A Strategy for Improving the Utilisation of Research in South Africa

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Prepared for:

The National Advisory Council on Innovation

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In collaboration with:
Innovation Networks

CONTENTS

LIST OF ABBREVIATIONS

DST - Department of Science and Technology
DTI - Department of Trade and Industry
CENIS - Centre for Interdisciplinary Studies, University of Stellenbosch
HES - Higher Education Sector
HSRC - Human Sciences Research Council
IP - Intellectual Property
NACI - National Advisory Council on Innovation
NSI - National System of Innovation
R&D - Research and Development
SAC - Science Advisory Council
SMME – Small, Medium and Micro Enterprise
THRIP-Technology and Human Resources for Industry Programme

EXECUTIVE SUMMARY

The National Advisory Council on Innovation has been created by legislation [NACI Act of 1997] to advise the Minister of Science and Technology of South Africa, and through the Minister, the Cabinet, on the role and contribution of innovation (including science and technology) in promoting and achieving the national objectives of

- improving and sustaining quality of life for all South Africans
- developing human resources for science and technology
- building the economy
- strengthening the country's competitiveness in the international sphere.

One of NACI's functions is to develop "strategies for the promotion of technology innovation, development, acquisition, transfer and implementation in all sectors" (Republic of South Africa 1997:3-10). In response to that mandate, NACI has commissioned research that would determine the extent to which research findings are utilised in South Africa in achieving these national objectives, and to map the dynamics of the utilisation process. This research on the utilisation of R&D in the country would serve to formulate strategies for the optimisation of the outcomes of the national R&D effort.

The first phase of the study entailed a survey of projects completed during 1997-98. The second phase of the study reviewed a sample of successful cases of research implementation and utilisation. The third phase consisted of the development of a strategy that would optimise the probability of the implementation of research findings in future. A panel was assembled on the basis of their individual expertise. The panel deliberated on the survey results as well as the case study reports, and developed a conceptual framework of the dynamics of the innovation system based on which key recommendations were formulated. The panel also proposed a framework for implementation.

Research utilisation can be broadly defined to include the advancement of knowledge, changing human behaviour, attitudes and values, developing new technologies and solving applied problems. A narrow definition of innovation and research utilisation could exclude the advancement of knowledge as a form of utilisation.

If one accepts a broad definition, the survey results suggest fairly significant levels of successful utilisation. However, considering a more limited definition as a point of departure, the survey paints a much bleaker picture with low levels of research utilisation. At the outset only 29.4% of research is undertaken with the intention of solving applied problems. In the case of research targeted at entering new markets the percentage falls below 7%. The successful utilisation of research aimed at the two categories mentioned above is about 50%.

The survey of academic institutions (including science councils) in phase 1 shows that the utilisation of research/knowledge is positively correlated with four key factors. These four factors are:

- the amount and nature of research collaboration in the project
- the partners in the research collaboration with whom there is collaboration
- the research experience of the project leader, and
- the size of the project as measured in the amount of project funding.

These findings were supported by the case studies as well as the interviews that were conducted by the expert panel. The strategic recommendations made by the panel address these issues by taking a systematic look at the dynamics of the innovation system. The proposed strategy addresses both supply-side measures as well as demand-side measures. These measures should be framed within an environment that would enable the objectives to be reached.

The key recommendations of the strategy are as follows:

The creation of Networks of Innovation

The concept of research collaboration is central to the proposed strategy. The creation of Networks of Innovation will enhance the utilisation of research results. These networks should be created in collaboration with the various industry sectors as well as with the final end-users. Collaboration should include interactions with decision makers, industry, local researchers and international researchers.

Close interaction and collaboration between stakeholders is essential to guide the development of research agendas, as well as to increase the capacity of industry and end-users to absorb the technological or social advances. Collaboration has the further benefit of creating trust and confidence in the research findings.

Networks of Innovation should be created around excellent scientific leadership. The surveys and case studies have indicated that the expertise and commitment of project leaders are important to ensure that research findings are utilised and that unexpected findings are exploited. The appropriate human-resource skill base should be put in place within these networks. Existing experience within a research team should be used to develop human resources with a particular emphasis on the transformation agenda in terms of race and gender. The presence of young researchers within a team is also encouraged to allow the teams to move away from the traditional notion of "science push" to one of "innovation pull".

The Innovation Rating system

Recognition of excellence should be given to researchers or institutions that promote innovation. The present financial mechanisms that are utilised (e.g. the NRF rating) should be encouraged integrate the recommendations of this study, for example by funding experienced scientist that have developed research protocols in collaboration with the end-users.

Innovation Policy for tertiary academic institutions

Tertiary academic institutions should be encouraged to develop innovation policies which are innovation and research utilisation friendly. This would include encouraging forms of R&D results dissemination other than academic publication. The teaching or service delivery load should be decreased for those members that bring in substantial grants.

