ä	My enterprise undertakes research in collaboration with higher education institutions	Ä
My organisation funds a research unit (s) at higher education institution(s)	Ä	My organisation utilises the physical resources available at higher education institutions to ensure that the research work has the technology required	Ä
Other, please explain			

G. ABOUT THE RESEARCH OUTPUTS FROM THE PARTNERSHIPS FUNDED BY THRIP & THE INNOVATION FUND

G1

Who owns the Intellectual Property Rights in relation to any research undertaken in the industry-higher education linkage project funded by THRIP and/or Innovation Fund?			
My enterprise owns the Intellectual Property	Ä	My enterprise and the HE institution share the Intellectual Property	Ä
The HE institution owns the Intellectual Property	Ä	The ownership of Intellectual Property has yet to be determined	Ä

G2

Are the findings of the research published?	Yes	No

If yes, who are the authors of published research?

Staff from my enterprise are the authors	Ä	The authors include staff from my enterprise and the HE institution	Ä
Staff from the HE institution are the authors	Ä		

G3 **Is there an expectation that product development or innovation will be DIRECTLY achieved through the process or outputs of the industry-higher education linkage funded by THRIP/ Innovation Fund.**

Ä Yes
Ä No

G3a **If YES, please indicate if any of the following could be considered intended products? You may select more than one response.**

Increased stock of published scientific knowledge	Ä	Increased stock of human resources who have knowledge in a given area at my enterprise	Ä
New innovations, including new technologies, products and processes	Ä	Increased stock of commercially exploitable knowledge	Ä
Increased stock of scientific knowledge	Ä	Increased stock of human resources who have knowledge in a given area at the HE institution	Ä

G3a **If YES, which innovations or products are expected to be developed, or have been developed? Use the space below to explain one that you believe has added (or will add) maximum value.**

G3b **If NO, why is the enterprise involved in the relationship with higher education? Use the space below to provide an explanation.**

G3c	From your perspective, are the intended products of the research being met (or will the intended products be met if the project is still ongoing)?	Yes	No

If no, please indicate from your perspective why intended products have been or are not being achieved

G4 **Are there any new applications which were developed (or are being developed) that were not initially envisaged?**

Ä Yes

Ä No

G5	From your perspective, what steps can THRIP and/or the Innovation Fund take to improve the relationship between industry and higher education? Please rank the list provided below by indicating in order of priority from 1 to 4.	
	THRIP and/or the Innovation Fund can facilitate the relationship between higher education and industry/ commerce by arranging workshops or meetings where higher education and industry can meet.	Ä
	THRIP and/or the Innovation Fund can facilitate the relationship between higher education and industry/ commerce by having a database available of the expertise available in higher education	Ä
	THRIP and/or the Innovation Fund can facilitate the relationship between higher education and industry/ commerce by printing a publication that shares ideas of innovative research	Ä
	Other. Please indicate _____	Ä

H. THE SUSTAINABILITY OF THE RELATIONSHIP WITH HIGHER EDUCATION

H1	How was the relationship with the higher education institution, that exists in the project(s) funded by THRIP/ Innovation Fund, initiated? Please select one of the following.	
	The Higher Education institution approached my enterprise	Ä
	My enterprise approached the Higher Education institution	Ä
	My enterprise had a prior relationship with the Higher Education institution and both parties initiated the partnership	Ä

H2

How will the relationship with the higher education institution, that exist in the project(s) funded by THRIP/ Innovation Fund, be terminated?	
The partnership will be terminated when the research outputs have been achieved	Ä
The partnership will continue when the research outputs have been achieved but in another form	Ä
It is unclear how the relationship will develop on completion of the project	Ä

I. NATURE OF THE RELATIONSHIP WITH HIGHER EDUCATION

I1

Please indicate how you would describe the relationship with the higher education institution by selecting, from the terms below, the concept that best describes (from your perspective) the nature of your institution's relationship with the higher education institution during the THRIP and/or Innovation Funded project.

