

"DACST REVIEW"

REVIEW OF THE CSIR

**REPORT TO THE DEPARTMENT OF
ARTS, CULTURE, SCIENCE AND
TECHNOLOGY**

1 DECEMBER 1997

The Honourable Lionel Mtshali
Minister of Arts, Culture, Science and Technology

Dear Minister Mtshali

REVIEW OF THE CSIR

I have pleasure in submitting a report on the review of the CSIR carried out by the Panel appointed by DACST.

The review was carried out over the period 3 – 17 November 1997, and sought to answer the questions raised by the Department in the Terms of Reference and the description of the overview of the process. The Terms of Reference are attached as Appendix 1 to the report.

The Panel was made up of the following members:

Dr Gerd Deuster
Mr John Hall
Dr Bill Howard
Professor Dave Kaplan
Professor John Martin (Chair)
Mr Peter Masemola
Dr Ramesh Mashelkar
Mr John Moalusi
Dr Bert Westwood

Brief CVs are provided in Appendix 2.

Dr Alistair Ruiters was appointed as a member of the Panel, but unfortunately has not been able to take part to any significant degree.

The review followed a process of consultation and discussion with a wide range of stakeholders and clients, together with the executive and other members of the CSIR itself. The programme is summarised in Appendix 3.

The report does not follow the outline suggested in the DACST overview document. The Panel has chosen to use a format that follows the logical development of its assessment. However, the sections of the report can be matched to the original chapter headings, and this is indicated in the in the Table of Contents and Executive Summary.

Based on its assessment of the CSIR, the Panel has made a number of broad recommendations that appear in the Executive Summary, and a number of specific suggestions that appear in the text of the report.

Yours sincerely

A handwritten signature in black ink, appearing to read "J B Martin". The signature is written in a cursive style with a large initial "J" and "M".

J B Martin

1 December 1997

CONTENTS

1. EXECUTIVE SUMMARY

- 1.1 Introduction
- 1.2 Synopsis of the Report
- 1.3 Recommendations

2. ALIGNMENT WITH THE OBJECTIVES OF THE NATIONAL SYSTEM OF INNOVATION [10]

- 2.1 Introduction
- 2.2 Innovation in the CSIR – Process and Products
- 2.3 Suggestions for New Measures and Initiatives for Enhancing Institutional Innovativeness

3. THE CSIR'S TECHNICAL CAPABILITIES TO MEET NATIONAL NEEDS [1, 2, 3, 8]

- 3.1 CSIR's Core Competencies [1]
- 3.2 Performance Assessment of Core Competencies [2]
- 3.3 Resource Allocations to CSIR Technologies [3]
- 3.4 Sector-Specific Issues [8]
- 3.5 Quality of Knowledge-Based Products: Scientific Papers and Patents

4. NON-TECHNICAL ISSUES

- 4.1 Governance, Ownership and Structure [9]
- 4.2 Management of the CSIR [6]
- 4.3 Human Resources [7]
- 4.4 Commercialisation Policy [4, 5]

5. CLIENT PERCEPTIONS [5]

- 5.1 Introduction
- 5.2 Market/Client Characteristics
- 5.3 External Contract Income
- 5.4 Client Perceptions
- 5.5 Conclusions and Suggestions

6. CONCLUDING REMARKS

Figures in square brackets [] refer to the section heading suggested by DACST in the document entitled "Appendix A: Overview of the Review of the CSIR".

1. EXECUTIVE SUMMARY

1.1 Introduction

The Review Panel was appointed by the Department of Arts, Culture, Science and Technology (DACST) to "conduct a thorough and comprehensive review of the CSIR". The specific requirements of the review are set out in the Terms of Reference.

The Review Panel has focused on the strategic directions of the CSIR in the course of its review. The Panel heard presentations from, and had discussions with, the Minister of Trade and Industry, members of the Portfolio Committees of DACST and DTI, the Director-General, Deputy Director-General and senior officials of DACST, members of the CSIR Board, the CSIR Executive, the nine Divisions, various internal groups including NEHAWU, and a range of stakeholders and clients.

The broad view of the Panel is that the CSIR is an effective organisation that is enthusiastically and vigorously attempting to meet the demands of the new policy climate in South Africa. In some areas it has been very successful in meeting its goals, while in other areas further progress remains to be made.

This report attempts to analyse, at the level of strategic directions, some of the CSIR's strengths and weaknesses in a way that leads to constructive recommendations and suggestions. The Panel believes that with appropriate support from government and continued good management the CSIR can progress from a very good organisation to a great one, with technical competencies of world class and contributing significantly to the nation's economic well-being.

1.2 Synopsis of the Report

The Report begins (Chapter 2 [10])¹ with an account of the manner in which the CSIR's philosophy and programme are aligned with the objectives of the National System of Innovation. Indeed, the Mission Statement of the CSIR states that the organisation is "committed to innovation" and the provision of "technology solutions and information to support sustainable development and economic growth in the (framework) of national priorities". The chapter continues with a description of the innovative process at the CSIR, its links with the traditional knowledge base, some products of the process, the need for and use of knowledge networks and partnerships, strategies to improve the efficiency of the process, and the suggestion that the "I" in CSIR might more appropriately refer to innovation than to industry.

Chapter 3 [1, 2, 3, 8] begins by addressing the issue of core competencies, their identification, quality, and the allocation of resources to them. The Panel concludes that the CSIR's core competencies reside in technology, namely materials, manufacturing and information technologies, and in outstanding management skills, exemplified by their development of a world-class system for the analysis, distribution and content of financial resources, and for its exemplary human resource development programme which has, for example, increased the number of black professionals from 68 in 1994 to 145 in September 1997 (13% of professional staff),

¹ The number in brackets, e.g. [10], refers to the number of the paragraph on p. 2 of DACST's document entitled "Appendix A: Overview of the review of the CSIR".

and of women professionals from 216 in 1994 to 271 in September 1997 (23% of staff). In addition, two of the four Executive VPs are now black, and one is female. The CSIR's commitment to transformation is real and the results are evident.

The Panel concludes also that, in manufacturing, the CSIR's work is on a par with work in manufacturing technology at a comparable laboratory in the United States, namely the National Institute of Standards and Technology (NIST); that the CSIR's work in materials is competitive with similar research groups around the world, but that it is spread too thinly to be competitive with some of the best, e.g. at Sandia National Laboratories. Information Technology is a pervasive activity throughout many of the CSIR's activities, but the CSIR's role in contributing to the development of this critical field needs to be defined, and the CSIR should consider hiring an internationally recognised leader to provide vision and momentum. Information technology, though critical, is not yet world class.

As implied earlier, the leadership of the CSIR is excellent. It is mission-focused, visionary, dedicated, energetic, of high technical ability and people-oriented.

Equipment at the CSIR is adequate at present, but investment will be required in computer simulation, virtual reality and biotechnology should management decide to pursue these areas, as has been advised. Similarly, financial resources are also adequate for now, but to enter the fields of technology just mentioned will require capital investments and additional funding, initially via the Parliamentary Grant, perhaps of the order of 10 – 25 million Rand per annum.

Chapter 3 concludes with some remarks on the organisation's capabilities in technologies other than those deemed "foundation", and discusses a number of other issues, including the CSIR's relationship with universities, various sector-specific topics [8], and the quality of technical publications.

Chapter 4 [4, 5, 6, 7, 9] focuses on non-technical matters such as governance [9] (e.g. the role of the Board); management [6] (including a number of suggestions directed towards the management of the CSIR); human resources (an assessment of the CSIR's effective and demonstrated commitment to transformation, equity and redress, illustrated by data on progress since 1994 and plans through 2001) [7]; and technology transfer - and intellectual property matters [5]. The report notes that the CSIR needs to develop a strategy and plan for commercialisation beyond the current somewhat ad hoc approach. Likewise, intellectual property protection should be more aggressively and systematically pursued.

Chapter 5 [5] addresses the markets for the CSIR's services, and clients' perceptions of their capabilities, responsiveness and value. In general, the majority of clients are well satisfied with the CSIR's performance, and even those for whom things did not go well in the past were constructive in their comments, and willing to use the CSIR's services again.

2.2 Innovation in the CSIR – Process and Products

2.2.1 The innovation process in the CSIR

Innovation needs to be the focus of all that the CSIR does. Understanding the imperative of building South Africa as a “knowledge society” as well as understanding the fierce competition in the “knowledge market” that it serves with the CSIR’s “knowledge workers” are crucial.

Building an innovation environment implies appropriate human resource policies, where innovators are identified, encouraged and rewarded. Does the CSIR provide a career space that promotes innovation? The CSIR has a four-stage career framework. It represents a mapping process (see Fig. 1) rather than a conventional dual ladder system.

It is possible, in this system, for an individual to develop a career trajectory in which he/she can move from a strong technical position to a strong managerial position, or vice versa. The rise to career stage IV profile, for instance, is supposed to recognise an idea innovator who provides ideas, intellectual breakthroughs, discoveries, new constructs, etc.

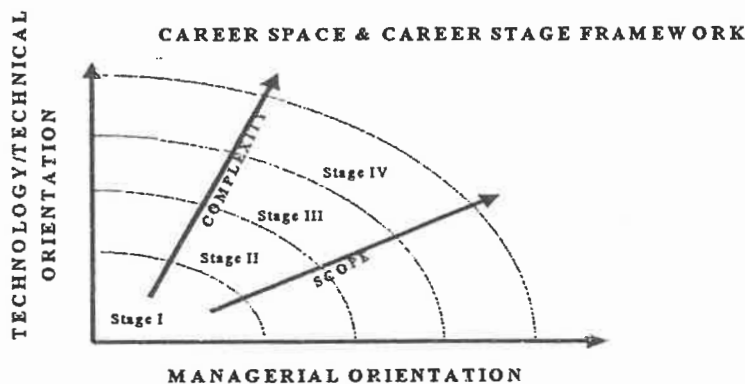


Figure 1 Management and technology space

These are some special initiatives also.

- The CSIR gives recognition to sustained technical excellence by awarding CSIR Fellowships, which represent the pinnacle of a technical career and are the highest level of recognition that is accorded to staff members by the CSIR. The CSIR fellows are those who have achieved sustained demonstrable excellence in their field of endeavour measured by international standards.
- Individuals whose unique research/technology initiatives have positioned them in the minds of clients and CSIR staff as true leaders within the business area covered by Divisional activities are recognised by elevation to Divisional Fellow.
- Individuals whose unique research makes a significant technical contribution to a programme are recognised by the title Specialist in their field of endeavour.

1.3 Recommendations

In assessing the role of the CSIR in South Africa, the Review Panel has characterised the evident attributes of the CSIR as **compassion, innovation and passion**.

Compassion requires that the institution react with sensitivity and empathy to the needs of individuals and communities in the broad society. **Innovation** implies an institutional capability and an institutional culture that fosters creativity and the generation of new ideas. **Passion** indicates the commitment and dedication required of innovators if their ideas are to be translated into products, processes and services that contribute to economic and social development.

The primary recommendations of the Review Panel are as follows:

1. DACST should support the CSIR in reconfiguring its technology portfolio, phasing out less mission-relevant activities and so releasing funds to develop significant new competencies in advanced manufacturing (e.g. computer simulation and virtual reality), modern biotechnology and aspects of information technology yet to be defined. Such initiatives will require some new funding. (Chapter 3)
2. DACST should support the CSIR in undertaking the **refocusing** of the divisions towards innovative longer term research projects directed towards developing enabling technologies on the basis of which industry can develop internationally competitive products. Initial development should be fully funded by the Parliamentary Grant, allowing full scope for creative thinking. As time progresses, externally generated funds should contribute to such projects. (Chapter 3)
3. The CSIR should actively encourage some of its own more entrepreneurial employees to leave, or take leave from, the organisation and establish knowledge-intensive technology based on small companies. The CSIR may wish to have an equity stake or in some other way share in the potential success of such ventures. DACST and the DTI should facilitate this process by drafting enabling legislation in this regard. (Chapter 5)
4. DACST should promote the CSIR as the leading link between the higher education institutions and industry as a means of mobilising the technological talent available in South Africa as effectively as possible towards the ends of the National System of Innovation. (Chapters 2 and 3)
5. The CSIR should develop a comprehensive system of national and international alliances, linking the CSIR to world-class centres of excellence. (Chapter 3)
6. The CSIR should focus on becoming an organisation in which there is a high throughput of bright young people. In terms of innovative capability, the most creative time in the careers of many scientists and engineers is probably between 25 and 35. Individuals should move into the CSIR early in their careers, and in due course move on to industry or other government institutions. The CSIR thus

should play a role in developing the people who pass through it, and in turn will gain from their energy and expertise. The development of a dynamic cadre of post doctoral fellows at the CSIR should be one element in this initiative. (Chapter 3)

7. DACST should ensure that the structures envisaged in the White Paper on Science and Technology (e.g. the National Advisory Committee on Innovation and the National Research Foundation) provide clear direction at the level of strategic technology to the CSIR (and other players in the NSI) on government priorities. (Chapter 3)
8. The CSIR should institute incentive schemes for researchers to develop marketable intellectual property. The incentives could be in the form of a share of royalties on patents or of licence fees, or some other appropriate scheme. (Chapter 4)
9. DACST should continue to support the development of strategic technological capacities in the CSIR through the mechanism of the Parliamentary Grant. In the short term, given the need to develop new strategic directions, the amount of the grant should be increased. Over the longer term, external contract income, especially from the private sector, should fund a larger part of the CSIR's activities. The size of the Parliamentary Grant should be determined on the basis of demonstrated need. However, the Parliamentary Grant will continue to be essential and should not fall below 30-35% of total income. (Chapter 5)
10. The planning and execution of strategic research will be considerably enhanced if there is some measure of security in the Parliamentary Grant. DACST should attempt to develop longer term funding mechanisms with the CSIR, a process that will be significantly facilitated by the advent of the Medium Term Expenditure Framework. (Chapters 3 and 4)
11. DACST should exercise oversight of the CSIR so as to ensure that the Parliamentary Grant is allocated to the development of pre-competitive medium-term strategic technological capacities. (Chapters 3 and 5)
12. The CSIR should continue to charge its clients on the basis of full cost recovery. Where individual clients benefit directly from the earlier development of such strategic technological capacities, this should normally be reflected in the charge. (Chapters 3 and 5)
13. The CSIR should significantly improve its marketing activities in order to draw more private sector clients into its portfolio, to improve its image as a provider of technology solutions across the whole spectrum, to ensure that its capabilities are widely known and to manage perceptions concerning its dedication and commitment to transformation within the institution. (Chapter 4)

These recommendations are supported in the following chapters of the Report. A number of suggestions directed to the management of the CSIR are also generated throughout the body of the report, and others are collected in Section 4.2.

2. ALIGNMENT WITH THE OBJECTIVES OF THE NATIONAL SYSTEM OF INNOVATION

2.1 Introduction

The White paper on **Science and Technology (Preparing for the 21st Century)** outlines the key features and the thrust of the National System of Innovation for South Africa. It emphasises that a National System of Innovation can be judged as healthy only if the knowledge, technologies, products and services produced by the national system of science, engineering and technology can be converted into increased wealth by industry and business, and into an improved quality of life for all the members of society.

Towards this end, a clear distinction is made in the related Green Paper between a strategy for science and technology and a strategy for strengthening a national system of innovation in the following way.

"A national S&T system focuses attention on the outputs of that system; that is new knowledge and new technologies. A strategy for S&T is aimed at ensuring that there is a sufficient supply of these outputs. A strategy based on a national system of innovation includes, but goes beyond that, seeking in addition to promote changing the ways in which society and the economy do things. It is specifically concerned with supporting and promoting the attainment of national objectives by the creative use of the outputs of the S&T system."

In this perspective, it is important to recognise the CSIR's mission statement.

*"As a uniquely South African organisation, CSIR is committed to **innovation**. It provides technology solutions and information to support sustainable development and economic growth in the context of national priorities."*

The general synergy between the vision of the CSIR and what is envisaged in the statement on the National System of Innovation is obvious. The challenge is to take this synergy forward by a definitive and actionable plan with the focus on deliverables in the context of the fulfilment of the basic national priorities, namely enhancing competitiveness, enhancing quality of life, developing human resources, working towards environmental sustainability and promoting an information society.