NACI's advocacy role

NACI's role as champion of innovation in the country was endorsed. However, a greater emphasis on its advocacy role within government and society was strongly recommended. NACI should advocate for the integration the recommendations of this study in to financial mechanisms that are in place for example, priority should be given to the funding of experienced scientist that have developed research protocols in collaboration with end-users. National and international research collaborations should be supported. Financial measures that encourage an increase in the capacity of industry to absorb researchers as well as to conduct more R&D should be explored.

1. INTRODUCTION

1.1 White Paper on Science and Technology

The White Paper on Science and Technology adopted the National System of Innovation (NSI) as a policy framework for science and technology (S&T) in South Africa. The South African Cabinet approved this policy in 1996. The adoption of the policy was in recognition of the move away from a "science push" framework to an "innovation pull" model. This notion had already gained currency within the industrialised nations of the world, as well as within the health-care sector in developing countries. It was a shift that moved the debate away from the notion of the "republic of science" to one where the relevance and use of scientific knowledge was questioned. South Africa was the first country to adopt such a framework as a national policy.

In addition to moving towards innovation pull, there is a global trend towards creating partnerships and linkages between centres of learning and industry. This greater collaboration is a fundamental value espoused in the S&T White Paper, and found expression in the establishment of the Innovation Fund by the Department of Science and Technology as well as the creation of THRIP by the Department of Trade and Industry. The move towards greater collaboration between science and industry, and a reliance on the demand side is also expressed by the Department of Health in adopting the philosophy of Essential National Health Research.

The National System of Innovation was defined as "a set of functioning institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives". The NSI framework defined innovation as the introduction into the market (economic or social) of new or improved products and services. The White Paper had clearly moved the debate towards the notion that economic growth depends on having the infrastructure that addresses sectoral issues within an enabling environment.

1.2 SA National Research and Development Strategy

The Research and Development strategy for South Africa identified six key success factors that would have to be addressed to enable the vision in the White Paper to be achieved, namely:

- appropriate funding
- strategic considerations
- human resources
- private sector R&D capacity
- intellectual property, and
- fragmentation of the R&D system.

These issues are to be addressed via innovation, human resource development and a connected government S&T system. Amongst the critical factors identified in the R&D strategy one factor has particular relevance to the utilisation of research findings. A gap exists between the producers of knowledge and the users of that knowledge. The R&D strategy refers to this as the "innovation chasm".

The authors argue that despite the implementation of a number programmes to breach this chasm, economic growth based on local innovation is low. The focus of R&D activities is on human resource development and incremental research. The R&D strategy proposes the development of technology missions, which have proven highly successful in the past both locally and internationally. Technology missions are defined as targeting significant investments to achieve competencies in key technology fields or industrial sectors. Technology missions provide a mechanism to focus limited resources within specific fields, which would attract new people and investments.

1.3 NACI Terms of Reference

The South African Government's investment in R&D during the 1997/98 financial year can be summarised as follows:

- HES (R850 million)
- Science Councils (R1, billion)
- National Facilities (R60 million)
- Government departments (R450 million), and
- State Corporations (R350 million).

Although the investment, as a percentage of Gross Domestic Product (GDP), is low and does not reach the level of investments of our competitors, the funding is substantial. It is not only the public's right but also a duty and responsibility of the National Advisory Council on Innovation (NACI) to understand what has been achieved with the funds spent on research. One of NACI's functions is to develop "strategies for the promotion of technology innovation, development, acquisition, transfer and implementation in all sectors" (Republic of South Africa 1997:3-10). In response to that mandate, NACI has commissioned research that would determine the extent to which research findings are actually utilised in South Africa in achieving the national objectives, and to map the dynamics of the utilisation process. This research on the utilisation of R&D in the country would serve to formulate strategies for the optimisation of the outcomes of the national R&D effort. The scope of NACI's research project is defined as follows:

- a survey of all major R&D institutions across science cultures
- a sample of projects conducted by a sample of major institutions across science cultures
- the projects completed by R&D institutions in 1997- 98, and
- the dynamics of the sample of projects.

2. METHODOLOGY

2.1 Project Design

The **first phase** of the study entailed a survey of projects completed during 1997-98. This required the establishment of

- a data base of institutions and projects
- a questionnaire operationalising the range of forms of implementation and utilisation

- the administration of the questionnaire to a sample of institutions to ascertain to what extent project findings have been utilised and in what ways.

This phase of the work was conducted by CENIS. The CENIS study on research utilisation comprised two main components:

- A questionnaire survey of research conducted by universities, technikons and science councils. The total number of 2058 completed questionnaires received constitutes a response rate of approximately 20%.
- A telephone survey of a sample of R&D managers in one hundred and sixteen South African technology intensive companies formed the second half of the study.