Partnership	Ä	Collaborative relationship	Ä
Professional relationship	Ä		

Please use the space below to define or explain the term that you selected above.

APPENDIX E – ADDITIONAL TABLES*

* The tables in Appendix E provide detailed breakdown data to support the arguments in the text. Note that the data in Table 9 reflects verbatim responses extracted from the industry survey.

Table 1. Researchers by race and gender for THRIP and Innovation Fund projects

GENDER	PROGRAMME	RACE	COUNT OF SURNAME
Female			
	Innovation Fund	African	9
		Coloured	4
		Indian	3
		Not provided	5
		White	31
		Subtotal	52
	THRIP	African	14
		Coloured	16
		Indian	10
		Not provided	5
		White	262
		Subtotal	307
	Total		359
Male			
	Innovation Fund	African	7
		Asian	1
		Coloured	2
		Indian	4
		Not provided	15
		White	72
		Subtotal	101
	THRIP	African	85
		Coloured	28
		Indian	38
		Not Provided	7
		White	863
		Subtotal	1021
	Total		1122
Not Provided			
	Innovation Fund	African	1
		Not Provided	77
		White	1
		Subtotal	79
	THRIP	White	1
		Subtotal	1
	Total		**80**
GRAND TOTAL			**1561**

Table 2. Researchers by NRF rating

Type	Programme	NRF Rated	Biotechnology	ICT	New Materials Development	Not ONE of the 3 bands	Grand Total
Grantholders							
	Innovation Fund	Not Provided	14	16	20	2	52
		Total	**14**	**16**	**20**	**2**	**52**
	THRIP	A				9	9
		B	7	2	7	19	35
		C	11	7	12	40	70
		L	1			4	5
		Not Rated	11	14	9	67	101
		P			1		1
		Y	3			10	13
		Not Provided			1		1
		Total	**33**	**23**	**30**	**149**	**235**
Grantholders Total			**47**	**39**	**50**	**151**	**287**
Research Team Member							
	Innovation Fund	Not Provided	77	66	17	20	180
		Total	**77**	**66**	**17**	**20**	**180**
	THRIP	A	2		2	5	9
		B	7	2	4	21	34
		C	17	9	12	49	87
		L	1		1	12	14
		Not Rated	139	93	69	618	919
		P	2		1	1	4
		Y	2	2	3	20	27
		Total	**170**	**106**	**92**	**726**	**1094**
Research Team Member Total			**247**	**172**	**109**	**746**	**1274**
Grand Total			**294**	**211**	**159**	**897**	**1561**

Table 3. Products/Artefacts by HEI and by technological band

TECHNOLOGICAL BANDS	ORGANISATIONAL TYPE	HE INSTITUTIONS	PRODUCTS / ARTEFACTS
Biotechnology			
	Technikon	Technikon Natal	0
		Subtotal	0
	University	Potchefstroom University for CHE	0
		Rhodes University	0
		University of Cape Town	5
		University of Natal	1
		University of Port Elizabeth	0
		University of Pretoria	2
		University of Stellenbosch	8
		University of the Free State	2
		University of the Western Cape	1
		Subtotal	19
		Total	**19**
ICT			
	Technikon	ML Sultan Technikon	0
		Technikon Pretoria	0
		Technikon Witwatersrand	0
		Subtotal	0
	University	Potchefstroom University for CHE	9
		Rhodes University	15
		University of Cape Town	3
		University of Durban-Westville	0
		University of Fort Hare	1
		University of Natal	4
		University of Pretoria	8
		University of Stellenbosch	21
		University of the Western Cape	3
		University of the Witwatersrand	5
		Subtotal	69
		Total	**69**
New Materials Development			
	Technikon	Cape Technikon	1
		Port Elizabeth Technikon	0
		Technikon Natal	0
		Technikon Pretoria	1
		Technikon Witwatersrand	0
		Subtotal	2
	University	Potchefstroom University for CHE	4
		Rand Afrikaans University	14
		University of Cape Town	0
		University of Natal	7
		University of Port Elizabeth	1
		University of Pretoria	21
		University of Stellenbosch	20
		University of the North	0
		University of the Western Cape	2
		University of Witwatersrand	3
		Subtotal	72
		Total	**74**
Not an area of HSRC Focus			
	Technikon	Cape Technikon	2