We propose first to evaluate the **process of innovation** in the CSIR, especially with reference to the CSIR's efforts to create the right intellectual and managerial environment, i.e. "space", for innovation, policy and management actions to enhance the innovation and creativity of its knowledge workers, building new knowledge networks (both intra and inter), etc. We will then evaluate some of the CSIR's **products of innovation**, which represent creative and innovative thinking of a high order, and against which the CSIR can benchmark itself. Finally, we will make some specific suggestions concerning new measures to enhance the alignment of the organisation to meet the goals of the National System of Innovation.

The CSIR has also initiated an innovative process for linking with the traditional knowledge base. Using university students, several technologies in rural villages have been identified. A workshop involving rural communities is planned for the beginning of 1998.

An audit of indigenous technologies has been initiated, involving the participation of the Universities of Northwest, Zululand, Fort Hare, Venda, etc. Each university will select about 50 students for the programme.

In the area of bioprospecting, links have been established with the Medical Research Council, Agriculture Research Council, Geoscience Council, Human Sciences Research Council, FRD, etc. The CSIR is actively participating with DTI and DACST on the problems of promotion of traditional heritage. Specific programmes, such as small-scale mining, where the beneficiaries will be small communities, also are being launched.

The CSIR sharply focuses the Parliamentary Grant on the basic national priorities highlighted in the National System of Innovation. An Investment Process Tool, developed in-house, allows for on-line planning, management and evaluation. For example, during 1997-98, the Parliamentary Grant investment is proposed to be spread over competitiveness (36%), quality of life (20%) environment (6%), information (12%), human resource development (12%), and other priorities (14%).

2.2.2 Some concerns

The Panel is concerned that the organisation is not doing enough to promote and reward innovation. "Management focus" has taken over from "innovation focus". Emphasis on cost controls and deadlines appear to have reduced the space for creativity and there is a need to bring innovation back to the centre stage via some management initiatives (see 2.3).

2.2.3 Products of innovation in the CSIR

Having considered the process element of innovation in the CSIR, it is important to examine the products of innovation from the CSIR.

By challenging the innovative ability of the knowledge workers at the CSIR, it is possible to generate significant innovations - be they products, processes or services. On reviewing several of the CSIR's offerings over the years, the Panel senses that the innovative and creative content of its products has diminished somewhat in recent years. Outstanding examples of high levels of earlier innovation against which the CSIR should now continuously benchmark itself, are highlighted below:

Innovations driven through new conceptual frameworks

Zebra Battery: Creativity in electro-chemistry and thermodynamics led to the development of high energy density batteries based on iron-sodium chloride systems. Considering that the sodium-iron chloride system had already been dismissed as of no importance relative to systems such as sodium-sulphur, this is a significant breakthrough. It has led to the generation of over 100 patents in the Zebra portfolio.

Lithium Battery Materials: The development of lithium manganese oxides as cathode materials for rechargeable room-temperature batteries was an innovation in structural chemistry within the lithium-manganese-oxygen ternary system. The stable phase and its utility in battery systems, which is described for the first time in the core patent, represents excellent intellectual rigour in elucidating the crucial role of the elusive lithium ions in the structures.

Innovation through cross-disciplinary thinking

Supertag: The core intellectual achievement that underpins Supertag is a statistical algorithm that permits the unique recognition of individual "markers" or tags which are not in themselves unique. This innovative thinking was combined with "hard" technologies such as radio frequency competencies, chip design, signal processing and system engineering to produce a technology demonstrator that constitutes a world first in the domain of tagging and tracking.

Seam Quality Evaluation System: SeamCAM represents a unique integration of mechanical, optical and software design and engineering to address a previously intractable measurement problem – the assessment of the seam quality of cans.

Innovations triggered by demanding targets

Tensojet: The Tensojet Tensile Tester is an instrument based on a new method developed by the CSIR for the testing of yarns. Tensojet differs completely from the classical tensile testing machines. It is a revolutionary high-performance testing capability that realises undreamed of possibilities for quality control at textile mills.

Breathing Rainwear: Textek has successfully advanced the technology of manufacturing waterproof materials that can breathe. Their approach involves laminating microporous or hydrophilic membranes to textile fabrics. Their products increase comfort and safety at much reduced cost. The commercial applications are diverse.

Innovations through partnership with people's knowledge

Appetite Suppressant: Foodtek have discovered and patented a novel appetite suppressant (for medical treatment of obese patients) from an indigenous plant, which is currently undergoing animal trials, and promises to be the world's first treatment for obesity with a natural product, free from adverse side effects. It may become the first important pharmaceutical discovered and developed in Africa, and also the first major chemical product derived from the rich biodiversity of this continent.

Innovation triggered through social demands

Alien Invader Plant Control: The CSIR's application of the findings elsewhere that the removal of water-demanding alien vegetation from river banks enhances water availability to the Theewaterskloof Dam catchment resulted in additional water being delivered at only 10,5% of the cost of that from the proposed Skuifraam Dam Scheme. The economic impact of this innovation is enhanced by the provision of jobs through the related "water for work" programme.

The products of innovation from the CSIR outlined above represent a few of the high points in the CSIR's history. They demonstrate that the CSIR can exhibit the capacity to innovate at the highest level. We note, however, that innovative productivity varies considerably from division to division, and may not have been sustained as well as it might have been. Enhancing the spirit of innovation through the measures described below should move the CSIR towards its destiny as an innovation-centred world-class organisation.

2.3 Suggestions for New Measures and Initiatives for Enhancing Institutional Innovativeness

2.3.1 Innovation chain-building through knowledge networking

Inter-divisional knowledge networking in the CSIR

The diverse interdisciplinary strengths in different CSIR divisions have to be synergised to create a borderless scientific community in the CSIR. Cross-disciplinary collaboration between scientists and engineers from different disciplines is crucial for technological advances, which can be, in the end, only a sum total of numerous creative ideas emerging from a multidisciplinary culture. Innovation is not a one-dimensional process. It is comparable to the intermeshing of the gears of a clock. This process of creating inter-divisional knowledge networks has to be driven by an enabling and imaginative research policy. A few suggestions follow.

- *A "Chat Room" on the Intranet:* the CSIR Intranet performs the function of information sharing. However, its scope could be enhanced to do problem-solving by establishing a chat room on the Intranet. Typically, any CSIR employee could pose a problem on the Intranet and any one of the CSIR's 3 000 employees could send in a proposed solution. Apart from creating borderlessness, it could encourage the entire CSIR to participate in the innovation process.
- *Cross-Disciplinary Brainstorming Sessions:* Invariably, research groups tend to brainstorm internally, without having any input from knowledge workers from unrelated fields. A system could be put in place where, as a matter of practice, a few "creative thinkers" from unrelated disciplines are invited to participate in such meetings.

2.3.2 Global knowledge networks

Innovation Chain Building with Academia

Although the CSIR has built some linkages with South African universities, the need to build innovative chains with them is urgent. The strategies and objectives would be as follows:

The CSIR should establish a system to regularly search for new ideas, concepts, and inventions from academia (Supertag is a good example of the rich benefits that may accrue from such an approach.) Towards this end, the following could be created:

- **The CSIR could consider generating a large and dynamic cadre of young researchers (such as post-doctoral fellows), who are not permanent employees of the CSIR, but who could provide a vigorous influx of new ideas. They could spend two (or a maximum of three) years at the CSIR. The best of these scientists (but not more than 10%) may be retained.**
- **A CSIR-University Innovations Platform, which provides an opportunity for idea sharing among a defined community of scientists. This could take the form of a biannual event in specific areas.**
- **CSIR technology scouts (as part of a future CSIR external technology acquisition group), whose entire responsibility would be to visit different universities regularly to scout for exploitable opportunities. Three or four creative people could serve this purpose.**
- **The CSIR should identify the fundamental knowledge requirements of some of its projects and contract such work to universities and technikons.**
- **The CSIR could create and fund CSIR Chairs or joint CSIR-academic appointments in universities and technikons to foster their areas of interest.**

Globalising CSIR's R&D business

The focus in high technology business is shifting towards a skill-based competition. A product is merely an intermediary between a company's skills and the market it serves. However, in view of the costs involved, companies cannot justify assembling all the skills in-house to carry out development. Assembling the skills from around the world by using appropriate knowledge networking to develop a product is becoming a challenge for the External Technology Acquisition groups in companies. **The CSIR has a great opportunity to become a part of this global research and development business by undertaking contract research, licensing, etc. with global corporations.**

The CSIR could benefit in many ways:

- Enhancing its research base and leveraging its intellectual property.
- Conducting research as a business, and gaining foreign income from niche markets.
- Sharing current knowledge with of companies abroad.
- Acquiring skills in innovation management by "holding hands and running with the best".
- Creating wealth and jobs in South Africa by contractual arrangements with foreign companies in which the products of such global collaborative efforts are produced in South Africa.

A beginning has been already made by the CSIR with some world-class companies abroad (Daimler-Benz, General Electric, Phytopharma, etc.) but the process needs to redefine a quantum leap in expectations via a Strategic Alliance Policy for globalising the CSIR's business.

The CSIR could also strengthen regional networks after assessing the R&D business needs in Southern Africa/Africa.

Improving the Innovation chain by linking with Human Sciences/NGOs

In the innovation chain, when the end user or a direct beneficiary is the community, it is important to link with multiple sources, such as human sciences, NGOs, etc. to complete the technology delivery process. (The CSIR's unsuccessful programme at the Tyumbu brickyard, where failure occurred due to the lack of interactive communication with the client, the client's lack of bookkeeping skills, and limited and expensive after-care requirements from technology providers, illustrates the crucial importance of such integration.)

Innovation partnerships with grass root Innovators

South Africa is rich in bio-diversity and traditional knowledge base. The informal system of innovation, through which a traditional knowledge base gets built, is through empirical art, resulting in a non-documented, scattered, and non-coherent knowledge base. The CSIR, on the other hand, has a formal system of innovation, with access to the tools and methodologies of cutting-edge science. There should be a synergistic partnership between the formal and informal system of innovations. Some strategies are:

- **The CSIR's present programme on tapping people's knowledge by using schools/ universities should be enhanced and given special funding and formal status.**
- **Exploitation of people's knowledge (such as the CSIR's appetite suppressant) will need some pro-active strategies. However, if wealth is to be created out of community-based knowledge, then the community should expect to receive rewards. In view of the diffused base of traditional knowledge, the potential beneficiaries are not easily identifiable. The CSIR needs to develop and establish a system for achieving this.**
- **The CSIR should build networks with NGOs to facilitate this process, rather than building direct links with the community.**
- **The CSIR could initiate a programme on the generation of electronic data bases in traditional knowledge-based systems, not only for its own research, but also to create an easy access to other research communities and users in South Africa.**

2.3.4 Strategies to raise the level of innovation

New Idea Fund: While it is gratifying to see innovations such as the Zebra battery, Supertag, Tensojet, the appetite suppressant, etc., the Panel feels that it is these types of breakthroughs that give an organisation a sense of pride, a standing in the international innovation community and also financial returns if the innovation succeeds in the marketplace. **In order to invoke this spirit of intellectual adventure, the CSIR could**

create a small President's "New Idea Fund" to support ideas that are risky, highly impactful, based on non-obvious or non-linear thinking, but exhibit explosive creativity, and possess great potential impact. It is to be hoped that such a fund would lead to the Reverse Funnel and Bridge syndrome!

2.3.5 Human resource issues and innovation

It is the quality of the innovation community that the CSIR builds that will drive its innovation process. It is therefore imperative that the CSIR address the HR issues in building itself into an innovation society. Some suggestions in this regard are:

- The CSIR presently uses a four-stage "mapping" process for career growth, which claims to provide flexibility. However, the CSIR should consider creating a dual innovation or management ladder system to promote access of growth for innovations and innovation managers as against business managers.
- CSIR knowledge workers have complained of lack of "thinking time" due to pressure to meet time targets. Reducing thinking time leads to reduced creativity. Some percentage of "free time" should be made available to pursue individual activities, such as the development of special skills, novel concepts, etc.
- Introduce an "Innovator of the Year" award to recognise and reward innovation and creativity at the CSIR.
- "Technology management" is rapidly moving towards "knowledge management" but tomorrow will belong to the "innovation managers". The CSIR should take a lead in developing skills, courses and training in "innovation management".
- In order to give a strong signal of the CSIR's intent to become a world-class innovative organisation, the CSIR should consider the creation of a Vice-President for Innovation Management. Additionally, senior positions for innovation leaders could be also created in each division to carry out this function. Such individuals should serve as the voice for innovation in the Boardroom.

2.3.6 The CSIR as an innovation institution

The CSIR should declare and broadcast its ambitious agenda to become not just an S&T organisation, but an innovation organisation. The question arises, should the CSIR change its name to reflect its new mission?

For example, should the CSIR become the:

- Council for Scientific Innovation and Research?
- Council for Innovative Scientific Research?
- Science Council for Research Innovations?
- Council for Innovation through Research and Technology?

The changing image of the CSIR as an innovative organisation might be well served through such a declaration, which captures well the spirit of the National System of Innovation.

3. THE CSIR'S TECHNICAL CAPABILITIES TO MEET NATIONAL NEEDS

The CSIR's applied research and development activities focus on acquiring, adapting and developing technology capabilities to meet South Africa's needs, assembling technological solutions to address a wide variety of South African problems, and deploying those solutions into industry and society in the pursuit of wealth generation and improved standards of living, nationwide. To carry out these functions, the CSIR must actively manage technology processes not only to foster innovation, but also to identify the best technology choices to promote social change, develop human technical resources, advance industrial competitiveness and assure a clean, safe environment.

The CSIR's diverse technical strengths enable it to address a broad spectrum of South African needs. Some of its technical strengths reside principally in a single division (such as mining engineering in Miningtek or environmental remediation in Environmentek); the loss of any one of these strengths would cripple only that division. Other "foundation" technical strengths are present virtually across the whole organisation: loss of even one of these would do serious harm to the entire institution. In light of the number and diversity of technical divisions, the Panel concluded that it was impractical and of little value to catalogue all of the CSIR's divisional strengths. In this report the Panel chose to concentrate on the foundation technical strengths, that, taken together with management of R&D and the development of human resources, form the corporate core competencies of the CSIR.

3.1 The CSIR's Core Competencies

Based on its study, the Panel concludes that there are three core competencies that define the basis of the CSIR's capability to perform its mission. They are:

- A broad knowledge base in materials, manufacturing and information technology, and skillful application of these foundation technologies to solve diverse problems
- An innovative and efficient approach to managing the research portfolio
- A management team that is dedicated in principle and practice to human resource development, focusing on technical professionals.

Figure 2 illustrates the conceptual relationships of these core competencies.

3.1.1 The foundation technologies:

The three interacting foundation technologies - materials, manufacturing and information technology - are fundamental to the CSIR's competitive capability of addressing a broad spectrum of South Africa's needs. These encompass areas as diverse as food processing, transportation, mining and housing. Each CSIR division has some specialised competency in each of these foundation technologies, but beyond this, each foundation technology has a division responsible for maintaining this corporate skill at an internationally competitive level.