The **second phase** of the study reviewed a sample of successful cases of research implementation and utilisation. The descriptions of the implementation processes followed in the case of these projects were analysed by means of a framework based on current models of implementation.

A consortium headed by the CSIR conducted this part of the study. The CSIR report consists of twelve case studies. The case studies describe a set of publicly funded research projects that cover a breadth of research types. The twelve cases were arrived at from an initial list of twenty. The grouping of cases was not based on formal sampling, but the emphasis was rather on covering the domains under investigation.

The **third phase** consisted of the development of a strategy that would optimise the probability of implementing research findings in the future. Three different organisations (AMI, Cyberknowledge Systems, Da Vinci Institute for Technology Management) were appointed to run parallel strategy formulation processes, using different methodologies. Da Vinci also chose to make use of an expert panel to generate their strategy.

2.2 Expert Panel Process

The expert panel was assembled on the basis of their individual expertise. The following individuals formed the panel:

-	Dr MS Jeenah	Independent policy consultant
-	Dr N Segal	Head of Graduate School of Business, University of Cape Town
-	Prof E Preston-Whyte	Ex-Deputy Vice-Chancellor, University of Natal
-	Dr R Maharaj	Policy analyst, CSIR
-	Prof P Ngoepe	University of the North
-	Dr R Skeef	Group Executive, National Research Foundation, and
-	Mr M Myers	Independent engineering and business consultant.

The expert panel had an excellent grasp of the academic sector, industrial sector as well as the science councils. In addition, the group had a strong public-sector and science-policy background. The expert panel assembled for 5 days (3rd to 7th February 2003) in Pretoria.

The seven-member panel received the outputs of the first two phases as pre-workshop reading. In addition the team also received the following documents:

- Institutional Framework (a document developed by the Da Vinci Institute for Technology Management that outlines the public-sector R&D institutional framework in South Africa)
- South Africa's National R&D strategy
- The Science and Technology White Paper, and
- Science Advisory Council (SAC) report of 1990.

The following presentations were made to the expert panel:

- CENIS Presentation on Phase 1 by J Mouton
- CSIR presentation on Phase 2 by R Maharaj, and
- SAC report presented by B Marais.

In addition, two of the other groups developing parallel strategies (AMI, CKS) made preliminary presentations.

The expert panel conducted a number of interviews with leading members of government departments and industry. The following individuals were interviewed:

Dr A Paterson	Chief Operating Officer DST
Dr D Kaplan	Chief Economist DTI, member of NACI
Dr S Lennon	Executive Director R&D Eskom, member of NACI
Mr I Robertson	BMW CEO
Mr H McClusky	Altron
Mr B van de Merwe	Director of R&D Sappi
Mr J Burns	Godisa CEO
Mr P Pelser	Parsec CEO

The panel deliberated on the presentations and developed a conceptual framework of innovation dynamics on the basis of which key recommendations were formulated. The panel also proposed a framework for implementation.