Table 4. Patents by HEI and by Technological Band

TECHNOLOGICAL BANDS	ORGANISATIONAL TYPE	HE INSTITUTIONS	PATENTS
Biotechnology			
	Technikon	Technikon Natal	0
		Subtotal	0
	University	Potchefstroom University for CHE	0
		Rhodes University	0
		University of Cape Town	4
		University of Natal	0
		University of Port Elizabeth	0
		University of Pretoria	1
		University of Stellenbosch	2
		University of the Free State	0
		University of the Western Cape	0
		Subtotal	7
		Total	**7**
ICT			
	Technikon	ML Sultan Technikon	0
		Technikon Pretoria	0
		Technikon Witwatersrand	0
		Subtotal	0
	University	Potchefstroom University for CHE	4
		Rhodes University	0
		University of Cape Town	0
		University of Durban-Westville	0
		University of Fort Hare	0
		University of Natal	0
		University of Pretoria	0
		University of Stellenbosch	0
		University of the Western Cape	0
		University of the Witwatersrand	0
		Subtotal	4
		Total	**4**
New Materials Development			
	Technikon	Cape Technikon	1
		Port Elizabeth Technikon	0
		Technikon Natal	0
		Technikon Pretoria	0
		Technikon Witwatersrand	0
		Subtotal	1
	University	Potchefstroom University for CHE	1
		Rand Afrikaans University	0
		University of Cape Town	0
		University of Natal	0
		University of Port Elizabeth	0
		University of Pretoria	3
		University of Stellenbosch	3
		University of the North	0
		University of the Western Cape	0
		University of Witwatersrand	0
		Subtotal	7
		Total	**8**
Not an area of HSRC Focus			
	Technikon	Cape Technikon	0

Table 5. Research Publications by HEI and by Technological Band

TECHNOLOGICAL BANDS	ORGANISATIONAL TYPE	HE INSTITUTIONS	RESEARCH PUBLICATIONS
Biotechnology			
	Technikon	Technikon Natal	15
		Subtotal	15
	University	Potchefstroom University for CHE	0
		Rhodes University	0
		University of Cape Town	21
		University of Natal	12
		University of Port Elizabeth	0
		University of Pretoria	85
		University of Stellenbosch	46
		University of the Free State	28
		University of the Western Cape	18
		Subtotal	210
		Total	**225**
ICT			
	Technikon	ML Sultan Technikon	9
		Technikon Pretoria	0
		Technikon Witwatersrand	0
		Subtotal	9
	University	Potchefstroom University for CHE	21
		Rhodes University	43
		University of Cape Town	40
		University of Durban-Westville	0
		University of Fort Hare	7
		University of Natal	30
		University of Pretoria	21
		University of Stellenbosch	85
		University of the Western Cape	13
		University of the Witwatersrand	22
		Subtotal	282
		Total	**291**
New Materials Development			
	Technikon	Cape Technikon	1
		Port Elizabeth Technikon	1
		Technikon Natal	1
		Technikon Pretoria	4
		Technikon Witwatersrand	0
		Subtotal	7
	University	Potchefstroom University for CHE	13
		Rand Afrikaans University	21
		University of Cape Town	1608
		University of Natal	21
		University of Port Elizabeth	9
		University of Pretoria	35
		University of Stellenbosch	61
		University of the North	0
		University of the Western Cape	14
		University of Witwatersrand	43
		Subtotal	1825
		Total	**1832**
Not an area of HSRC Focus			
	Technikon	Cape Technikon	16