CSIR Core Competences

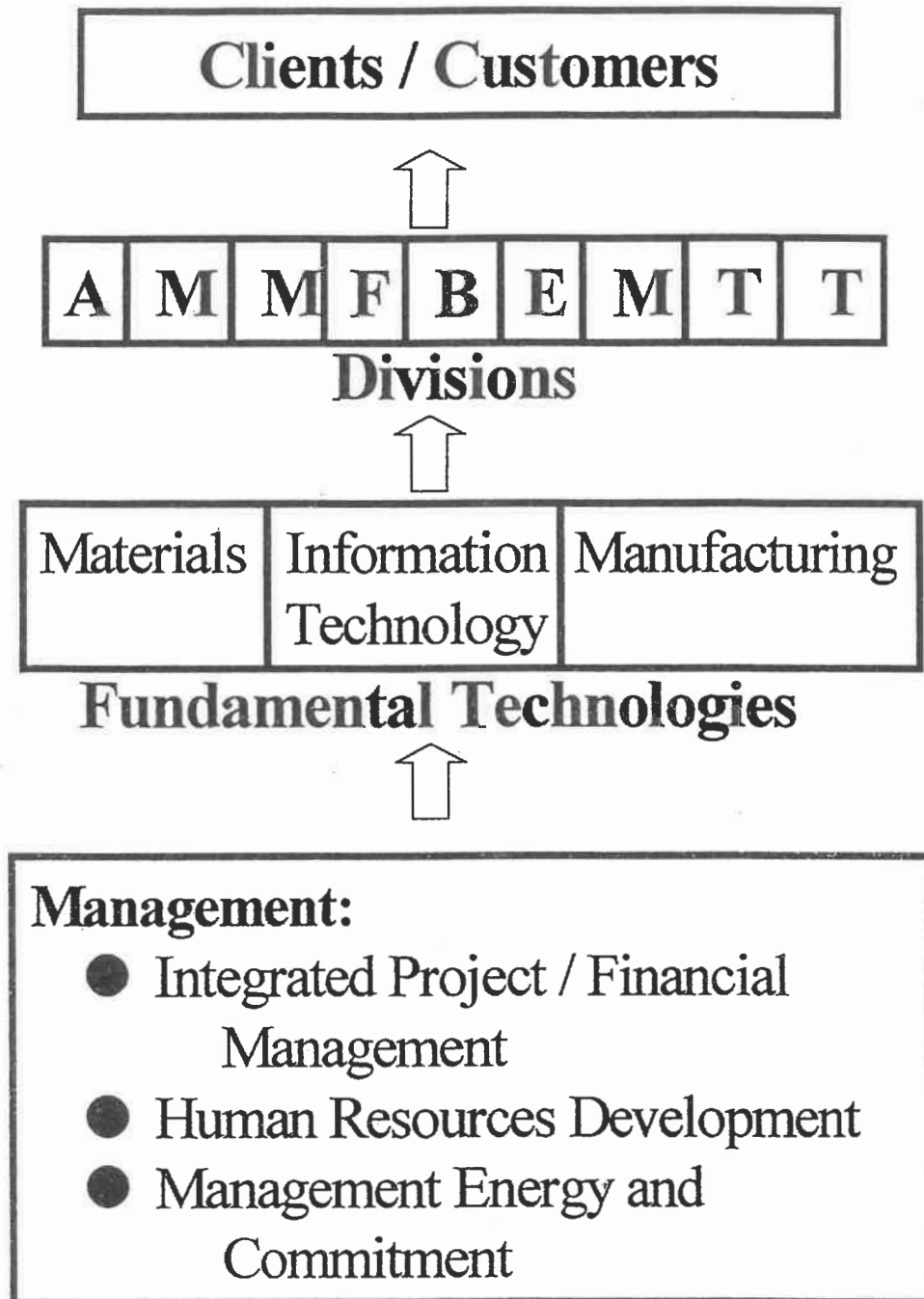


Figure 2 The CSIR's Core Competencies

- **Information technology** is the key ingredient in network-based communications, modelling and simulation tools, data sensing, control systems, database manipulation and decision-making for complex situations. Information technology plays a crucial role in formulating effective solutions to multi-variable, multi-disciplinary problems of the kind often faced by the CSIR and its clients. Mikomtek is charged with maintaining the skill level of the CSIR in information technology.

- **Materials processing, properties and application** are critical elements in many CSIR and client problems, whether they relate to defence, clothing, mining, housing or food. Mattek is the CSIR home for this competency.
- **Manufacturing** implementation and systems are involved a wide variety of CSIR contexts, such as food processing, home construction, textiles and transportation. However the methods and tools of manufacturing apply also to the organisation and planning of complex activities. Aerotek is the division responsible for maintaining and enhancing this competency.

The three foundation technologies, along with sector-specific expertise and other valuable technologies, are embedded in the CSIR's technical divisions. These organisations serve as focal points for a variety of industrial sectors, and the number and focus of the sectors change with time and circumstance. Divisions are expected to identify and acquire the most appropriate technological solutions to their customers' needs, be they high- or low-tech, either by acquisition from global sources or by inventing solutions when none are available. The CSIR then adapts, improves, customises and assembles the knowledge or components to deliver a comprehensive solution to the client's problem.

The CSIR's nine technology divisions address a diverse set of South African needs, namely:

- Aerotek: Aeronautics, Defence Products and Manufacturing Systems
- Boutek: Housing and the Built Environment
- Environmentek: Care and Reclamation of the Environment
- Foodtek: Food, Food Processing and Biological Testing
- Mattek: Materials and Materials processing
- Mikomtek: Information Technologies
- Miningtek: Mining
- Textek: Textiles
- Transportek: Roads and Road Transportation Systems

Each division incorporates the knowledge base and capability needed to apply the three foundation technologies to the special needs of the sector it serves, as illustrated schematically in Figure 3. Cooperative efforts among the divisions are critical to ensure optimal use of the CSIR's three foundation technologies and its diverse sector skills. Such cooperation is guided by the CSIR's thrust programmes.

The CSIR and the divisions themselves have deployed certain technical operations out of Pretoria to facilities in Stellenbosch and Durban (Environmentek) and Port Elizabeth (Textek). Additionally, the CSIR has established provincial development offices in each province to identify local needs. This process is not yet complete but as it proceeds it will enhance the CSIR's capabilities to address job creation and industrial development needs across the nation.

3.1.2 Management of the research portfolio:

Management of the research and development processes at the CSIR is world class. Corporate leaders have enthusiastically embraced the challenge of developing strategies and methods for the selection, conduct and control of R&D tasks and, in effect, are carrying out a programme to manage the research and development function that is as imaginative and innovative as the best of the CSIR's more conventional technology programs.

Technology thrusts, developed at the corporate level, are one expression of CSIR strategy. These extend across several divisions and form the basis for portfolio shaping and project decision at every organisational level. The thrust approach ensures that each division's project portfolio supports overall CSIR goals and objectives.

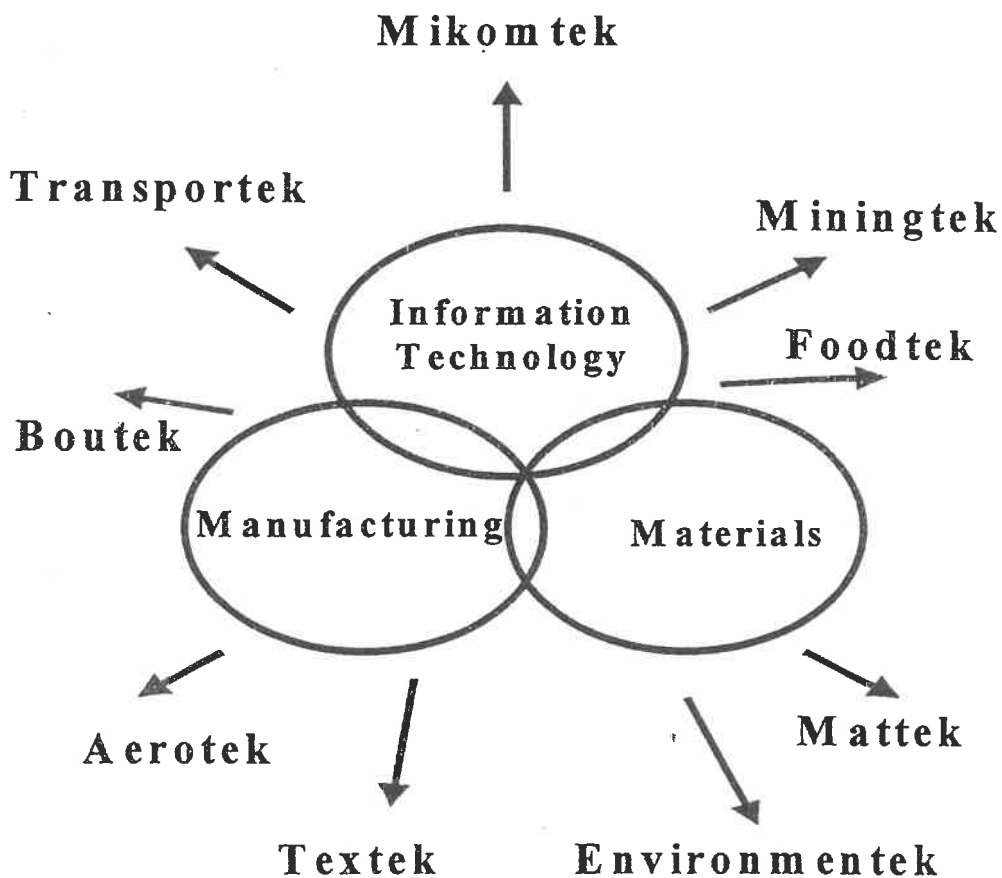


Figure 3 Relationship between the Divisions and the Core Competencies

Information for formulating goals, and data for administering CSIR operations, comes from an in-house developed system of integrated management and finance tools that address every facet of the business, including client identification and development, marketing, project planning and tracking, personnel data, financial management, organisational structure and performance tracking to goals. The CSIR's information system allows managers throughout the organisation to have access to relevant information at any time.

The CSIR has also developed a number of quantitative goals to measure its progress in meeting customer service, human relations and marketing goals. Particularly impressive is the set of independently administered client/customer and employee satisfaction surveys that are used to track CSIR performance in these important aspects of organisational performance.

The degree to which the CSIR has developed an efficient, transparent and accessible research and development planning and management methodology is a core competency, independent of, but integrated into, the specific technology elements of the CSIR's research and development portfolio.

3.1.3 Human resource development focusing on technical professionals

South Africa does not yet make effective use of its human resources to improve the nation's quality of life and to create prosperity, let alone promote equity. Competitiveness on a global scale requires that the best people, regardless of gender or race, be enabled to contribute to national and personal well-being. Since technology is the leading contributor to global economic growth, the training of technical professionals and the development of well-paying jobs to utilise their skills is critical to South Africa's economic future. While technikons and universities have the primary responsibility for the tertiary education of technical professionals, the CSIR is contributing by developing the technical leadership skills of its own cadre of employees, as well as by training students.

The CSIR has in place an aggressive set of race and gender goals, and is making excellent progress towards meeting them. For many young technical professionals, the CSIR provides an apprenticeship in research and development practice. Over and above these initiatives, however, is the CSIR's innovative Advanced Leadership Development Programme, which provides inspirational career development skills for a broad cross section of first-line managers. The programme emphasises confidence building, creativity, initiative and responsibility. In this respect, the CSIR is helping to provide a core of talented leaders of diverse background and skills to help build South Africa's future.

Besides developing its long-term staff, the CSIR also provides the opportunity for "practicum" experience for graduate South African technologists. Pilot activities in Mattek have established the benefits of such programmes in developing latent innovative and entrepreneurial capabilities.

3.2 Performance Assessment of the Core Competencies

3.2.1 Foundation technologies

Information technology

Information technology is a cross-cutting technology present in virtually all of the CSIR's efforts. Whether through global computer and communications networks (such as the Internet), or in control systems for manufacturing, climate control or crime prevention, decision aids for complex management problems or in data acquisition, retrieval and manipulation, information technology is a foundation technology. The information technology field is growing swiftly, and is subject to rapid shifts in emphasis and opportunity. The CSIR must have the capability to develop information technology for South Africa and Southern Africa that is flexible, reacts quickly and is able to cover all the major elements of modern information systems.

Mikomtek, the division responsible for maintaining and increasing the CSIR's information technology capabilities, has undergone substantial redirection and restructuring in the past two years. Microelectronics and sensor device and fabrication efforts have ceased, defence support has shrunk drastically; operations research and information and communications technology remains. The Panel is unclear about which information technologies the CSIR considers its strategic needs for the future, and which vehicles are the best choices to develop these technologies in the South African and Southern African market. While endeavours such as database mining, network security and radio propagation remain as strengths of the Division, an overall perspective of the information technology needs of the area is lacking, and the role of the CSIR in meeting those needs is uncertain. Projects presented appear to be targets of opportunity, reflecting existing Divisional capabilities and spot markets and not information technological growth possibilities for the CSIR and Africa. Despite the high level of innovation and skill evident in the Division's work, strategic leadership is not evident.

Other divisions within the CSIR have made good use of modelling and simulation, decision support tools and database manipulation in their individual efforts. Transportek, Environmentek, Miningtek and Boutek in particular utilise the CSIR's geographical databases and database manipulation capabilities in meeting the needs of their clients.

The Panel suggests that, given strategic direction from DCAST, that the CSIR hire an internationally recognised and visionary leader in the relevant fields of information technology, and develop challenging goals for growth and impact. This development should be supported by a strong industry advisory group with international representation.

Manufacturing

Manufacturing technology at the CSIR is a multi-disciplinary systems engineering effort applied to a variety of problems. Since manufacturing efforts require a mix of diverse engineering tools and technologies, and because its resources are limited, the CSIR can concentrate on only a few core efforts in-house and must rely on alliances and purchases from outside to provide the additional capability needed for specific manufacturing

projects.

Aerotek's acquisition of machine vision technology is a good example of how the CSIR identifies, acquires, innovates, adapts and applies key new technologies for South African manufacturing systems in a cost effective way. Aerotek first identified machine vision technology as a critical element of many South African future manufacturing systems and determined that it was not available in this country. It then conducted a systematic, global search for the most appropriate hardware technology for its applications and identified a source. The CSIR acquired the critical technology through licence with a British firm, and has proceeded to add its own complementary digital signal processing value to provide machine vision control for critical manufacturing, test and evaluation equipment. The application of this technology to the development of a novel production tester for aluminum can seals provides an excellent demonstration of how this important manufacturing technology, combining elements acquired abroad and complemented by CSIR innovations, will be applied in South African manufacturing systems.

Aerotek, the division responsible for developing foundation manufacturing technology, has proven to be an effective partner with other CSIR divisions in the applications of manufacturing methods to meet a wide variety South African industry needs, including food products, packaging, mining, textiles and cars. The modelling, simulation and decision support tools for manufacturing developed within Aerotek have specific applications in many of the CSIR's technical programmes.

Aerotek also designs, and manufactures, under contract, special products to demonstrate design and manufacturing methods. In doing so, it gains valuable experience on the practical issues of production management, quality assurance, and cost control that must underlie all its manufacturing activities. The CSIR uses this experience base in its developing network of Manufacturing Advisory Centres to support SMMEs throughout the nation.

Based on its experience, the Panel concludes that the CSIR's foundation manufacturing competence ranks with the world's best, given the resources available. The choice of key technologies is appropriate for South African manufacturing. The CSIR has added significant innovation and applications value to its manufacturing acquisitions, and design and production projects have given the CSIR manufacturing experience. The CSIR is deploying its manufacturing competence through partnerships with established South African firms, and is reaching out to small, medium and micro enterprises through a developing network of support centres. The CSIR's manufacturing activity, both in content and delivery is on a par with effective manufacturing technology efforts in other countries, such as the Manufacturing Technology Laboratory and Manufacturing Extension Center programmes at the National Institute for Standards and Technology (NIST) in the United States.

The Panel notes, however, that the use of massive computer simulation and virtual reality technology will become standard practice in the integrated CAD/CAM environment now being introduced to speed design and manufacturing operations. **The Panel suggests, therefore, that the CSIR plan to acquire the necessary equipment and skills and, in the interim, suggests that CSIR establish a collaborative relationship with leaders in the field, e.g., Sandia National Labs in the USA. This will be a critical next-**

generation engineering technology.

Materials

Research and development on the processing, properties and performance of materials represents one of the largest and most highly regarded activities at the CSIR. Much of this work is undertaken by Mattek, and this division has contributed to the production of both CSIR leaders and significant technological advances. It receives high marks from clients for its responsiveness and delivery on promises. One sponsor of work in Mattek noted that its work in support of SANDF was invaluable; its work on the metallurgy of superalloys for aircraft engines being just one of many examples.

Other achievements of this division include a battery that is a major contender for world-wide application to electric vehicles, hydrogel products for a variety of medical applications including a superior drug delivery system, and a new approach to the recovery of a valuable metal oxide from processing wastes.

Textek also conducts research into the application of indigenous fibres for clothing, medical products, ropes, etc., and is beginning to focus on superior high performance fibres or fibre-based systems for such applications as top-of-the-line suits for men, breathable clothing and car interiors, as well as improved production technology. They are much involved in the development of processes to utilise such natural products as silk, flax and cashmere, and in training rural workers to exploit such developments.

Transportek and Boutek also contribute to the CSIR's strong foundation in materials, recently helping to define the standards of performance construction companies must meet in order to produce roads and homes of the quality the nation will need as it moves to bring rural townships into the 21st century.