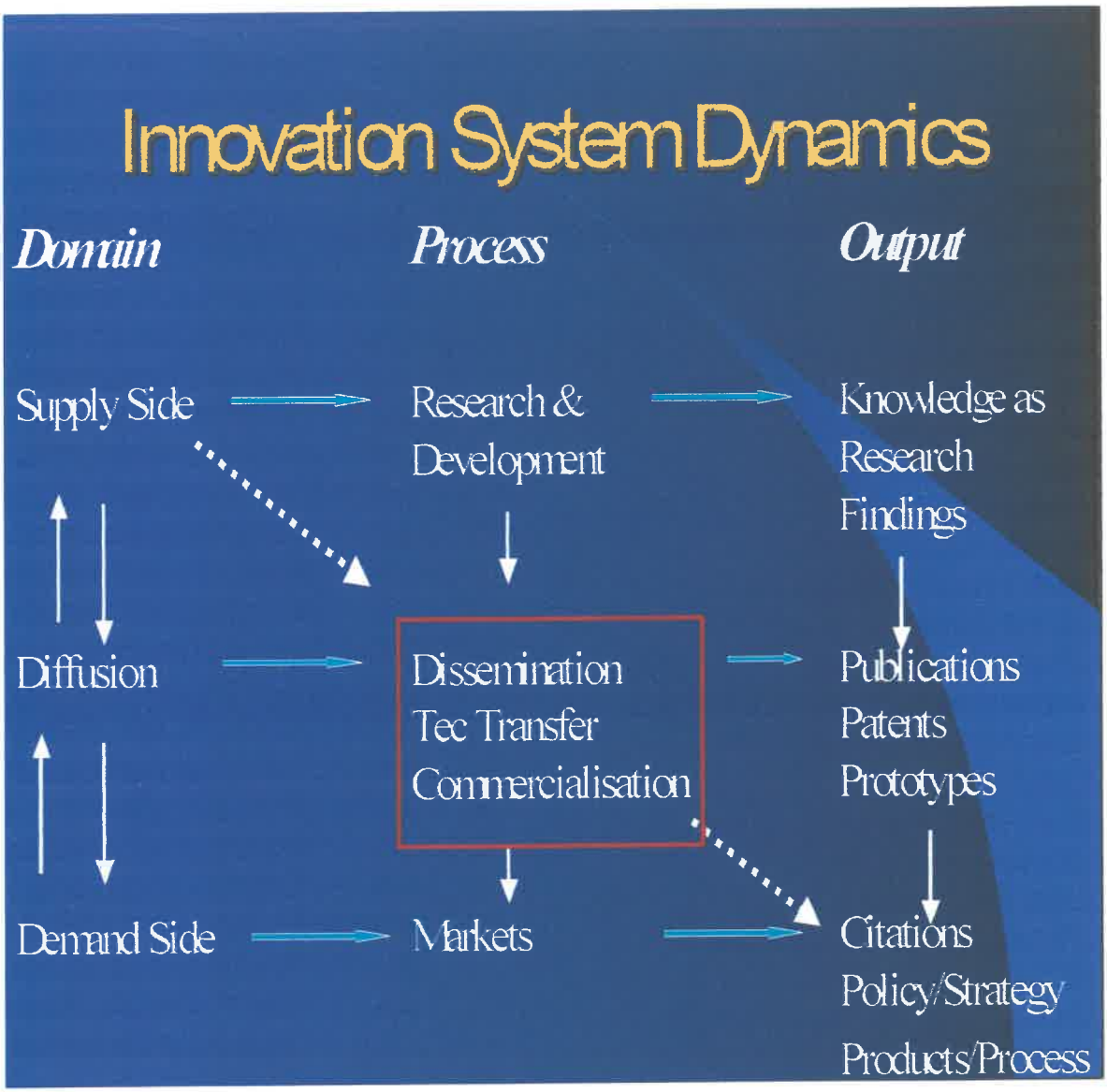
3. CONCEPTUAL MODEL OF INNOVATION DYNAMICS

3.1 Innovation System Dynamics

A major criticism of most government-developed strategies is that their perspective is heavily biased towards government. Understanding the systemic location of "research" within a value matrix is an essential component of attempting to address NACI's concern regarding the utilisation of research findings. A fresh conceptualisation of the innovation system dynamics

was thus conceived to provide a framework for the strategy development. This model is presented in Figure 1 below.

Figure 1 – Conceptual model of innovation dynamics



In this model, *supply* issues are identified and *demand* conditions explored, with an important interlinking *diffusion* domain. The information flow between the domains is considered to go both ways in a constant process of feedback.

The different domains are characterised by different processes. The *supply* side is characterised by the research and development process together with the specific inputs that would be required to make the system viable. The supply-side process leads to knowledge generation in the form of research findings.

These findings are *diffused* via number of processes or dissemination mechanisms such as technology transfer and commercialisation. This list is not intended to be exhaustive, as a

number of other diffusion processes exist. The diffusion outputs can be in the form of publications, patents, prototypes, etc.

This knowledge is *driven* by differing market needs and utilised in differing ways. Note that the demand for knowledge is necessary to ensure that there is a well-developed feedback mechanism. The market for research findings is segmented into:

- Academia
- Government, and
- Industry.

The outputs that are generated by the different markets range from citations to policy formulation to products and processes. The products that are generated do not have a one-to-one correlation with the markets. Each market is not confined to using only one form of research knowledge. Industry, for example, could use citations within its patent application for a product.

The overriding consideration emerging from this model is that it is the diffusion process (marked by a red block in Figure 1) that holds the key to unlocking the potential within the innovation system. This process can most effectively be described by the term 'research utilisation' or 'innovation' in the narrower sense (cf. Section 3.2. below).

3.2 The Nature of Research Utilisation

The expert panel began its deliberation with a number of assumptions about the nature of research that it had hoped to test against the findings of the first two phases as well as in the interviews. There is a distinct perception within government and industry that research is not fully utilised. It had also been accepted that utilisation of research takes on a variety of forms ranging from the advancement of knowledge, changing human behaviour, attitudes and values, developing new technologies and solving applied problems. All forms of utilisation were considered within the study. In their research, the CENIS group refers to a wide and narrow definition for research utilisation. The wide definition includes knowledge generation as well as knowledge application whilst the narrow definition relates only to knowledge application.