Table 6. Students involved by HEI and by technological band

TECHNOLOGICAL BANDS	ORGANISATIONAL TYPE	HE INSTITUTIONS	STUDENTS
Biotechnology			
	Technikon	Technikon Natal	17
		Subtotal	17
	University	Potchefstroom University for CHE	4
		Rhodes University	7
		University of Cape Town	35
		University of Natal	19
		University of Port Elizabeth	1
		University of Pretoria	68
		University of Stellenbosch	129
		University of the Free State	17
		University of the Western Cape	30
		Subtotal	310
		Total	**327**
ICT			
	Technikon	ML Sultan Technikon	3
		Technikon Pretoria	11
		Technikon Witwatersrand	6
		Subtotal	20
	University	Potchefstroom University for CHE	62
		Rhodes University	46
		University of Cape Town	87
		University of Durban-Westville	0
		University of Fort Hare	12
		University of Natal	34
		University of Pretoria	29
		University of Stellenbosch	121
		University of the Western Cape	18
		University of the Witwatersrand	16
		Subtotal	425
		Total	**445**
New Materials Development			
	Technikon	Cape Technikon	2
		Port Elizabeth Technikon	6
		Technikon Natal	12
		Technikon Pretoria	6
		Technikon Witwatersrand	3
		Subtotal	29
	University	Potchefstroom University for CHE	14
		Rand Afrikaans University	14
		University of Cape Town	25
		University of Natal	22
		University of Port Elizabeth	3
		University of Pretoria	50
		University of Stellenbosch	57
		University of the North	1
		University of the Western Cape	10
		University of Witwatersrand	38
		Subtotal	234
		Total	**263**
Not an area of HSRC Focus			
	Technikon	Cape Technikon	10

Table 7. University outputs by technological bands

HE Institutions	Technological Bands	Research Publications	Patents	Products / Artefacts	Students
Potchefstroom University for CHE	Biotechnology	0	0	0	4
	ICT	21	4	9	62
	New Materials Development	13	1	4	14
	NOT one of the 3 technological bands	134	2	18	195
	Total	**168**	**7**	**31**	**275**
Rand Afrikaans University	New Materials Development	21	0	14	14
	NOT one of the 3 technological bands	13	1	7	33
	Total	**34**	**1**	**21**	**47**
Rhodes University	Biotechnology	0	0	0	7
	ICT	43	0	15	46
	NOT one of the 3 technological bands	0	0	0	6
	Total	**43**	**0**	**15**	**59**
University of Cape Town	Biotechnology	21	4	5	35
	ICT	40	0	3	87
	New Materials Development	1608	0	0	25
	NOT one of the 3 technological bands	213	1	26	207
	Total	**1882**	**5**	**34**	**354**
University of Durban-Westville	ICT	0	0	0	0
	NOT one of the 3 technological bands	6	0	0	30
	Total	6	0	0	30
University of Fort Hare	ICT	7	0	1	12
	Total	**7**	**0**	**1**	**12**
University of Natal	Biotechnology	12	0	1	19
	ICT	30	0	4	34
	New Materials Development	21	0	7	22
	NOT one of the 3 technological bands	95	0	8	120
	Total	158	0	20	195
University of Port Elizabeth	Biotechnology	0	0	0	1
	New Materials Development	9	0	1	3
	NOT one of the 3 technological bands	10	2	0	15
	Total	**19**	**2**	**1**	**19**
University of Pretoria	Biotechnology	85	1	2	68
	ICT	21	0	8	29
	New Materials Development	35	3	21	50
	Total	**141**	**4**	**31**	**147**