Based on its experience, the Panel concludes that the CSIR's materials effort can compete with other leading research groups in the world, but not with the very best. It has some extremely innovative researchers, is dynamically led and results oriented, and is focused on customer service. This is a very solid initiative, but there are some concerns: attention to materials science, as opposed to materials application, may be inadequate to provide a sufficient basis for continued success. **The Panel proposes the formation of new strategic alliances with leading academics in South Africa and elsewhere.** In addition, the project portfolio may be too fragmented for the CSIR to be a major contributor to any field of material engineering. Groups working in polymers or sensors, among others, are good, but lack depth and breadth. Management may wish to determine on which few areas of materials technology, critical to South Africa's future, it should concentrate, and re-deploy its resources to be able to collaborate and compete with the world's centres of excellence in these areas.

3.2.2 Management of the research portfolio:

The management team at the CSIR is outstanding.

The Panel chose as a framework for its evaluation of the CSIR the phrase "Compassion, Innovation and Passion", as defined in Section 1.3. In this context, the management team

scores very well indeed.

Some notable achievements of the management team include: (i) The development of a system of management processes for the analysis, distribution and control of financial resources. This system compares favourably with any of which the Panel is aware. It is world class inasmuch as the CSIR has both developed progressive theories of research management and put these concepts ideas into productive practice. (ii) They have hired some outstanding new managers with diverse backgrounds and talents. The new leader of Textek (a dynamic and charismatic black woman, educated in textile engineering in the US and with broad US management experience) is an outstanding example. (iii) They exhibit a deep commitment to the recruitment and training of formerly disadvantaged men and women, and (iv) They express an open and concerned style of management, emphasising communication and commitment supported by an evident sense of energy and vitality. In short, the management team is an exceptionally talented group of men and women, black and white, devoted to the CSIR, and dedicated to the best interests of this nation.

Of course, there remain some matters to which management's attention should be directed. For example, the Panel has sensed that management may have become focused on the process of managing the organisation to the detriment of concern for technical quality of the product, and of the scientific foundations of the organisation.

The Panel suggests that the development of strategic alliances with outstanding academics to strengthen the basic science element of the CSIR which existed some years ago be considered. Management should also consider mechanisms for setting standards of technical performance that will lead to world-class competitiveness in those limited number of areas deemed critical to South Africa's economic success. Ensuring that critical masses of intellectual effort are focused in areas such as mining, materials processing, high technology textiles, appropriate areas of information technology, and the computer simulation of design and manufacturing processes might be possibilities.

Initiating "co-development" projects with industrial partners, avoiding the pitfalls inherent in the now outmoded concept of technology transfer, should be investigated.

Re-emphasising the publication of significant findings in major, reviewed scientific journals could enhance both critical thinking and the image of the organisation.

Several other possibilities are mentioned elsewhere but, to summarise, this is a well managed organisation, basically on the right track. The management team are imaginative, talented and flexible, and should have no problem in making the adjustments necessary to ensure that the CSIR becomes an increasingly utilised and admired element in the emergence of the new South Africa.

3.2.3 Human resource development focusing on technical professionals

The CSIR's performance in the human resource development of technical professionals is covered in Section 4.3.

3.3 Resource Allocation to CSIR Technologies

3.3.1 Management of internal resources

Resources come in various forms, including a knowledgeable technical staff and adequate funds, up-to-date equipment, intellectual and industrial connections, and champions in government. It was not possible within the time constraints to evaluate any of these resources in depth, so what follows should be recognised as being based on limited perceptions.

Staff

Critical to the success of any research organisation is a knowledgeable, motivated, and productive staff that is adequately remunerated and appropriately rewarded. In this regard, the CSIR is reasonably well positioned. The 520 PhD-MSc level staff are supported by some 600 university graduates and 340 technikon graduates, the ratio of these being 1:2. This is appropriately placed between the range of about 1:1 (for NIST) and 1:3 (for more applied research organisations in the US).

The staff who made presentations on core competencies to the Panel were enthusiastic and usually quite knowledgeable, though occasionally a limited awareness of the state of the art was detected. Essentially, they appeared to be somewhat disconnected from the arena of international competition. **In this regard, the Panel suggests that management may wish to encourage scientists travelling abroad to conferences to spend an extra few days visiting the leading foreign industrial organisations in their field of interest, assessing their state of the art and seeking out expert opinions on trends and opportunities.**

Remuneration (perhaps with the exception of Miningtek) is generally perceived to be somewhat (5-15%?) below market value, but this is considered to be offset by excellent working conditions and relative stability. However, as will be mentioned elsewhere, there is no mechanism beyond a one-time bonus for rewarding creative staff members whose inventions lead to significant royalty income to the CSIR or profits for its customers.

Morale appears to be good. Many of the staff expressed their pride in the CSIR, especially the CSIR Fellows. They are happy to be part of the organisation, and feel that the CSIR is making and will continue to make a significant contribution to the economy and quality of life.

Equipment

The CSIR appear to be adequately equipped in terms of standard equipment, but will need to develop capacities for utilising the world of virtual reality and more powerful computers to undertake the large-scale simulation studies that will underpin not only scientific studies, but also design-to-manufacturing capabilities. In the meantime, alliances should be sought to share and learn about state-of-the-art equipment elsewhere, e.g. at national laboratories in the US.

Funds

An analysis of the funds from the Parliamentary Grant (PG) and external income in constant Rands, Figure 4, illustrates the three fiscal phases through which the CSIR has passed since the mid-80s. In Phase I (1984-89), both the Parliamentary Grant and external income were modestly increasing and providing a resource of approximately 700 million Rands (in 1996-7 Rands). In Phase II, the Parliamentary Grant decreased significantly, from approximately 500 million Rands in 1989 to about 280 million Rands in 1994. Fortunately, funds from other sources decreased only slightly from about 400 million Rands in 1989 to about 350 million Rands in 1994 (again in 1996-7 Rands). Thus, the average total available income stayed approximately the same in Phase II as Phase I, but with a significant downward trend. In Phase III, however, the trend reversed, with the Parliamentary Grant increasing from about 250 million Rands in 1995 to some 300 million Rands in 1997. Meanwhile, external income has increased from 350 million Rands in 1995 to 400 million Rands in 1997, the total again averaging about 700 million Rands in 1996-7 Rands. Thus, despite the inner turbulence caused by the changing nature of the objectives of the CSIR, its funding has been relatively stable, and is currently enjoying an upward trend.

As regards the investment of these funds in the foundation technologies, analysis of the CSIR's financial data indicates that approximately 50% of the Parliamentary Grant is invested in the materials, manufacturing and information technologies, with manufacturing taking over as the principal area for investment over the past three years. The proportion (50%) is considered appropriate, but **the Panel suggests that the rate of growth of investments in information technology be increased at the expense of other areas of potential importance.**

The overhead rate applied to contracts with industrial clients (1,5 times labour costs) also is comparable or slightly less than the rates applied by similar organisations in the US. However, since universities tend to ask for only marginal costs on their contracts with similar clients, the possibility of "unfair competition" from the academic community should be considered by appropriate government authorities.

3.3.2 Thrust funding

The Panel notes that virtually all of the CSIR's technical thrusts are funded by a mixture of Parliamentary Grant and external contract funds. This dispersion of grant funds can compromise the CSIR's ability to renew its technical knowledge base, which is its distinctive competency, and its ability to invest in new, innovative enabling technologies. Additionally, the Panel is concerned that external contracts are not priced to account for the CSIR's need to renew its technology base.

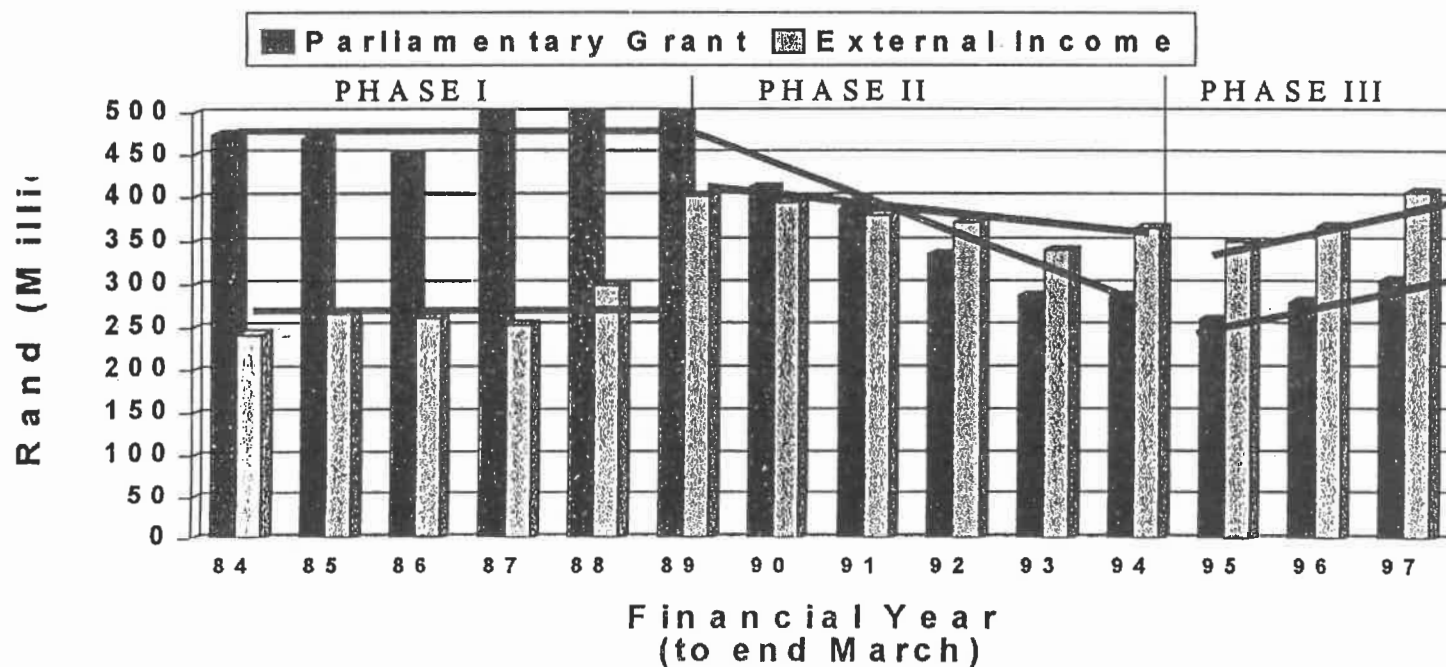
The Panel recommends that the CSIR plan its thrusts in three categories:

- Those funded exclusively from the Parliamentary Grant
- Those requiring a mixture of Parliamentary Grant and external contract funds, and
- Those supported entirely by external contract funds.

Figure 4

CSIR Parliamentary Grant and External income

(Adjusted for Inflation 1996/97 = 100)



Thrusts funded entirely from the Parliamentary Grant should address the development of new capabilities for the CSIR. These should be considered "seed" efforts, supported for no more than two or three years, that will attract future contract support. **The Panel suggests that a portion of the Parliamentary Grant be devoted to a CSIR "new idea" fund.** Support from this fund could be allocated to winning proposals in an annual contest, the proposals being submitted by members or groups of the technical staff. Projects supported in this way could be provided full support for up to two years with the option for a third year renewal. Discretionary funds of this type have proven to be important stimulants to innovative ideas in US laboratories with missions similar to that of the CSIR.

The Panel suggests that pricing for external CSIR projects should contain a modest tax (5% to 10% of total contract price) to support renewal of existing CSIR competencies. While the funds raised in this way would be insufficient to pay for full renewal costs, this measure would help to answer the criticism that clients are exploiting the CSIR's past technology base investments without supporting the need for the CSIR to continue to develop enabling technologies in all of its activities.

3.4 Sector-Specific Issues

This section addresses sector issues that were raised in presentations, tours and discussions and which demand particular attention. The comments provided are consistent with the general philosophy of the Review Report, and the issues are covered in no particular order.

3.4.1 The position of Foodtek

The question of whether Foodtek was appropriately positioned within the CSIR was raised with the Panel. The argument was made that Foodtek is part of a spectrum which includes agriculture and agribusiness, and that there would be greater synergy if Foodtek were part of the Agricultural Research Council.

The Panel rejects this argument. It believes that the core competencies of Foodtek are closely aligned with those of the CSIR in general. The technical expertise of the CSIR in the areas of manufacturing and process control, information technology and materials is an essential pillar of Foodtek's areas of operation. Further, the CSIR's management expertise provides considerable strength, as illustrated by the success of the Fishing Industries Research Institute (FIRI) since it has become part of Foodtek.

3.4.2 Molecular biology competency

The CSIR does not have a significant capacity in molecular biology. Future technological development will increasingly involve concepts developed in molecular biology, particularly developments in health technology and agricultural technology. Competency in this area will become as important as the current foundation competency in manufacturing, materials and information technology.

The Panel suggests that the CSIR develop an in-house capability in molecular biology as an additional foundation technology similar to materials, manufacturing

and information technology, and ensure that researchers in appropriate fields are exposed to this knowledge domain so that they can recognise when and how it can be of value.

3.4.3 Interaction between the universities and the CSIR

Technological capacity in South Africa is shared between the SETIs and institutes in the higher education system, particularly universities and technikons. Given its current mission, the activities of the CSIR and the higher education institutions are largely complementary rather than adversarial. The question arises, therefore, of how greater synergy between the CSIR and the universities and technikons can be achieved.

The CSIR is focused on technology acquisition, development, transfer and deployment, with (currently) limited pioneering research to support this focus. The higher education institutions, however, are less constrained by a commercial bottom line because of their dual role in research and human capacity development, and are freer to explore innovative solutions and scientific development.

The National Research Foundation will fulfil the agency function with respect to higher education institutions. THRIP is a major and well established player in the funding arena and is becoming increasingly important. A third component of government input is the Innovation Fund.

The creation of the NRF, together with THRIP and the Innovation Fund, provides a rare opportunity to introduce incentives for industry, the CSIR and university/technikon collaboration. It is widely recognised that competitive technological advancement in South Africa will depend on interdisciplinary, multi-disciplinary or trans-disciplinary interactions, bringing together groups who can collectively initiate new developments.

The Panel suggests that the CSIR leverage their innovative capability by acting as a broker between industrial clients and the higher education institutions, making use of THRIP Innovation Fund support. In this way the cost to industry of the university or technikon based research is subsidised, and the CSIR can offer its clients its own expertise supplemented by the specialised expertise that the higher education institutions can offer. This collaboration could be achieved through some formal structure, the formation of which could be facilitated by the CSIR. This organisation should be led by industry, and should be devoted to technology roadmapping; it could also harness the CSIR's research management expertise.

A prototype of this kind of collaboration exists in the co-operative project on deep mining which is currently under discussion. This project involves the CSIR, the mining industry, the University of the Witwatersrand and DTI through THRIP.

3.4.4 The CSIR's role in the development of SMMEs.

The issue of CSIR promotion and support of SMMEs and in technology for development has been raised in several quarters.

On one hand both the pursuit of economic growth and equity in South Africa in the short term will depend significantly on the empowerment of small business and community organisations in both rural and urban areas. The deployment of appropriate technology, together with organisational and management support, is an essential feature of this empowerment.

On the other hand, the CSIR is a technology-based institution, which should focus its efforts on technological solutions and not enter any arena of development for which other bodies are more suited and experienced.

The Panel believes that this question cannot be answered easily. There is an imperative at the present time to address the social and economic problems of disadvantaged communities, and this cannot be ignored. It is also clear that if a service is offered to small business and disadvantaged communities it must be in the form of a one-stop shop. It is not sufficient to offer technology based solutions at this level; the package must include advice and assistance on financing, marketing, accounting, logistics, training, material supply etc. as well as technology.

Nevertheless, the CSIR should use its efforts effectively and in areas where there is greatest need. Partnership with NGOs and other bodies that can provide the human and social support required in development projects should be further explored.

3.4.5 Issues of focus at the Divisional level

Focus was an issue in many Panel discussions. Is the CSIR trying to cover too wide a field of activity? Should it focus more on topics of major importance?

The CSIR functions in two primary modes. First, it provides technical services, many at a sophisticated level, in areas where industry, parastatals or government cannot support a facility. Second, it provides innovative leadership in the development of new technologies which can be further developed and exploited by the private sector.

Each division must balance its activities in the two categories; the first being activities that generate contract income, the second being the activities to which the Parliamentary Grant should be applied. In achieving this, the guiding parameters should be quality and excellence, and the ability of expertise developed in the innovation mode to support and enhance the service function.