The CENIS survey data indicates a fairly healthy utilisation of research findings if the broad definition is used. A more problematic picture does, however, emerge if one is concerned with the application of knowledge in the limited sense. At the outset only 29.4% of research is undertaken with the intention of solving applied problems. In the case of research targeted at entering new markets the percentage falls below 7%. The successful utilisation of research aimed at the two categories mentioned above is about 50% (Mouton et al. 2003). It was agreed by the expert panel that, if the whole innovation system is to be taken into account, a more holistic picture has to be comprehended, and the broader definition was therefore adopted for the purposes of this study.

The development of a strategy to optimise the utilisation of research findings also recognises the complex internal and external factors that would determine success within different domains. The differences between various industrial sectors in terms of their maturity and innovation absorptive capacity would require strategies that are tailored to the needs of the sectors. Finally, the transformation agenda in South Africa in terms of the economy, race and gender provide unique challenges to the dynamics of the innovation system.

4. SUPPLY-SIDE MEASURES

On the supply side, three factors were identified that should be addressed to obtain greater utilisation of research findings, namely: strong project leadership, skilled research teams and funding. Although these issues have been raised previously in the context of the R&D system, the surveys and case studies provide a strong link to research utilisation.

4.1 Project Leadership

The case-studies project and the survey indicated a strong correlation between the leadership attributes that are essential to the successful utilisation of research results. Most of these leadership attributes amounted to the typical traits of a strong leader and it was clear that such a person is the essential central pillar that ensures the sustenance of the research project and ultimately the usable research results.

Some of the specific traits that were observed included the following:

Commitment - Strong leadership and the commitment of the research leaders and their teams to see projects through is vital for the delivery of research products.

Flexibility - Project leaders need to manage projects in a manner that allows for flexibility as circumstances around the project change, such as when:

- Research-funding sources dry up
- The needs of the users change as the project progresses
- The scope or project costs are underestimated.

Such situations may necessitate the sourcing of more funding as well as renegotiating agreements to achieve project objectives. The project leader would then also have to ensure that there is an appreciation for this need for flexibility within his or her team.

Communication skills - Research leaders must command well-developed communication skills and should make strategic use of various media for different purposes (e.g. policy briefs and or useful technical articles for industry). This skill is clearly necessary in managing relationships with the various stakeholders and even in managing the challenges of midstream project changes.

Managing stakeholder relationships - Project leaders need to be networked with research-output users, other researchers (local and international) and institutes. Engaging the correct stakeholders and keeping regular contact and information exchanges with stakeholders is vital. In general, managing relationships with major stakeholders needs careful attention and certain stakeholders might have to be engaged very closely with the research process to ensure commitment and buy-in to the projects, as well as confidence in the results to facilitate utilisation.

Salvaging projects - Research projects may "fail" in the course of events, for various reasons. A strong project leader should be able to assess the value of salvaging such projects particularly to minimise the loss of investment already made in the project. In the process, the challenge would be to win the confidence of other stakeholders in the project on the basis of decisions that the leader may take.

Recognition - The project leader should be an individual who has experience and who is recognised and respected in the stakeholder community. Such a person ensures a level of confidence from the stakeholders, in the project and its outputs, soliciting attention and maximising the chances that the project outputs would be utilised.

Project management - A project leader ought to have good project management competencies to ensure that the project is appropriately resourced and that as far as it is possible, projects are conducted on brief, on budget and on schedule.

Recommendations

In awarding research projects, a system that will ensure the allocation of projects to teams led by good research project leaders, i.e. project leaders having all or most of the above attributes of good leaders, should be used. However, as this is done, recognising the need in South Africa for skills development and for the generation of more good research project leaders, such awards should be linked to capacity development. Leaders should develop their teams.

To assist with creating, identifying and retaining good leadership, a credible recognition system for innovation and research utilisation should be developed. This could be similar to the rating system of the NRF but specially tailored for this purpose.

4.2 Research Teams

The benefits of conducting research in teams have long been recognised. It is apparent from these studies that such arrangements also enhance the likelihood of utilisation of research results.

4.2.1 Key Findings

Some of the specific findings with respect to research teams include:

Cohesion - There needs to be cohesion and a common commitment in the research team. Achieving this is aided by clear goal setting, which is an important ingredient for obtaining the desired results. Disagreements and lack of cordial relations can hamper progress and therefore has to be managed carefully.

Flexibility - Research teams must be flexible and be able to respond to the new needs of users. They may even need to communicate their research results differently for different stakeholders as the project develops and spin-offs or results not originally anticipated are produced. The possibility of utilising the research findings for others users has to be constantly assessed.