Table 8. Technikon outputs by technological bands

HE Institutions	Technological Bands	Research Publications	Patents	Products / Artefacts	Students
Cape Technikon	New Materials	1	1	1	2
	NOT one of the 3 technological bands	16	0	2	10
	Total	**17**	**1**	**3**	**12**
ML Sultan Technikon	ICT	9	0	0	3
	NOT one of the 3 technological bands	0	0	0	0
	Total	**9**	**0**	**0**	**3**
Port Elizabeth Technikon	New Materials Development	1	0	0	6
	NOT one of the 3 technological bands	8	2	0	14
	Total	**9**	**2**	**0**	**20**
Technikon Free State	NOT one of the 3 technological bands	0	0	0	0
	Total	**0**	**0**	**0**	**0**
Technikon Natal	Biotechnology	15	0	0	17
	New Materials Development	1	0	0	12
	Total	**16**	**0**	**0**	**29**
Technikon Northern Gauteng	NOT one of the 3 technological bands	0	0	0	0
	Total	**0**	**0**	**0**	**0**
Technikon Pretoria	ICT	0	0	0	11
	New Materials Development	4	0	1	6
	NOT one of the 3 technological bands	13	2	3	66
	Total	**17**	**2**	**4**	**83**
Technikon Witwatersrand	ICT	0	0	0	6
	New Materials Development	0	0	0	3
	NOT one of the 3 technological bands	0	0	0	1
	Total	**0**	**0**	**0**	**10**
Vaal Triangle Technikon	NOT one of the 3 priority Technological Bands	0	0	1	8
	Total	**0**	**0**	**1**	**8**
GRAND TOTAL		**68**	**5**	**8**	**165**

Table 9. Which products are expected to or have been developed?

- © The development of the Gneiss microkernel.
- © The development of Laser based gas detection products, laser based gas detection services and manufacturing technologies using laser ablation. The most value is in constructing customized products for detection of hazardous pollutants.
- © The highest values comes from development of intellectual property in specific technology areas of interest to my company.
- © The molecular genetic characterisation of fundamental biological defects which leads to these forms of blindness is meant logically lead to gene-specific or gene-based therapies, including Gene therapy, Pharmaceutical intervention, Growth Factor intervention and stem cell manipulation amongst others.
- © Geocell product used a sacrificial mould to cast interlocking cement-block paving. 3D interlock relies on distortion in vertical plane of the cell wall to simulate a rounded keyway joint. Performance can be understood and predicted. This is a reengineered product.
- © The development of Glucose oxidase.
- © The development of new earthquake proof building technology for poor and developing countries
- © Crane loading developments resulting in change to loading codes this impacts on whole industry.
- © New cultivars (of Proteas) are in development.Knowledge treatment of pathogens ,these projects need to be continued, post - harvest care studies continuing, pruning methods study continuing, biological control studies are long term and need to be continued.
- © The development of a packaged (mobile) treatment unit for effluent, generated in the wine, juice and spirit industries this has commercial potential. The development of a framework for the implementation of environmental management systems has already proved beneficial.
- © A higher quality recycled polypropylene granule used for automotive lead/acid battery cases.
- © The development of desalination equipment and processes utilising renewable energy , this is leading edge technology and superior product quality.
- © The development of a baculovirus product as a biological control agent for pests of agricultural crops.
- © Tomography, the development of numerous applications in the chemical process industry to be used a contract work by the Universities to generate income. Bagasse, sufficient knowledge to make decision regarding the viability of the project. Drying, the direct application of the information to company designs.
- © Lead compounds may be identified that can be optimised to generate new drugs for TB, particular markers have been identified that have the potential to be developed into simple kits for diagnosis and prognosis of TB.
- © The development of wear resistant materials containing fine vanadium carbide.
- © We have produced 56 new indigenous polyploid species which could have commercial value. Evaluation of this potential is just starting, if any are successfully they could start new industries.
- © Development of a volatile corrosion inhibitor systems for plastics packaging , development of an improved flame retardant systems, development of an improved purging compound for cleaning plastics machinery , development of a prodegradant additive for use in plastic bags.
- © We connect for underground mining communications specifically for data, video and voice communication. This product has been patented and a company formed to commercialise the product.
- © A patent on a new device for the monitoring of membrane fouling to be used in the filtration and desalination of sea water and treatment of industrial waste water.
- © The development of a route optimisation system branded as logics(www.logicslink.co.za).This is intended to become a commercial piece of software that will lead to financial benefit for our enterprise.
- © Research is specialised in digital communications, these technologies will be used in products in 3-5 years.
- © New polymer based So2 sheet for the control of botrytis decay of table grapes. Same or better So2 release pattern over time, at a lower cost, with faster screening of new varieties has lead to more product development
- © Task 7.2.1 develop air scrubber technology for recognition air ,to enable controlled re-circulation and re-use of ventilation air. Potentially this will lead to a 40% reduction in air power and improved cooling distribution. The financial benefit will be in the region of R16 million per annum per mine.
- © Armgold specialises in managing mines that are marginal or near end of life, the extraction of the shaft pillar is generally the last mining to take place. With improved efficiency and safety we have the potential to increase revenue by say 10% ,this equates to R40 million per shaft.
- © The mining system has the potential to increase minable gold reserves of future mine industrial partners by enabling low grade, previously uneconomical narrow reefs to be extracted economically through the implementation instope long hole drilling.
- © Ultimately the aim is to produce locally made specialised carbon forms (graphite) of high value, which will be made from local natural resources, using local technology for power generation.
- © Developing the know how to predictably pump explosives in a pipeline service an existing and rapidly expanding market, developing the know how to formulate chemical compositions of explosives blasting accessories that have highly precise and controllable reaction speed.
- © The development of a national online vehicle identification system through unique metallurgical fingerprints and vehicle prints.
- © The development of an improved and faster, therefore shorter method to identify the presence of micro-organisms in potable water and thereby to reduce the associated health risks to consumers.
- © The development of fully sealed lead acid batteries and high power battery and 36/42 volt batteries.