3.4.6 Mining research and development expertise

The mining industry in South Africa depends heavily on the mining research and development support of Miningtek. Many of its projects in rock mechanics, mining techniques and mine survey technology (such as ground penetrating radar) provide important capabilities for deep-level mining. Particularly important is the Division's participation in the multi-disciplinary deep level mining technology development activity that will nearly double the depths from which ore can be retrieved. Miningtek's reputation for developing state-of-the-art technology, and its freedom from company mine operations pressures, make it the authority on the best available mining technology.

The Panel suggests that mining research and development, while not a foundation competence in the sense of those pervasive technologies identified in section 3.1.1, is an area of special technical strength within the CSIR. The Panel believes that Miningtek has benefited significantly from its shift into the CSIR from COMRO, both from association with other parts of the CSIR and from the direction of CSIR management, and that any suggestion to move it elsewhere should be rejected.

3.4.7 Environmental modeling and remediation expertise

Generations of neglect have left South Africa with a legacy of environmental problems that adversely affect the quality of life in the nation and pose serious concerns for natural resources such as water availability and cleanliness, and air quality. Through its Environmentek Division the CSIR has been able to mobilise sophisticated technological resources to begin remediating the most critical of the problems. For instance, the CSIR's satellite-based Geographical Information System provides important data for assessing the effects of vegetation changes on water supply, and the CSIR's modeling skills are critical to meeting South African quality of life goals. The complementary competencies of Environmentek and other CSIR divisions give South Africa a state-of-the-art capability that is available nowhere else in Africa.

3.4.8 CSIR's Strategy 2002

The CSIR's current strategy document recognises the emerging importance of biological science and the "CSIR will have to strengthen its 'bio-connectedness' ..." (CSIR Strategy 2002, Appendix 4). Information and communication technology (ICT) is also identified as a necessary area for further investment. However, this is not linked to the considerations of the core competencies of the organisation, and the document is silent on how this is to be effected, or which areas of biotechnology and ICT should be developed.

3.5 Quality of Knowledge-Based Products: Scientific Papers and Patents

3.5.1 Scientific research papers

The credibility of CSIR's knowledge workers is critically dependent upon, among other things, scientific output as measured by the excellence of its scientific research papers. Although the CSIR has decided not to emphasise new basic knowledge generation, a presence in leading journals is an important part of connecting to the leading edge of science and technology and global technical peer groups.

Analysis of CSIR publications in refereed journals from 1994 to 1997 indicates that both the quality and quantity of publications is a cause for concern. CSIR authors produce approximately 100 papers per year (in 1994 it was 111; in 1995, 137; in 1996, 106 and in 1997, to date, 72). The quality of publications is judged by the impact factor of the journals in which they appear. Less than 10% of the 1994-1997 papers appeared in journals with impact factors greater than one. Several were in local journals having a zero impact factor.

The Panel suggests several possible actions to improve the effectiveness of the CSIR's technical publications: (i) measure and communicate internally the results of quantitative measures of the CSIR's research publications (citations indices and impact factors); (ii) set quantitative goals to raise the CSIR's publication quality; (iii) recognise and reward the author(s) of the best technical paper of the year.

3.5.2 Patents

Section 4.4 contains the Panel's assessment of the CSIR's patent filings and recommendations for enhancing intellectual quality and output.

4. NON-TECHNICAL ISSUES

4.1 Governance, Ownership and Structure

4.1.1 General overview:

In conventional terms of good governance, systems procedures and controls, the CSIR would be given an excellent rating in line with the standards required of large public corporations. However, this chapter seeks to investigate the appropriateness and practicality of legislative operational constraints within and outside South Africa, and the appropriateness of the current mandate and arrangements for governance, management, asset control and the institutional framework of the CSIR.

To contextualise this, it is important first to outline the present structures and frameworks of CSIR/government. relationships. The elements of the governance system are as follows:

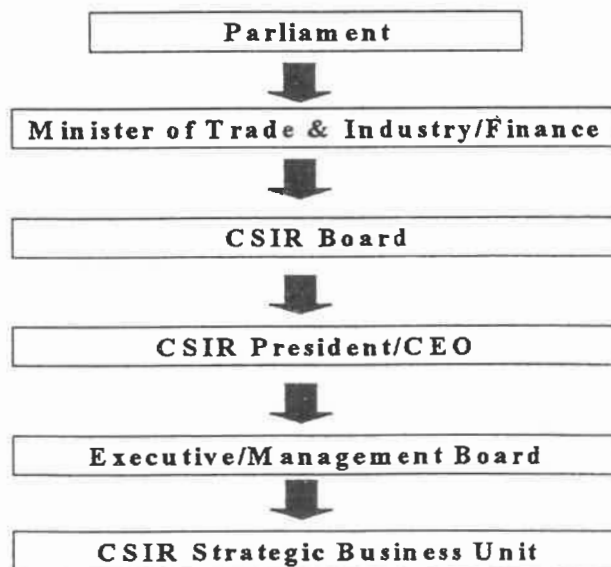
- Statutory arrangement/authorities and structures
- Roles and responsibilities
- Systems
- Reporting process and intervals, including periodic management performance audits.

The Statutory Arrangements and Authorities are as follows:

a) **STATUTORY ARRANGEMENTS**

Scientific Research Council Act (No. 46 of 1988)
Reporting by Public Entities Act
Auditor General Act
National Systems of Innovation (White Paper)

b) **AUTHORITIES**



c)

ROLES AND RESPONSIBILITIES

Foundation	Responsibility	Approval	Frequency
Strategic Plan	Exec/Man Board	CSIR Board	3/5 years
Strategic Plan Review	Exec/Man Board	CSIR Board	Annual
CSIR Business Plan (Goals/Objectives)	Executive	CSIR Board/DTI, DACST	Annual (multi year planning cycle – DACST)
Strategic Unit (SU) Business Plan	SU's/Executive	Executive	Annual
CSIR Budget	SU's/Executive	Exec/Board/DTI	Annual
SU Budget	SU Management Team	Executive	Annual
Pgm/Ohd budget	Programme Manager	SU Head	Annual
Project Budget	Project Leader	Programme Manager	Ongoing

d)

REPORTING PROCESS AND INTERVALS

FUNCTION	LEVEL	INTERVAL
Programme	SU Manager	Weekly Monthly
SU	CSIR-Exec	Monthly Quarterly meetings
CSIR	Exec/Chairman	Monthly
CSIR	Board	Quarterly
Annual Report	Parliament (through – line dept.) Board Stakeholders	Annual
External Audit	Audit Committee	Twice per year
Internal Audit	Audit Committee CSIR-Exec	Twice per year Ad hoc to Management

4.1.2 Legislative Operational Constraints

An analysis of the Scientific Research Council Act (No 46 of 1988) revealed a few issues that need to be reviewed and redesigned to ensure clear mandates for the management of the CSIR. The issues are centred on functions, powers, duties, control, committees and staff of the CSIR.

Functions, powers and duties of the CSIR

Clause 4.2a suggests that the CSIR is a calibration centre, which it should not be because this function is neither fundamental nor innovative in nature. **It is recommended that such activities be progressively removed from the CSIR, and outsourced to a company (preferably one associated with previously disadvantaged group), as has been happening.** This does not necessarily mean physical removal from CSIR premises, but a change in ownership.

Clause 4.2b further suggests that the CSIR should be involved in certification, which really falls within SABS's area of responsibility. **It is therefore recommended that any such activity be transferred to SABS.** Close co-operation for scientific intellectual asset transfer (physical or electronic) should be explored.

Exercise of the powers of the CSIR outside the Republic

Clause 5.1 restricts the authority/powers of the Board if prior Ministerial approval is required to undertake research outside the Republic. **It is the Panel's view that the Board should be empowered to decide on this, whilst ensuring that national interests are not neglected.** This will facilitate faster decision-making that will lead to swifter capture of global opportunities. It will also afford the CSIR the opportunity to become a globally competitive player, which will be necessary if the CSIR is to foster impact-making innovations.

Similarly, Clause 5.3 should end with "approval by the Board" instead of "the Minister".

Control over, and management of the affairs of the CSIR

Clause 7.4 suggests that the Minister should determine the remuneration structure in the CSIR. There are two main problems with this.

Firstly, it disempowers the Board, and secondly it deprives the CSIR of the opportunity to be market-competitive in an area that is knowledge/skills sensitive. In order to assure the hiring and retention of superior talent, it is recommended that salaries **not** be constrained by the Public Service Commission and the Minister. **Instead, it is recommended that the Board be empowered to do this.** The last part of the relevant sentence would read therefore:

"as the Board may determine with the concurrence of its Remunerations Committee".

Note that the Minister of Finance is replaced by the Board's Remunerations Committee, whose structure is discussed shortly.

Clause 9.2 should be reworded to allow for the formation of the Remunerations Committee, if the change in Clause 7.4 is adopted. **It is suggested that the Remunerations Committee include two independent experts from the private sector, appointed by, and responsible to, the Minister.** This will ensure transparency of the Remunerations Committee without taking power from the Board, and will inform the Minister of all irregularities.

In Clause 12b, similarly, "Minister" should be replaced by Remunerations Committee, and the phrase "with the concurrence of the Minister of Finance" should be deleted.

The changes in these clauses must be seen as a measure to remove legislative and operational constraints and to establish appropriate mandates. Operational decisions should not have to be referred to the Minister. The demarcation of responsibilities between the Board and the Minister will also be enhanced with the adoption of these suggestions.

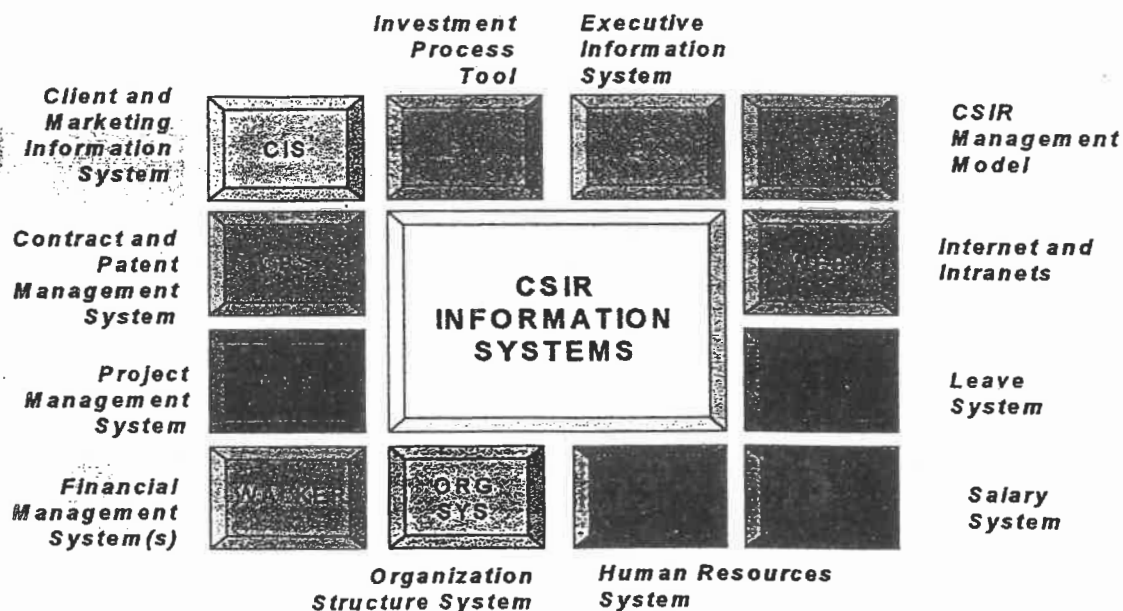
4.1.3 Systems

Interviews with the Executive team and the Audit Committee Chairman confirmed that the financial systems controls are in place, and probably surpass those found in some private sector companies. This is further verified in that their Annual Reports are signed by the Auditor General without qualification. The CSIR also operates a computerised integrated system comprising the following clusters:

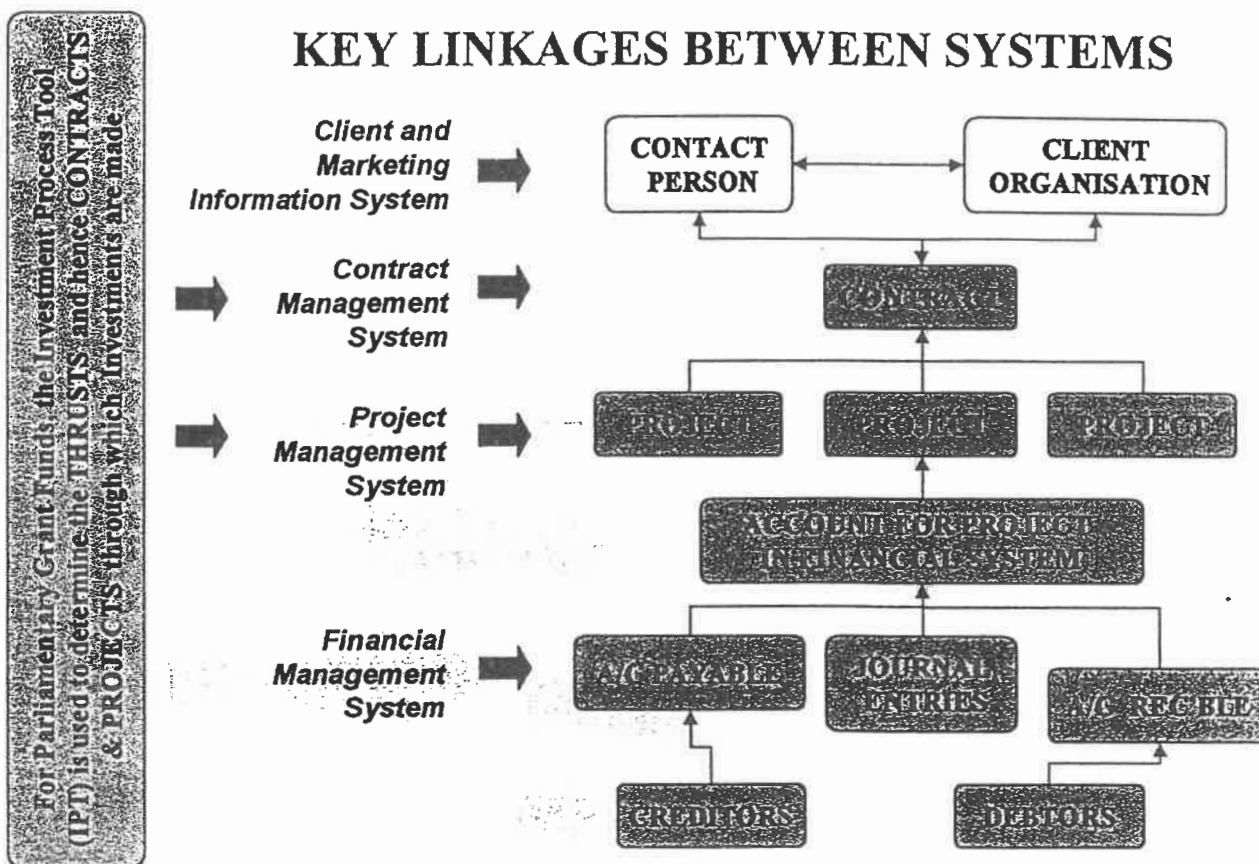
- Management System
- Financial System
- Project Management System
- Contract Management System

These were also verified by logging on the computer, and the following two figures show the different integrated systems available:

AN OVERVIEW OF CSIR INFORMATION SYSTEMS



KEY LINKAGES BETWEEN SYSTEMS



One shortcoming in this system is that it locks research into financial accountability by time spent, which can detract from research impact, and may result in a research staff that feels under-appreciated. A percentage of the Parliamentary Grant (STEP) should therefore be allocated to research outside of the normal financial constraints. Such funding is discussed elsewhere, and is referred to as the CSIR Innovation Fund.

4.1.4 Mandate

The CSIR operates adequately within the present legislative mandate. However, the Panel was concerned that there is a lack of clarity at the level of the Board regarding the government's priorities in respect of the CSIR that limits the overview role of the Board. In addition, there is a lack of clarity on issues around the transfer of technology to the marketplace; increasingly this will have to be done through partnerships, and issues of what constitutes "fair" and what constitutes "unfair" competition need to be resolved urgently.