Mix of researchers - Having the right mix of senior and junior researchers, as well as postgraduate students, as well as linkages to national and international researcher partners creates a dynamic environment for the generation, dissemination and utilisation of research findings. At the same time this also creates a healthy environment for the development of appropriate high-level skills. The encouragement of young researchers within the team helps create the new culture that is required for research utilisation. Often the more senior and highly experienced researchers continue to live within the "republic of science" paradigm and don't anticipate the possible socio-economic potential of research findings.

Knowledge accumulation - Working in teams provides for a concentrated accumulation of know-how and expertise. This knowledge and expertise is readily available to the team and can be actively utilised in more applied projects.

Skills - There is a serious concern about the skills shortage and the effect of this on the utilisation of research results. The users of research outputs and in particular the private sector especially expressed this concern. There are just not enough graduates and most of them are not well trained, encouraged or supported to commercialise research findings.

4.2.2 Recommendations

We should build research teams around good project leaders, with a clear and common purpose and focus. The team should be diverse, constituted according to the output expectations from the team.

The above ties in well with the concept of centres of innovation, a growing phenomenon in the country. We should ensure that there is an adequate presence of these in the country, at least covering the prioritised industrial sectors. The design and nature of these centres should be such that they have the traits mentioned in the key findings above.

The appropriate training and skills development of science and technology students should be accelerated. Mechanisms for this acceleration could include:

- The number and the value of bursaries for young people should be increased to attract and retain them in the system.
- Firms should be encouraged to take on science students and researchers into their laboratory or appropriate production environments.

4.3 Funding

It is inevitable that the lack of funds, in a variety of forms, would be highlighted as a major constraint to the successful implementation and utilisation of research and development. There is, however, substantial evidence that the better utilisation of funds is a first priority.

4.3.1 Key Findings

The main aspects of funding indicated in both reports requiring attention were:

Contractual arrangements - The contractual arrangements around funding need to be clearly defined at the outset between researchers and end-users to reduce the potential for conflict, and to improve the probability of a successful outcome. Inadequate costing and financial planning in terms of the total cost, as well as the cash flow, can hamper both the successful completion of the project and the potential utilisation of the findings.

Approval process - SMME's were particularly critical of the long period required for the approval of funding. Newer technologies have shorter "concept to product to market" time frames and require a rapid response to market opportunities. The approval process is currently geared to the academic environment and to large companies that can absorb the resultant cash flow crises.

Venture capital - The lack of true venture capital was also highlighted as a restriction in the growth of research and development utilisation. Often the evaluation of the project was on financial performance only and not on technical merit or other positive attributes.

Intellectual property - The low conversion rate to IP, mostly in the form of patents (in SA 1 in 40 compared to 1 in 3 in Europe) was ascribed to the lack of funds. The main reasons were given as the cost of IP, the inability to defend an attack on the IP due to the costs involved, the perceived or real complexity of the IP process, and the dangers related to publishing innovations that could be easily copied.

Size of grants - Project funding was significantly correlated with successful research utilisation. The survey data shows a strong correlation between the size of the grant and the utilisation of research. This suggests that larger projects, which have access to more resources (more researchers, equipment, infrastructure, more intellectual capital in the form of networks), are more likely to lead to effective utilisation.

4.3.2 Recommendations

Funds Management - It is essential that there is a good written understanding between the parties involved regarding the amount of funds available. The use of funds, the conditions or allocations intended for certain aspects of the project, the exact period and the rate over which the funds are used to achieve specific outputs, should be clearly specified. The monitoring and evaluation periods of fund utilisation vs outputs must be agreed. If possible, contingency scenarios for unexpected variations to the contract should be developed.

Large collaborative grants - Funding should be allocated to large collaborative projects. The larger collaborative projects are more likely to lead to effective utilisation. The relatively high cost of the allocation of funds to many small projects and to maintaining these projects compared to their outcomes were not considered effective.

Allocation process - It is essential that the government fund allocation process is revisited in cases where the time to get 'concept to product to market' is critical to the success of the project.

Incentives - The incorporation of incentives in the funding package would be beneficial in addressing the following issues:

- The ratio of publication to patents and other forms of diffusion should be increased.
- The pool of researchers to overcome the skills shortages should be enlarged.
- Preset targets should be achieved.

5. ENABLING ENVIRONMENT

This study indicates that the environment plays a critical role in the successful uptake of research. In addressing the following three areas it is anticipated that an enabling environment for research utilisation would be created. The three areas are:

- Collaboration
- Support systems
- Project management.

5.1 Collaboration

Both CENIS and the case studies reflect a high correlation between the scale of collaboration and the extent of research-result utilisation. This is mainly ascribed to the enrichment brought to a research programme by collaboration in terms of the resources and extended networks. These findings were largely confirmed by interviews that were held with users of research results in industry.

5.1.1 Key Findings

Multidisciplinarity - It is noted that collaboration that is multidisciplinary and which involves researchers from various sectors, brings innovative ideas and leads to the more effective utilisation of research results.