- © Developing a new vaccine against HPV virus to counteract cervical cancer, the registering of three patents. Developing new tests to be able to detect colon cancer earlier. Developing new drugs against cancer, three patents have been registered. Capacity building at higher education resulting in Msc and PhD students and publications.
- © Developing the expertise in the modelling and control of process systems, as well as developing software for offline data analysis.
- © The development of a manufacturing excellence cdrom, which will be used by firms as guide to bolster competitiveness, for in/formal training, for the facilitation of change management programmes.CDRom and manuals are due for completion by April 2003,this will be a world class product which will benefit South Africa enormously.
- © Limited angle tomography has been shown to be a possibility, there are also s me longer term and less tangible possibilities.
- © Expertise is being established focusing on the repair of structurally critical composite components for instance primary load bearing composite aircraft structures. The technology is also directly applicable to the design of reliable bonded joints between composite and metal components, which has become a growing demand in the automotive and bridge construction industries.
- © There is scope for product optimisation in the area of impact copolymer polypropylene grades. Research at the higher education institution needs further in-house and commercial thought to be brought to reality. The projects are developing on a continual basis, with the resulting development of human resources and skill.
- © The development of a national online vehicle identification system (novis) .Proof of concept in demonstration system
- © Process of SSM.
- © Scientific information on the citrus bluespot fungus, is responsible for inspecting fruit and restructuring of export to be expanded. Some of this information is used to overcome barriers to international trade in citrus.
- © Selection of options for ensuring appropriate acid resisting properties for modified concrete used for the manufacture of lining of concrete sewer pipes used in various applications with differing corrosion properties.
- © Pilot protection structure proposes a new seating arrangement which should enhance pilot survival in the event of a crash or bad landing.
- © Developing the process of carbon source utilisation to profile a microbial population in a paper mill under different microbial regimes, including enzyme technology and microbides. This is an innovative approach to bio control.
- © The development of a micro turbo jet engine.
- © The development of a Broadband wireless router for rural connectivity.
- © The work on grain refining could assist in setting up a different marketing angle. The work improves relationships between team members, and allows for mutual exploitation of marketing opportunities.
- © In order for a non ceramic insulator to be accepted by ESKOM, the supplier had to have the insulator tested at a costly price overseas.ESKOM now provides such a service that is now also used by other utilities worldwide.
- © Gene constructs for enhancing sugar production in sugar cane via genetic engineering.
- © Keeping timber plantation trees healthy.
- © A collaborative research programme between UCT, WITS, Stellenbosch and UDW into aspects of concrete durability has resulted in changes to the way concrete is being specified and accepted in industry.
- © Publication of research findings in research monographs or conference or seminar proceedings.
- © An alloy like 3CRR was developed and improved by research and development at the higher education institution, even predating THRIP. Currently 50 000 tons are sold every year.
- © Research in both projects lead to the development of new polymer currently being commercialised. Both projects have yielded an increased HR capacity at our enterprise. There has been an increase in knowledge of polymer science at the higher education institution and in our enterprise.
- © Lallemand is a Canadian based yeast manufacturing company. The research project develops new wine yeast that can be used by specifically the South African wine industry to produce wine and brandy, to be able to breed and market a yeast with a distinct South African genetic background.
- © There are several projects that will eventually lead to new products or better use of existing technologies, for example a yeast that also sterilises wine resulting in lower sulphur levels, which is popular with consumers. Grapes which are resistant to pathogens will use less chemicals resulting in more profit and less environmental harm.
- © The wet granulation of titania slag that was developed in the Innovation Fund project.
- © The development of Cavendish bananas with improved resistance to fusarium wilt. The development of Molecular markers for rapidly identifying the pathogen from soil, water and plants. Molecular markers are also able to rapidly identify resistance in plant selections.
- © The development of bar coding for copper cables at COE at Rhodes university by Professor Clayton's team
- © The development of organic pacifying pigments for paint and novel emulsion binders for paint.
- © The development of a new bio bleaching process. New sources of lacasses and other novel applications of biotech within the forest product industry.