4.2 Management of the CSIR

4.2.1 General comments

As has been expressed elsewhere, the Panel finds the management of the CSIR to be excellent. The management team under Dr. Garrett's energetic and visionary

leadership is mission-oriented, dedicated and well informed, and provides a supportive working environment.

The members of the management team appear to be on first name terms with many of the staff, and the laboratory atmosphere is congenial. Morale is high. The team's relationships with the CSIR Board are friendly and relaxed, and the Board, especially its Chair, is strongly supportive. The quality of life at the CSIR is pleasant. Building and grounds are well maintained, and security appears to be adequate.

In short, this is a very good organisation that could, with continued effort, and sustained support from DACST and the Government, become a great organisation, one that contributes to the economy and prestige of the new South Africa.

Given the above, the Panel recommends that the present leadership be congratulated for the remarkable job it has done over the past few turbulent years.

In this spirit, the Panel now offers some suggestions for management's consideration and with the intent of contributing to the CSIR's future success.

4.2.2 Some suggestions

- (i) South African industry, academia and the CSIR do not appear to be acting as the integrated, wealth-generating system that this nation needs to meet its growth and prosperity goals.

The Panel suggests, therefore, that the CSIR management work with leaders of industry and academia to form an "Industrial Innovation Institute" (I3). The purpose of this should be to provide a forum for senior executives to identify and share solutions to management problems, raise the national level of technical management skills, and co-develop strategies to enhance international competitiveness in technologies declared critical to South Africa's future. The use of "road mapping" is recommended to facilitate the identification of national industrial objectives and the technological road blocks that must be overcome to meet them.

- (ii) No nation, or industry, or organisation such as the CSIR, can generate all the information it needs to be competitive. However, few institutions have a systematic approach to developing the network of information sources critical to its success.

The Panel suggests, therefore, that with the assistance of a "Committee of Experts", the CSIR identify the leading organisations or practitioners around the world in its fields of long-term or emerging interest, and pursue vigorous collaborative or complementary projects with them. The portfolio of such alliances should be developed strategically and not, as is often the case elsewhere, on some ad hoc basis.

- (iii) The Panel has noted that the CSIR has few, if any, external advisory panels. In our experience such groups, when so directed, can help an organisation avoid being technically blind-sided, can provide insights into external perceptions of the organisation, i.e. its "image", and can provide perspective on the focus and balance of the organisation.

Accordingly, the Panel suggests that the CSIR (re-)appoint External Advisory Panels at Executive and Sector levels.

- (iv) There are clients who perceive that the CSIR does not always deliver on its promises. Since the CSIR's internal perception is that, more often than not, it does, this may be simply a case of a bad memory lingering on. In any case, this problem should be addressed.

The Panel suggests, therefore, that the CSIR initiate an effort to establish a more positive image by publishing its helpful contributions to the success of its clients whilst, at the same time, being careful to give most of the credit for such success to its customers!

- (iv) Long-standing issues regarding whether or not institutions such as the CSIR, or even industrial research laboratories, should conduct basic research (i.e. research focused on the generation of new knowledge per se), are now being bypassed by the proposition that a better approach is to undertake "pioneering research". This approach, as recently propounded by J. Seeley Brown of Xerox Corporation, holds the view that, given the rate of change of the state of the art of many technologies today, a research programme should only be initiated on the basis of a clear and important customer need. However, the approach to meeting this need should be fundamental. In other words, all the basic assumptions that were used to develop yesterday's solution must be critically re-examined, and every step of the process chain reconsidered. Then, the intellectual challenge of the problems so identified should be raised to a sufficient level that, if solved, fundamentally new and more efficient processes (products) result. But also, because of the intellectual level of the endeavour, a valuable by-product is a fundamentally superior understanding of the mechanisms involved in the process, i.e. good basic science has also been accomplished.

Accordingly, the Panel suggests that the CSIR consider the adoption of something akin to the "Pioneering Research" concept as a more intellectually stimulating way of conducting its investigations. If successful, innovation will be enhanced, and technical papers of greater quality and citability produced.

- (v) Concern has also been expressed that the CSIR's recent focus on "products" is usurping the purview of industry.

The Panel suggests, therefore, that the CSIR focus whenever possible on the co-development of "enabling technologies", i.e. the development of innovative process platforms on the basis of which the private sector partner can develop a portfolio of competitive products.

- (vi) The real basis for an organisation's competitiveness is not its core competencies, which are usually common to several organisations, but rather the innovative manner in which it combines and permutes them to produce novel developments that permit entry into new markets before the competition appreciates this possibility.

Accordingly, the Panel suggests that the CSIR produce a matrix of its technical and managerial skills, and then have its staff brainstorm possible non-obvious opportunities arising from new areas of collaboration between sectors and skill areas.

- (vii) One objective for the CSIR management is to increase income from co-development or other support activities in the private sector. Unfortunately, experience indicates that, except perhaps in the case of entrepreneurs, good researchers rarely make good marketeers. This may be because marketeers must focus on the virtues of the state of the art, whereas researchers focus on the problems that remain to be solved. In any event, it is apparent that the CSIR could benefit from the addition of a small, but persuasive and technically aware, marketing force.

Therefore, the Panel recommends that management consider developing a small, (initially 3-5 person) technical marketing group which, with the support of relevant members of the technical staff, would have the responsibility for significantly increasing private sector business.

4.3 Human Resources

4.3.1 Introduction

Human Resources (HR) in the 1990s must be both business and people orientated. It must emphasise the integration of human resource strategies and programmes into overall business strategy and facilitate the achievement of broader organisational goals.

The human resources function's long-term goals must be to sustain organisational effectiveness and survival. Key aspects of these HR goals should include the need for the creation of a learning organisation through the development of strategic, leadership, and management and technical competencies. Organisations in the 1990s demand that HR must add value by facilitating the development and implementation of progressive performance measurement and management techniques.

In transforming South African society, the HR function must also focus on ensuring that an organisation's internal climate is well-aligned with its immediate external environment. It is imperative that issues such as transformation, workplace democracy, transparency, inclusive and participative processes, redress and equity feature prominently in the HR function's programme.

This primary objective of this section is to provide a qualitative and quantitative assessment of the CSIR's HR strategies and programmes in the context of the background sketched above.

4.3.2 Context

The Terms of Reference for the Review Panel emphasise issues of equity and redress. Whilst these issues were explored in depth during the assessment, a broader contextualisation was assumed. Equity and redress cannot be the only determinants of the organisation's HR well-being. A qualitative assessment of the HR strategies, plans and processes is crucial to ensure the long-term success of the institution in sustaining equity and redress programmes. In addition, the CSIR is expected to address aspects outlined in the White Paper on Science and Technology.

In this review, the CSIR's HR policies were tested to determine their alignment to new labour legislation in South Africa that attempts to balance the tension between institutional goals and individual employee aspirations. The rights embodied in our constitution, Labour Relations Act, and Bill of Rights were used as a benchmark for the CSIR's human resources policies, e.g. the right to belong or not to belong to a trade union or staff association.

The CSIR's Vision Statement, namely "To be the best in technology, leadership and partnering and through our people fight poverty and build global competitiveness in order to make a real, enduring difference in peoples lives", served as the basis for evaluating management's commitment to the implementation of human resources strategies.

4.3.3 Human resources positioning and strategies

The role and positioning of the human resources function at the CSIR at both the Corporate and Divisional levels is very strong. The creation of the Vice-President (Human Resources) position was crucial in ensuring that HR plays an integrative role in the institution. The HR functions at both Corporate and Divisional level are highly regarded.

The HR function within the CSIR is made up of intellectually capable people from diverse disciplines. The general perception is that most of the HR personnel are strongly independent, and are willing to challenge management where necessary to ensure required change and development.

The size of the HR staff in relation to total complement is more than adequate, with the exception of the Organisational Development area where more resources are required to achieve greater impact in change and transformation.

The CSIR has developed and formalised a clear Human Resources Strategy and Plan. This strategy and plan are fully integrated with the overall CSIR strategy and operational Divisional plans. The HR strategy and plans are well prioritised to ensure effective resource allocation within budget constraints.

4.3.4 HR systems, policies and procedures

A comprehensive set of HR systems, policies and procedures within the CSIR were evaluated to determine their relevance and integrative and synergistic effect on the institution and HR strategies. In particular the following systems were evaluated:

1. HR information system
2. Performance management system
3. Employee satisfaction index
4. Recruitment policy and procedures
5. Equity and employment policy
6. Recognition agreements and wage settlements.

The review revealed that these systems, policies and procedures, which are significantly progressive in character, are being rigorously implemented and monitored by management and HR professionals within the CSIR.

The desire to create inclusive and participative systems and policies was fully demonstrated. Positive criticism and suggestions were well received during interaction with management and members of the HR function. However, the Nehawu shop stewards raised a specific concern around the recruitment policy. Their broad concern can best be summarised, however, as the desire for some form of real and meaningful participative processes to be created, and that they be included in these processes.

4.3.5 HR processes

The culture of the CSIR is progressive. Efforts to achieve an inclusive, participative and highly professional approach have been demonstrated. The results of an Employee Satisfaction Index Survey conducted during the last three years indicate significant achievements in the CSIR's striving for excellence.

A very strong team approach from executive to staff level was amply demonstrated. The climate being created by the leadership is also closely aligned to CSIR Vision and Mission statements.

The CSIR must be commended for systematically addressing organisational issues such as affirmative action and redress through formalized organisational development (OD) programmes, as well as for its determination to appoint women and black people to all levels of the organisation to achieve transformation.

A more African cultural context may help to develop still better and healthier institutional culture. The OD function should play a major role in this regard. The existing Transformation Forum could contribute effectively, provided the union agrees to participate.

- **Workplace democratisation**

The CSIR has concluded a Recognition Agreement with Nehawu and is in the process of negotiating an amendment to this agreement. The current formalised

Transformation Action Groups play a positive role in representing employee aspirations. However, these groups lack the legal status for consultation and the negotiation process to occur outside of the established bargaining unit with Nehawu. This implies that the aspirations of employees outside of the bargaining unit may be neglected.

The creation of a Workplace Forum is encouraged, provided that all workers are included. Apart from monthly meetings within divisions, there is presently no vehicle to enhance relationships between management and worker representatives. In particular the need to discuss policy and strategic issues at CSIR corporate level with representative staff bodies is imperative. This could be achieved in the broader context of a Workplace Forum.

- **Equity (race, gender and pay)**

The CSIR has through a consultative process developed and is implementing a comprehensive equity policy and programme to address race and gender issues. A recruitment and human development strategy is in place together with a rigorous review mechanism to ensure the achievement of these plans. A number of tables which support this are presented in Appendix 4.

A climate preparation exercise has also been conducted (Sekunjalo) to create a supportive environment for female and black employees.

In addition to its internal programmes, the CSIR has launched through all divisions, an external empowerment process to develop the skills and competencies of people from disadvantaged communities. Considerable financial resources, time and expertise are being employed to ensure skills transfer.

- **Human development**

Several training and development strategies, including further education for internal staff, allocation of bursaries (see Appendix 4), and technical and leadership training are rigorously pursued. These targets form part of the institutional plan and all managers are assessed on their ability to deliver on these programmes. A state-of-the-art mentoring programme is also in place in a number of CSIR Divisions.

Overall, the human development strategies and plans are progressive, innovative and focused. Full integration of these plans into the institutional plans and the White Paper imperatives is being achieved.

4.3.6 Conclusion

In conclusion, within the time constraints of this review, it can be said with confidence that considerable progress is being achieved. Further, as indicated above, a holistic approach is being developed and management's commitment is fully demonstrated.

The culture and values in the CSIR support a participative climate that will ensure a positive outcome for all stakeholders.

4.3.7 Some suggestions to management

- A closer relationship should be formed with trade unions and other staff representative bodies, and meetings to clarify strategy and policy issues held. It is important that Executive level employee participate, and external worker representatives be involved as well.
- The potential for the existence of two cultures, one at professional and another at lower levels of staff, should be countered. Some of the proposals above should deal adequately with this issue.
- The HR function's performance and impact must be continuously re-evaluated.
- HR's role and accountability should be strengthened by ensuring that the Vice-President (Human Relations) has ultimate accountability for HR programmes and their success. The current structure and arrangements, although successful, reflect a weakness in that Divisional Directors appear to have more influence in directing the human resources activities.
- The possibility of creating a workplace forum to achieve an all-inclusive process should be pursued. This will help create cohesion within a very complex, knowledge-driven organisation.

4.4 Commercialisation Policy

4.4.1 Introduction

The White Paper on Science and Technology emphasises the importance of encouraging innovation in the private sector. There is a need to develop coherent strategies to promote linkages between SETIs and the private sector in order to share risk, resources and insights.

The Panel reviewed the commercialisation policy of the CSIR and concluded that this aspect of the organisation's activities tends to be somewhat ad hoc. Moreover, the formal commercialisation strategy document was published in 1990, and much has changed since then.

It is the view of the Panel that the linkage between the CSIR and private sector business should be seen in terms of an ongoing partnership. Current R&D management philosophy is not to think in terms of technology push versus market pull, or even in terms of technology transfer as a "unique event" wherein new understanding is packaged and handed over to a presumably receptive industrial organisation. Experience shows that this rarely works. A better approach is co-development, whereby the research organisation and industrial partner (or consortium) work together to define a significant industrial need of a few (5-10) years hence, identify the technological obstacles between where they are today and where they need to be, and then develop a road map that defines the problems to be solved, in what order and on what time base, and with what economic constraints.

The researchers and partner industrial organisation then work together, using a common data base, a common strategic purpose, and real time communication towards a common set of objectives.

Rather than technology push, market pull, therefore, it is considered more useful to think of the researcher-customer relationship in terms of a complex, adaptive system of technology and market, with real time feed forward and backward information loops. Thus, technical understanding and problem clarification proceed seamlessly and continuously, building mutual trust and commitment, and greatly increasing the chances of timely success. Government will play an important role in facilitating such interactions and providing an enabling and non-turbulent climate.

For now, increasing the number and effectiveness of partnerships between the CSIR and its main customer segment, namely private industry, should be a focus of management's attention. Proposals are made elsewhere in this report on how to enhance this process, but we draw attention now to the more commercial aspects of this relationship.

4.4.2 Marketing

Currently the CSIR devotes 3,4% of its overall turnover to marketing. This is low by international standards, with the norm being in the range of 6-8%. This low figure may, in part, reflect the fact that the CSIR has a number of clients, e.g. in defence and mining, who undertake ongoing and long-term programmes with the CSIR and where, accordingly, marketing costs can be much reduced. On the other hand, the Panel noted the slow growth in the CSIR's external income derived from private sector industrial customers (Chapter 5). This, together with the perception prevalent among some customers and potential customers that the CSIR is only a source for lower technology, cheaper solutions (Chapter 5), suggests that a more aggressive marketing programme should be undertaken, particularly directed towards the industrial sector. Co-development of innovative and enabling technologies should be the focus of most of such endeavours.

The Panel suggests that the CSIR devote more of its resources to marketing its services and products, particularly to private industry. It will be especially important to generate and advertise positive customer perceptions with regard to the excellent quality of the CSIR's offerings.

4.4.3 Intellectual property rights (IPRs)

In terms of its governing act (The Research Council Act, 1988), the CSIR controls the intellectual property rights that have been developed by the organisation. Thus, the customers of the CSIR who wish to secure ownership of intellectual property developed in the course of programmes or projects with the CSIR must specify this in their contractual arrangements.

There are two basic categories of patents:

- CSIR-owned patents. These can be licensed or packaged with services provided to customers, and
- Client-owned patents which have been developed under contract obligations.

The latter category of patents are also beneficial to the CSIR because costs of patenting are borne by customers and long-term income streams eventually may be created (the Zebra battery and the Highveld "Titanic" programmes serve as examples).

The Panel considered the procedures and processes in relation to intellectual property with a number of important CSIR innovations. There were some earlier situations in which the CSIR might not have efficiently capitalised on its innovative activities, such as the Zebra battery. However, the Panel believes that the organisation has been able to learn from its experiences, and its negotiating capability is now considerably improved.

The Panel concludes that the CSIR's procedures and capability to secure ownership and eventually derive income streams from its intellectual property is consistent with good business practice. The Panel has some incremental suggestions to improve this capability further.