Composition - Collaboration that endeavours to have a balanced mix of experienced researchers and postgraduate students and which is also composed of local, continental and international partners achieve most objectives of utilisation. The latter also provides researchers with the mobility that fosters acquaintances and optimises the assimilation of tacit knowledge.

Agreements - Effective utilisation occurs where users and stakeholders are involved from the conception to the completion of projects. Collaboration partners should agree on Intellectual Property rights before entering into collaboration.

These findings were confirmed by the interviews that were held with the users of research results in industry.

5.1.2 Recommendations

- Research collaboration should be institutionalised through the appropriate funding mechanisms and incentives.
- Local and international collaboration that cuts across different sectors should be encouraged.
- Dialogue between the users and producers of research should be promoted, by matching them, for example in holding seminars on success stories that would attract both communities.
- Proper agreements should be in place from the early stages of producing the results up to the final stages of using the research results.

5.2 Support Systems

The successful utilisation and dissemination of research results proliferates in a supportive environment. The issues grouped under the heading of support include basic research, institutional support and funding.

5.2.1 Key Findings

Basic research - A strong foundation of basic research, with a good record of scientific outputs, is essential for the successful implementation of research results.

Institutional support - The understanding and support (in terms of opportunities and resources) provided by institutions hosting research activities contributes significantly to the utilisation of research results. In particular, the creation of an environment conducive to research utilisation and innovation by an institution, with minimum bureaucratic processes and restrictions on projects encourages innovation. A clear framework for those researchers that are involved in innovation provides a sense of security and encouragement. The capacity of the private sector should also be enhanced to increase their absorptive capacity.

Funding - The provision of long-term funding creates stability, and makes it possible to conduct the comprehensive pre-competitive research connected to the effective utilisation of research results.

5.2.2 Recommendations

Rating system - A rating system for innovation that is parallel to the NRF rating system should be developed to rate institutions as well as individuals. The system should be used to recognise and encourage innovation and research utilisation.

Innovation policy - Institutions should be encouraged to develop clear policies that outline the role of innovation within a predominantly academic environment. Full-time researchers at higher-education institutions who dedicate their efforts to research and to the utilisation of its results should be recognised and encouraged. The restructuring of the higher-education framework should be negotiated to increase support for research, innovation and the utilisation of research results.

Institutional support - Full institutional support for research programmes should be ensured through the explicit indication of institutional commitments in research proposals by all partners. Additional resources for encouraging the utilisation of research results, which is not in competition with the development support for human resources, could be helpful. Research-result users should be supported to enhance their absorptive capacity.

5.3 Project Management

The implementation of and adherence to the basic principles of project management were regarded as vital to the success of research and development programmes.

5.3.1 Key Findings

The main aspects of good project management were identified as:

i. Funding lines and reporting requirements should be clearly defined and agreed upon at the outset.
ii. Intellectual Property rights and the process and funding thereof should be agreed at the outset.

iii. Management and reporting structures should be well defined.
iv. The progress and outputs, both internally and with users, should be monitored and evaluated.
v. Appropriate budgets and management of funds should be in place.
vi. External review processes should be in place.

5.3.2 Recommendations

Training - Research leaders and research teams should complete training courses on project management, communication skills, etc.

Experience - 'Hands-on' training in project management should be incorporated into local programmes to provide postgraduates with exposure and experience in project participation and management.

Professional management - In most cases the research leader does not possess the project management skills to effectively manage the program, as well as to increase the probabilities of research utilisation. The appointment of professional managers should be considered as a priority in large projects where the possible benefit for research utilisation is self-evident. Where appropriate, the sharing of professional managers could be considered for smaller projects.

6. DEMAND-SIDE MEASURES

The main factor on the demand side that has a bearing on research utilisation is the notion that there should be stakeholder interaction from the very beginning of research projects, even in the earliest phases of setting the research agenda. Viewed from the perspective of the research programme, sector involvement is essential from the outset in setting the research agenda, including the phases of problem conceptualisation, costing and the dissemination of the research results to the larger community that may have use of them

6.1 Stakeholder Interaction

The main factors concerning the involvement of stakeholders that were identified were that stakeholders should be involved in the identification, design and progress of research projects so that trust can be built, tacit knowledge can be tranfered effectively and the absorptive capacity of industry for research findings can be improved.

6.1.1 Key Findings

Consultation - In post-apartheid South Africa social interactions are characterised by high degrees of consultation and transparency. In the research arena this translates into an expectation that researchers should not only consult their clients and the potential beneficiaries of their work, but have them as active *participants* from the earliest phases of project identification and design, and subsequently keep them informed of progress throughout the course of the research. Ideally clients should also take part in the evaluation of the final report on the research. International experience and the background research and

reports prepared for the working group documented the importance of the above participative and consultative process in ensuring that research results are meaningful to beneficiaries, thus optimising the uptake of these results.