Table 10. Total departmental links by grantholder/primary beneficiary's department

a) For all projects

	Own Department	Other Department in same institution	Other institutions
No links	96	164	167
ONE link	56	30	34
TWO links	32	19	17
THREE links	24	7	6
FOUR links	8	7	7
FIVE links	10	1	3
6-10 links	21	6	5
> 10 links	5	6	2
> 20 links	1	4	1
Missing	18	27	29
TOTAL LINKS ASSOCIATED WITH GRANTHOLDER	**271**	**271**	**271**

b) For projects Biotechnology

	Own Department	Other Department in same institution	Other institutions
No links	10	21	22
ONE link	10	6	4
TWO links	5	2	1
THREE links	4	1	1
FOUR links	2	0	2
FIVE links	2	2	1
6-10 links	1	1	2
> 10 links	1	0	1
> 20 links	0	0	0
Missing	1	3	2
TOTAL LINKS ASSOCIATED WITH GRANTHOLDER	**36**	**36**	**36**

c) For projects in ICT

	Own Department	Other Department in same institution	Other institutions
No links	9	17	17
ONE link	4	1	6
TWO links	5	1	1
THREE links	1	1	1
FOUR links	1	2	0
FIVE links	0	0	0
6-10 links	5	1	0
> 10 links	1	2	0
> 20 links	0	0	0
Missing	2	3	3
TOTAL LINKS ASSOCIATED WITH GRANTHOLDER	**28**	**28**	**28**

d) For projects in New Materials Development

	Own Department	Other Department in same institution	Other institutions
No links	14	25	25
ONE link	7	3	2
TWO links	3	3	2
THREE links	6	1	1
FOUR links	1	1	1
FIVE links	0	0	0
6-10 links	2	1	0
> 10 links	1	0	0
> 20 links	0	0	0
Missing	3	3	6
TOTAL LINKS ASSOCIATED WITH GRANTHOLDER	**37**	**37**	**37**