The objective is to stimulate higher levels of innovation and, through ensuring timely and effective legal protection of intellectual property (IP), maximise the benefits to the CSIR.

Inter alia the following measures could be adopted :

- **develop skills among scientific staff to enable them to understand and analyse the techno-legal and business information contained in patents and other IP documents**
- **use information acquired from the analysis of IP documents to direct and mount strategic R&D programmes**
- **establish systems to record and document experimental results that would be accepted and respected by patenting authorities**
- **manage the portfolio of IP as a business activity**
- **utilise the patent portfolio to forge strategic alliances/international collaborations**
- **analyse and assess techno-legal and business information and market intelligence to identify potential strategic alliances and to exploit uncovered areas of opportunity.**

4.4.4 Creating a patenting culture

While appreciative of some very significant CSIR innovations that have resulted in patents, the Panel are of the view that much more could and should be done to spur patenting activity within the organisation.

At this stage, there is not a widespread appreciation and understanding of the issue that percolates through the organisation. The major deficiency in this regard, in the view of the Panel, is that there are insufficient incentives to promote this activity. While an individual's role in developing and securing patents will be rewarded in terms of promotion and possibly some bonus payment, this is insufficient reward when seen in the light of the effort entailed.

The Panel suggests that more generous incentives related to the ultimate income streams generated by the patent be developed at both the individual and divisional group level. Practice varies, of course, but in equivalent laboratories in the US and India, incentives range from 20% of institutional royalty income returned to the innovation team to a limit of R500,000 to 40% of royalty income with no limit. The CSIR might wish to consider a similar level of incentives. A further suggestion is that most of the remainder of the royalty stream be allocated to the Innovation Research Programme, from which most innovations are likely to arise in the future.

4.4.5 Patenting organisation

The CSIR has 100% share of Technifin which holds a number of CSIR patents. However, Divisions that develop patents are free to decide whether or not to utilise the services of Technifin or any other organisation. The Panel agrees with this policy.

The Panel's impression is that Technifin's performance is improving and that it is of considerable benefit to the CSIR. However, it would appear that the capacity of Technofin is rather limited. Also, the Panel is of the view that Technifin's requirement that 50% of any future revenues accrue to them is excessive, when compared with similar organisations elsewhere.

4.4.6 Accumulating and assessing CSIR's intellectual capital

Innovation through Assessing and Forecasting based on Global Intellectual Property Trends

The CSIR's intensity of patent filing, especially international patents, is not large, but, as it achieves its ambitions by globalising its R&D offerings, it will have to become more knowledgeable on issues linked with generating world-class intellectual property, documenting, protecting, valuing, and exploiting it through outright sale, strategic alliances, etc. Thus, it may be worthwhile to establish a small but creative group within the organisation to assess trends in international intellectual property practices as they affect the CSIR's business and future technology strategies that may be created within the CSIR.

The CSIR may even consider offering value-added patent information services to industry and the government (a technical intelligence service). The trend analysis of international patents could provide insight into changes in product life cycles, investment opportunities in new business and potential infringement issues. It could also help identify possible joint venture partners based on their technology portfolios as assessed by patent filing trends, etc., provided that such outside services could also help the CSIR enhance its own capability in innovation management.

Quantitative tools for continuous assessment of CSIR's Intellectual Capital Portfolio

Wealth is no longer measured in terms of fixed assets but rather in terms of knowledge-based systems that are able to create and add value. The CSIR is a "knowledge organisation", and therefore it should keep track of its worth in the "knowledge market" that it serves by continuously assessing its intellectual capital. Since the CSIR has already pioneered the quantification processes, it would be appropriate for it to develop and use quantitative tools for annually assessing its intellectual capital accumulation.

4.4.7 The creation of new technology based small companies

One of the most important mechanisms for getting new technology into the marketplace is to facilitate the creation of new companies developed and directed by employees of the organisation. In one equivalent organisation, employees are given 2-3 years to develop a company, utilising the knowledge and skills that they have gained. The organisation puts them in touch with potential providers of venture capital. At the end of this period, if their new company is not a business success, they are welcomed back into the organisation.

The advantages of such a programme are many. Successful firms are future customers. Unsuccessful firms still provide a hands-on training in the commercial world. A number of research institutions abroad, e.g. Sandia National Laboratories, have had considerable success with such programmes. Experience in the US is that many such spin-out companies do not succeed the first time around. But the innovators learn from the experience and are more often than not successful in a succeeding venture.

The Panel noted that many of the best qualified people at the CSIR have been in the organisation for a long time, that there is insufficient flow of young people into the organisation and that there are too few people with industrial experience in the CSIR. These factors reinforce the need for such a small company spin-out programme.

The Panel suggests that the CSIR encourage and facilitate the establishment of companies by some of its more entrepreneurial personnel – particularly those who have been with the organisation for some time and who have the technological knowledge and potential business acumen to be successful in such ventures. Different modalities are possible here (for example, the CSIR may or may not take an equity share in such a company), and these should be further investigated.

5. CLIENT PERCEPTIONS

5.1 Introduction

The CSIR is a market-driven institution with a commitment to search for and satisfy the needs of customers. This approach is driven by senior management, but it percolates through to lower levels of the organisation and is operative in all divisions.

There are well established management tools to track markets and to monitor and analyse customer satisfaction.

5.2 Market/Client Characteristics

Over two thirds of the CSIR's market revenue is earned on accounts of more than R250,000. These constitute less than 2% of the CSIR's accounts. Within private sector manufacturing, large firms (over 500 employees) account for some 75% of revenue. The financial viability of the CSIR therefore is particularly dependent on satisfying the requirements of its few larger clients.

Foreign revenue is significant and growing, but represents currently some 4% of total revenue and some 7% of market revenue. Client satisfaction in relation to foreign accounts could not be ascertained and is accordingly is not reflected here.

The domestic client base can be divided into the following broad segments:

1. Department of Defence and related defence industry procurement
2. Government line departments and parastatals – e.g. the Department of Transport, ESKOM
3. The mining industry – not including the individual mining houses
4. Private sector – principally, but not exclusively, manufacturing related
5. Developmental – NGOs, SMMEs, and related development work.

5.3 External Contract Income

One clear macro-indication of market orientation is the share of income generated in the market. Income from market sources as opposed to the parliamentary grant has been increasing steadily and for 1997 was R407 million. Total income, including the Parliamentary Grant (R304 million) is R711 million. The proportion of income generated from the Parliamentary Grant has been declining slowly¹. The proportion of income that is generated from external non-government grant sources is high by comparison with most other comparable technology institutes, particularly those in the industrialised countries. This is shown in Table 1.

¹ In 1993, the former COMRO was incorporated into the CSIR, boosting the share of external income. Since 1994, the share of the parliamentary grant in total income has fallen marginally from 43.9% to 42.8%.

<i>Institution</i>	<i>Year Established</i>	<i>Size – No. of Employees</i>	<i>Annual revenue US\$m</i>	<i>Percentage publicly funded</i>
IPA, GERMANY	1971	170(+600)*	73	30
IVF, SWEDEN	1964	180	19	60
PERA, UK	1946	300	46	30
BMI, USA	1925	8,450	864	80
KIST, SOUTH KOREA	1966	1,600	26	80
ITRI, TAIWAN	1973	5,500	350	50-70
SISIR, SINGAPORE	1973	550	28.5	50
HKPC, HONG KONG	1967	500	40	70-80
CSIR, SOUTH AFRICA	1945	3,000	160	43

Table 1. Characteristics and Funding of Nine Technology Institutes

Notes: * Includes staff who work on a "casual" basis
Data for early 1990s. Data for the CSIR, 1997.

Source: Rush *et al*, *Technology Institutes: Strategies for Best Practice*. Thompson Business Press, 1996. Table 1.1.

The CSIR's external income declined from a peak reached in 1989 until 1993. In that year, COMRO became part of Miningtek – inflating external revenues. For the last three years, real external income has been rising, steadily but not spectacularly. In 1997 real external revenue was some 14% higher than in 1995. ²Private sector contract income³ has remained static while public sector contract income has declined. Growth has come from the defence and security and international contract income. This growth in real income should be assessed against a backdrop, in this period, of higher rates of macro-economic growth; significant rates of growth for the manufacturing sector and the first-time opening up of new external opportunities for the CSIR. On the other hand, there have been cutbacks in some government departments and public sector contract income has declined.

² Data supplied by the CSIR management. In 1996/97 rands, external income amounted to R 350 million in 1995 and R 400 million in 1997. The 1997 amount was equal to the peak year, 1989.

³ The private sector includes "market-oriented" parastatals such as ESKOM.

It is important to "unpack" the category "external income". External income includes some one-off items as well as a considerable income derived from interest. External income earned in the market, designated as external contract income, in 1996/7 stood at R334.2 million. In addition, there is a small amount of royalty income – some R3 million in 1996/7. It is more meaningful to measure the "market orientation" of the CSIR by comparing the magnitude of external contract income (including royalty income) with the Parliamentary Grant. The share of external contract income has risen slowly over the last five years, from 50% of the total in 1992/3 to 52% in 1996/7.⁴

Thus, overall there has been some progress, albeit slow, in the earning of external income. This has been achieved against a backdrop of broadly favourable conditions.

What is the potential for increasing external contract income further? How large is the potential market for the CSIR and how rapidly might it grow? It is difficult to give clear answers to these questions. In assessing the major component of the market for external contract income, namely the private sector which accounts for R180 million (54%) of external contract income, best estimates would suggest that the CSIR probably has between 35%-55% of the existing market.⁵

This would suggest that the ability of the CSIR to increase its earnings of external contract income will be strongly dependent on the rate of growth of the domestic market and on exploiting new opportunities abroad.

5.4 Client Perceptions

5.4.1 CSIR client surveys

In general, client perceptions of the CSIR are favourable. The CSIR's customer survey shows that 71% of customers register 100% satisfaction. However, measured against

⁴ CSIR Business Plan, 1997/8. Attachment A- Financial Growth Measures- CSIR Consolidated.

⁵ The CSIR's own best estimate is 49%. This is based on the following assumptions. Total business R&D of R1 943m (derived from the 1994 R&D Survey and assuming a 30% undercount); total outsourcing of R&D by business of 20% of their expenditure on R&D; and the "scope" of CSIR's activity as covering some 65% of total business R&D (there being some areas where the CSIR is non-operative) and allowing for 20% of the CSIR's contract income from the private sector as being unrelated to R&D, e.g. product testing.

Two factors that will influence this assessment need to be taken into account. Firstly, the overall size of the market will be considerably higher if we take account of innovation rather than R&D. Overall, formal R&D expenditures are only one-third of innovation expenditures (Blankley and Kaplan, Innovation Patterns in South African Manufacturing Firms, FRD, 1997, page 4). On the other hand, many non-R&D innovation expenditures e.g. re-tooling, are very likely to be in-house. Secondly, the size of the market is, in part, a function of the CSIR's capacities. Many South African firms, for example, contract with research organisations abroad in the perception, rightly or wrongly, that the CSIR cannot perform the necessary functions.

its competitors, customer perception of the CSIR is not high. The latest survey of customer perceptions as carried out by the CSIR⁶ shows:

- (i) The CSIR's value ratio (the ratio of customers ranking the organisation as very good and excellent as compared to those ranking the CSIR as below average) is broadly on a par with that of domestic competitors and significantly lower than that of international competitors.
- (ii) Customer perception is that the CSIR's sole advantage over its international competitors lies in the fact that it is cheaper, and more relevant to the development needs of the country.

While there are difficulties in interpreting the comparability of earlier surveys, it would appear as if this comparative picture has been essentially static over the last few years. With the opening up of the SA economy and the advent of new international competitors, this is cause for some concern.

International competitors outperform the CSIR in service quality. The critical components of this differential service quality lie in project delivery (giving the customers what they require) and contract management. These are the two key areas that the CSIR will have to improve if it is to have a more favourable perception in the market place.

A major concern is that many clients appear to see the CSIR as a source for relatively low-level, low-priced technological solutions, and competitors, particularly overseas-based competitors, as the source for higher level, higher priced technology. These perceptions, when combined with the market orientation of the CSIR, reinforce other tendencies in the organisation (see Chapter 2) to underplay the significance of substantive innovation. A cause for further concern is that some of the clients who have demanded higher level technological capacity and whose needs have supported the development of more strategic capacities within the CSIR are likely to decline in importance – most notably defence-related activities.

5.4.2 Panel interviews

In general, the interviews with clients confirmed their high regard for the organisation. There was general satisfaction, and in some cases considerable enthusiasm, for the quality of the service rendered. With few exceptions, clients expressed a very high regard for the technological competence of the organisation and some were firm in their insistence that the CSIR was "world class." Some clients drew attention to the fact the market was becoming increasingly competitive, but overall customer loyalty was strong.

⁶ Customer Value Management. Executive Summary – Executive Report. August 1997

Defence Industry

Principal operative divisions: Aerotek; also Mattek and Micomtek.

Overall assessment of clients: very positive.

Perception of the quality of the CSIR's technological competency: high, state of the art.

While specific arms of the defence force require support for the development of products, the key client need was defined as "a state of the art technology/science base" – the "rendering of high level advice of a technological/scientific nature in order to assess, for example, weapons systems". The CSIR would certainly be the preferred location for this technology/science base. This is of particular importance to the CSIR since, apart from the revenue, a demand would be generated for high-level strategic technological capability on an ongoing long-term basis.

The perception is that the cost is low and that the quality of research is generally high. Confidentiality is not a problem. The CSIR is seen as highly responsive, with an excellent support system.

In relation to defence, the major suggestion made was that the CSIR should work much harder at establishing a direct interface with the ultimate end users, namely the operational arms, so as to appreciate their problems and concerns and to take account of these in their various defence-related activities.

Government Line Departments

Principal operative divisions: Environmentek; Transportek; Boutek; Foodtek.

Overall assessment of client : positive

Perception of the quality of the CSIR's technological competency: good, best in Africa, but none of the government line departments saw the CSIR as having unique competencies. Although the CSIR has the advantage of local knowledge/experience, in technological terms they are not, in general, at the world frontier.

The CSIR often provides an ongoing service and advice to government departments – largely of a "soft" sort – data collection, information and planning. In the main, this has been done well. In Environmentek, for example, divisional management has been particularly proactive in seeking to define a longer term ongoing partnership with the department. Boutek was particularly complemented for having a good interface with the community.

Two concerns were expressed from this client segment. First, the entry of new competitors particularly from abroad, but also domestically from the private sector, will sharpen competition for the CSIR in many areas. Many of the activities undertaken by the CSIR could be, and in some cases are, performed by other players including the private sector. They will increasingly be able to compete with the CSIR,

which is perceived by several clients as "not cheap". International competitors entering the local market may do so via foreign assistance programmes and so be very competitive in terms of price. The likelihood is that the CSIR will lose market share in this area. There is a strong need for the CSIR to form more and stronger consortia. Second, the CSIR is perceived to be Pretoria-based and to be very remote from the provinces. The organisation does not have strong credibility at the provincial level – the ultimate end users of the CSIR's services. The client recommended that the CSIR decentralise its operations and locate them closer to the end-users.

The Mining Industry

Principal operative division: Miningtek

Overall perception of client: positive

Perception of the quality of the CSIR's technological competency: excellent. A few areas of weakness, but generally world class, particularly in the area of deep-level hard rock engineering.

Miningtek performs some 80% of the safety research programme under SIMRAC, which is ongoing and has a high level of security of funding. This allows for the maintenance of a core of expertise that can deal with safety and related issues and provide direct solutions to problems of a safety nature. The CSIR fulfills its obligations under this programme well.

There is a further aspect of the CSIR's work with the industry, namely the potential to solve longer term, more fundamental technological problems in the mining industry. Here the relationship is said to be less optimal. There are problems in defining the concerns and in establishing a concrete working programme. Lack of clarity emerges on both sides. More structured liaison would improve the situation. However, very deep level mining was singled out as constituting a possible project which would require long term commitments on both sides. This could be of considerable national importance and provide the CSIR with some longer term projects and funding security which would support the development of more strategic technological capacities. The possibility of utilising new funding mechanisms, such as THRIP and the Innovation Fund, adds force to such an orientation. This would also allow for more consortia based research.

Currently, external revenue is very low, but as South African mining companies exploit new opportunities abroad, the potential for earning more foreign revenues will certainly increase.