Trust - Continual interaction with clients also serves to avoid potential misunderstandings and assists in bringing the cultures of the industrial client and academia closer together. Participatory processes nurture trust between participants and provide the opportunity for obviating client scepticism, which often inhibits the use of research findings. It also allows for some important principles of successful innovation, such as spin-offs for small companies, to be more widely appreciated.

Tacit knowledge - An important gap in successful technology transfer was identified in the failure to pass on tacit understandings of the process both to stakeholders and also to younger members of research teams. This was mentioned specifically in the client interviews as one of the major stumbling blocks in successful research utilisation, particularly for research funded by public money.

Sector involvement - Besides consultation with clients and potential beneficiaries, the background documents highlighted the need to involve all sectors and stakeholders likely to be affected by the implementation of the research. This should be done at the highest leadership levels to ensure the buy-in of the decision makers in these sectors and among stakeholders and to obviate future misunderstandings and problems. Such consultation will also ensure that these participants have the opportunity to bring a holistic and macro-perspective to bear on the definition of the research problem and to make an informed assessment of the likely impacts of the implementation of the results.

Absorptive capacity - Consultation will also serve to inform and sensitise public-sector leaders and stakeholders to the latest research developments and ground-breaking trends in technological development that may open up new horizons for local application. In this manner a mindset for the successful technological transfer into the public domain is fostered.

Diffusion - Research findings should be made accessible to all sectors as soon as possible, and should not simply be reflected in academic publications. Mechanisms need to be developed at the project formulation stage to ensure the appropriate dissemination of the research results

6.1.2 Recommendations

Business planning - The business planning of public science must ensure that sector-wide consultation and participation considers and caters for all interests - national, regional and individual - in advance of implementation.

Research Programmes - Research Projects/Programmes should be developed in consultation with potential users and stakeholders at all levels. The development of research proposal should be based on sound conceptual principles, which should be enhanced by a strong basic research foundation.

Market research - Adequate market research must be undertaken and a real need for the research identified.(This could be either a short-term need in the case of pressing problems faced in industry or longer term as in 'blue-sky' research conceptualised by the academy in consultation with industry).

7. CONCLUSION: A Framework for Implementation

A number of detailed recommendations have been made in terms of the innovation system that has been developed here. However, implementation of such a range of diverse recommendations in a piecemeal way may result in a dissipation of energy and fail to achieve the desired outcome. A framework for implementation, which will give focus to NACI's efforts to improve research utilisation, has thus been provided in the form of four key initiatives.

7.1 Networks of Innovation

A cornerstone of the strategy to optimise the utilisation of research results would be the creation of a number of 'networks of innovation'. The field of work should be determined in a consultative manner between researchers, industry and government. The choice of centre should be in line with the government's priorities, research capacity, international trends and the capacity of industry to absorb the outputs of research.

The principle investigators should be highly experienced researchers with strong international and local links to both the research community and industry. The qualities of project leaders are elaborated in Section 4.1. A large, strong research team should be built around experienced project leaders. Teams should have a mixture of experienced senior researchers as well as strongly motivated graduate and postgraduate students. In addition, the teams should also address the issues of transformation both in terms of race and gender.

It has been demonstrated that projects with substantial funding are more likely to have successful outcomes. This funding should be provided to collaborative projects. In order to manage substantial funding, dedicated project mangers should be employed to ensure that targets are met in time and within the budget.

The various institutions, including the private sector, that are involved in the project should provide committed institutional support.

Responsibility
NACI should interact with DST and create Networks of Innovation within the science vote budget.

7.2 Rating System for Innovation

A rating system should be instituted for innovation. The present NRF system caters for the academic community but it does not cater for all disciplines and science councils. The new Innovation Rating should be for individuals as well as institutions. The system could be run by NACI.

Responsibility
NACI should develop an innovation rating system.

7.3 Innovation Policy

Institutions should be encouraged to develop policies that are innovation friendly. This would include forms of dissemination other than academic publication. For those staff members that bring in substantial grants, teaching or service-delivery loads should be decreased.

Responsibility
DST should engage with the DoE and the heads of the various institutions to develop an Innovation Policy for Institutions.

7.4 NACI's Advocacy Role

NACI should play a much greater role as advocates for innovation. A regular publication should be instituted that highlights innovation in South Africa. In addition, a database of successful innovation should be maintained.

NACI should also play an important role in encouraging government departments and the private sector to establish environments that are conducive to innovation and research utilisation.

NACI should play an active role in supporting the protection of intellectual property (IP). This should be done through incentives to register IP as well as in removing obstacles to the registration of IP.

8. REFERENCES

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