The Private Sector

Principal operative divisions : Mattek; Micomtek; Textek; various

Overall assessment of clients: positive - very positive

Perception of the quality of the CSIR's technological competency: excellent.

Responses were, in the main, very positive. The organisation was perceived as being responsive to customers, with technological competence at a high level and services fairly priced. A few concerns were raised. First, one important client stressed the need for the CSIR to internationalise, through developing new contacts with overseas-based research organisations. Two clients stressed the need for the CSIR to continue to build a "basic longer term knowledge base" and one client felt strongly that the CSIR was not doing nearly enough to maintain high level intellectual knowledge in key science areas. A suggestion was made that a previous system of joint CSIR-industry industrial advisory committees should be revived to provide information and reality checks. In this regard, there needs also to be closer collaboration with the universities. A lack of industrial skills on the part of many CSIR people sometimes creates a gap between industry and the organisation. Finally, one client suggested that, while generally cheap, the CSIR seemed to be confused in terms of its pricing policies. Prices were said to be set somewhat arbitrarily, and were sometimes set too low and sometimes too high.

Developmental

Principal operative divisions: Boutek; Foodtek

Overall assessment of clients: positive

Perception of the quality of the CSIR's technological competency: good

The Task Team were not able to undertake many interviews with clients in this very diverse market segment. However, the perceptions were generally favourable. One client regarded Boutek as "indispensable". Quality and delivery were said to be good. There was adequate delivery, but one client saw a gap between CSIR and the client that was described as "cultural".

On interviewing customers, the impression that CSIR activities in this area were low-technology was confirmed. Moreover, the lack of adequate delivery mechanisms/organisations often leads the CSIR into direct delivery. In some cases, projects have not been very effective. This perception is gained less from customers than from management presentations relating to some of the CSIR's developmental activities.

5.5 Conclusions and Suggestions

The positive responses of clients confirm that the CSIR is a technologically proficient and market-driven organisation, responsive to client needs. The suggestions below are derived from our analysis of client perceptions and are designed to reinforce this orientation.

A number of steps could be taken by the CSIR to strengthen its linkages with customers:

- **Ensure more migration of persons between industry and the CSIR. More persons should be recruited from industry and more CSIR persons located in industry. Short-term arrangements should also be possible. The CSIR needs to have persons with intimate insider knowledge of its major customers.**
- **Each major programme with industry would benefit from the presence of one or more persons with genuine industrial experience.**
- **There is a need to establish long-term cooperation committees with key clients and with industrial associations in order to liaise on longer-term technological needs and demands.**

The CSIR will need to improve perceptions in the marketplace if it is to attract significant new business, particularly from the private sector:

- **The CSIR will need to improve client perceptions of the organisation. In particular, the perception, in some quarters, that the CSIR is only appropriate for lower-technology and cheaper solutions.**
- **While the CSIR's performance is strong, the increasing degree of competition, particularly from foreign research organisations, will require that it improves in the areas of project delivery and contract management if it is to build market share.**
- **There are some areas of activity, notably in the development field, which need to be examined carefully; in particular, activities which require only low levels of technology and activities where the CSIR is itself engaged in undertaking delivery directly to the ultimate end-user. The CSIR is performing a function here which is strongly in accord with national priorities, and performing this function, in the main, well. In the longer term, however, this function should not be part of the CSIR's core activities.**

6. CONCLUDING REMARKS

The Panel has found the review to be an interesting and challenging experience. The Panel has worked effectively as a team, and individual members, particularly those from outside of South Africa, have brought important individual experience and expertise to the process.

The Panel recognises that some of its recommendations and suggestions are incorporated in CSIR STRATEGY 2002, the CSIR's strategic plan for the next five years. In that the Panel has reached its conclusions independently, this convergence is encouraging and strengthens our confidence in the CSIR management.

The Panel wishes to acknowledge the willingness of all those it has consulted to assist in the execution of its mandate. The Panel is particularly grateful to the Executive of the CSIR, headed by Dr Geoff Garrett, for the forthright and open way in which they have presented information about the CSIR and responded to requests for additional information. The Panel is confident that it was freely provided with access to any information it wished to obtain.

The Panel is particularly grateful for the efforts of the team that provided it with logistical and other support. This team was made up of Dr Adi Paterson, Ms Anita Loots, Mr Hennie Venter, Ms Berenice Bruwer and Ms Christa Fryer. Every effort was made to provide the members of the Panel with everything that they needed, and the members of the team shared the long hours worked by the Panel.

**Appendix 1:
Terms of Reference for the Review of the CSIR**

The National Review of Science, Engineering and Technology Institutions (SETIs)

INTRODUCTORY COMMENTS

Terms of Reference for the Reviews

In consultation with all SETIs and their line departments, the DACST has prepared the following:

- ▶ a set of generic terms of reference for the reviews of SETIs which will be applicable to all SETIs, and
- ▶ a set of tailored terms of reference for each SETI to take account of the specificity of that organisation.

The full set of generic and specific terms of reference for the review of SETIs are clarified later on in this document.

Core Competence Clusters

Prior to drafting 'tailored' terms of reference for individual SETIs, DACST discussed with each SETI to be reviewed, the identification of the SETI's *core competence clusters* which will form the basis of its review.

By "*core competence cluster*" is meant the set of activities, within the SETI, from research through technology development to production, marketing and sales of products or services relating to a specific area of core technological competence. For most SETIs the set of activities will include research, technology development and marketing and sale of the related intellectual property. In some SETIs, such as the AEC, the set will include production, marketing and sale of bulk commodities and products and the offer of commercial services.

Characteristics of core competence clusters include:

- ▶ they possess the ability to create a competitive edge, increasingly in global markets;
- ▶ they are sustainable;
- ▶ they are difficult to emulate in the short to medium term;
- ▶ they have multi-product applications which add value
- ▶ they can attract investment from outside the organisation
- ▶ they are the product of long-term strategic thinking, planning and investment.

Review Structure

There will be three important facets to each review. These are as follows:

- ▶ An end-user review, in which the contribution of the output of the SETI to the needs of end users as well as to the realisation of national goals or international commitments will

be assessed;

- ▶ A peer review, in which the scientific or technical quality of the output of the SETI will be assessed; and
- ▶ A management performance review to benchmark the quality of SETI management and management systems against criteria of efficiency, economy, effectiveness, capacity to provide leadership and capacity to employ strategic management concepts to the program of the SETI.

Each team of reviewers will be constituted to ensure that, as a group, the reviewers for each SETI have all of the skills and experience necessary to execute the review.

The White Paper on Science and Technology

The White Paper on Science and Technology identifies five primary domains of activity for the National System of Innovation. These are:

- ▶ Promoting Competitiveness and Employment Creation;
- ▶ Enhancing Quality of Life;
- ▶ Developing Human Resources;
- ▶ Working Towards Environmental Sustainability; and
- ▶ Promoting an Information Society.

The White Paper also acknowledges as 'important dimensions' of South African science:

- ▶ The importance of knowledge generation, and
- ▶ The role of the human sciences in innovation.

The National Review of Science, Engineering and Technology Institutions (SETIs)

TERMS OF REFERENCE FOR REVIEW OF THE CSIR

For the purposes of this review, the CSIR will be deemed to consist of the set of 'core competence clusters' set out on Page 9 of this appendix, together with its administrative infrastructure.

The Review of the CSIR will seek to answer questions within the following domains:

Performance Assessment

The contribution of the output of the SETI to the needs of end users as well as to the realisation of national goals or international commitments will be assessed. The aim of this aspect of the review should be to gauge the opinion of major stakeholders as to whether the outputs of the SETI are consistent with what the sector expects from it, in terms of fulfilling both national and sectoral goals. This will extend from an examination of the basic utility of the SETI within its sector of the economy or the knowledge chain, to an overall strategic view of its capability to contribute to future technology and information requirements.

1. *To assess the adequacy of the systems in place within CSIR to ensure the maintenance of high quality standards in all aspects of its work and of high relevance to the needs of the sector it is designed to serve. In particular, CSIR's arrangements for technology or information diffusion to its user community should be assessed.*
2. *To assess the extent to which CSIR has been able to distinguish between*
 - ▶ *situations in which there is a 'capacity' within its organisation, expressed in terms of the availability of trained people and of appropriate facilities, to undertake work in a given technological area; and,*
 - ▶ *situations in which there is a 'competence' to develop and diffuse or commercialise innovations under market conditions in such technological areas, and where the 'market' may be either public or private depending on the particular case.*
3. *To assess, from an external perspective and on a sampling basis to be determined by CSIR, DACST and the Review Team, the current performance standards of the core competence clusters within CSIR.*
4. *To identify and assess the extent to which CSIR engages in consistent and constructive interactions with other relevant participants in the markets in which CSIR's core competence clusters are active and to assess the results of these interactions.*
5. *To benchmark the quality of CSIR management and management systems against criteria*

of efficiency, economy, effectiveness, capacity to provide leadership and capacity to employ strategic management concepts to the program of CSIR.

6. *To review and assess the extent to which CSIR competes for and obtains funding from international sources, public or private, and to comment upon the policy used by CSIR to manage such interactions.*

Resource Allocation

7. *To assess the appropriateness of the allocation of the CSIR's resources across its core competence clusters in the light of the goals and national needs in each of the main thematic areas set out in the White Paper on S&T.*

Each SETI can have access to four distinct forms of government support for research and/or technology development. These are as follows:

- ▶ The Parliamentary Grant, intended to ensure the existence and maintain the quality of a scientific or technological capacity needed by the country and which no other sector can be expected to finance;
- ▶ Contracts for the performance of research or technology development needed by a department or agency of government and for which the department or agency is prepared to pay;
- ▶ Competitive grants from programs such as the Innovation Fund or THRIP; and
- ▶ Revenues from the sale of services or products to government.

With respect to Government responsibilities for financing S&T through Parliamentary Grants, the White Paper on S&T indicates that government should take the lead

- ▶ in pre-competitive research, until a culture develops in the private sector where such research is seen as a business imperative;
- ▶ in areas where barriers related to equipment and human resources are high;
- ▶ in areas where the activity is considered to be a service which the Government has a duty to provide; and
- ▶ in areas of public good in which, to achieve the greatest benefit, the research results and technology transfer need to be placed in the public domain.

8. *To determine, for each of the core competence clusters identified by CSIR, which elements of these clusters should be:
financed entirely by a Parliamentary Grant, because of the nature of the activity; or
receive Parliamentary Grant support which should be supplemented by cost-recovery revenues from clients, including governmental clients; or
be fully financed by commercial revenues.*

9. *To determine, for each of the core competence clusters identified by the CSIR, the nature and*

extent of specific services, if any, which could be provided directly to government.

10. *To assess the strategic planning capacity of CSIR and the ways in which that capacity is used to determine the internal allocation of CSIR funds obtained from the Parliamentary Grant and from other sources.*

Market Spread and Sustainability

The primary mission of government-funded SETIs is to maintain and extend the national technology and knowledge base, and hence to contribute to the healthy functioning of the national system of innovation. In a rapidly changing global environment, where the competitive technologies and firms of today can become obsolete and uncompetitive tomorrow, it is important to know that the national system of innovation is able to respond to new problems.

Apart from the overall dynamism, depth and competitiveness of the SETIs themselves, the important factor to consider in this respect is whether or not South Africa has today an appropriate range of government-funded SETIs to be able to provide technology or knowledge-based solutions to entirely new classes of problems. In order to obtain an overview of the present situation, the 'market range' of individual SETIs first needs to be established.

11. *To identify, for each core competence cluster within CSIR, the sectoral coverage of the cluster's market interests, the relationship of that coverage to the mandate of CSIR, the boundaries of the business which the cluster is in (i.e. is it only in technology development or is it involved in production or sale of services?), and to assess the prospects which it has of commercial viability.*
12. *With respect to each of the core competence clusters currently managed by CSIR, seek to identify responses to the following questions:*
- ▶ *Is the original need for the function performed by the cluster still applicable?*
 - ▶ *Who are its customers?*
 - ▶ *Do they pay for it? If not, why not?*
 - ▶ *If customers pay, what is the role and need for public funding?*
 - ▶ *What would happen if the function ceased?*
 - ▶ *Must the public sector be responsible?*
 - ▶ *Must the public sector provide the function itself?*
 - ▶ *What is the scope for rationalisation?*

In assessing the appropriateness of the cluster's role in technology or knowledge development within a market segment, the review should seek to quantify factors such as the value of the output of the sector, the total South African R&D input into the sector and the SETI's share of that input, and it should compare South Africa's and the SETI's R&D expenditures as a percentage of sales with any available data from competing countries (e.g. data which might be available from OECD concerning the industrialised countries.)

Equity and Redress

The reviews will address the issue of how to promote the achievement of the goals for corrective action laid down in the White Paper on the Public Service. In general, because of the knowledge-intensive nature of SETI activities and the legacies of education under apartheid, representation of historically disadvantaged groups in the management and research echelons of SETIs is even lower than in the professional ranks of other private and public sector institutions. Furthermore, the demand from the private sector for technology-literate black people is high, resulting in a greater than average attrition rate of black professionals from the SETIs.

13. *To assess the adequacy of the design, resourcing and implementation of CSIR's initiatives to promote equity and redress within its staffing patterns, in the light of government's commitments on these matters.*
14. *The review should also investigate the feasibility and desirability of the CSIR and other institutions (subject to the imminent system-wide review) negotiating among themselves and adopting a common approach to equity and redress in order to accelerate the processes on a system-wide basis.*

Governance, Ownership and Institutional Frameworks

One of the primary purposes of the reviews will be to investigate the extent to which the full ownership by the State of certain SETIs, core competence clusters of SETIs, or even technologies produced by SETIs, is appropriate in today's circumstances. If government remains the owner of a SETI, its governance and management systems and the institutional frameworks (mandates and legal structure) which it has in place may need to be redesigned or refined. Some of the questions which will need to be addressed include

The Corporate Board (used in all of the SETIs under review)

- ▶ What powers are allocated by the SETI's legislation to the Board?
- ▶ Does management get its powers directly from the legislation or by delegation from the Board?
- ▶ Is the separation of responsibilities between Board and Management clearly demarcated and clearly understood?
- ▶ Who appoints the President and Senior Management?
- ▶ What provisions exist for periodic performance audits of the management function in the SETI?

Governance Systems at the SETI Level

- ▶ How appropriate is the present reporting line to government for the SETI?
- ▶ What are the legislative constraints determining the SETI's operation within and outside national borders? Are these constraints appropriate and/or practical?

Governance Systems at the Core Competence Cluster Level

- ▶ What structures of governance and management are in place for each core competence cluster?
- ▶ Is there any external governance system in place or is all responsibility vested in management?
- ▶ What is the relationship between management at the core competence cluster level and overall corporate management, including the corporate board?
- ▶ Is continued public ownership of the core competence cluster appropriate? Is continued public ownership of the technologies at the base of the competence appropriate?

Ownership of Assets

- ▶ Does the SETI become involved in any joint-venture activities which involve joint ownership of assets?
- ▶ Would acquiring a 'strategic equity partner' make sense for any of the core cluster competencies make sense?
- ▶ If yes, what are the circumstances in which such arrangements are made and what is the decision-making process involved in reaching agreement on the issue?
- ▶ How is asset-ownership audited? By whom? On what time-table?

Institutional Framework and Mandate

- ▶ Does the mandate capture adequately the role and functions which the SETI is expected to perform in today's South Africa or are there terms in need of revision?
- ▶ Does the SETI's legislation permit it to create subsidiaries, and if it does, what is the legal status of the subsidiary?
- ▶ Does the SETI's legislation place any limitations on the purposes for which subsidiaries might be created?
- ▶ Are there any legislative barriers to the SETI entering into alliances of any kind, particularly with private sector organisations?

15. *To advise government on the appropriateness of current mandate and arrangements for governance, management, asset control, and institutional framework within CSIR and its core competence clusters in the context of the White Paper on S&T.*

Alignment with the Strategic Objectives of the National System of Innovation

16. *To assess the contributions made by CSIR (within the domains of activity and important dimensions of South Africa's national system of innovation as set out in the White Paper on S&T, at the levels of the whole institution and of its constituent core competence clusters) to innovation, to technology transfer and services, and to its own internal capacity building in anticipation of providing future services.*

17. *To assess, in the context of the sector(s) in which CSIR is active, the responsiveness of the activities of CSIR to relevant sectoral policies.*
18. *To advise government on the appropriateness, in today's (and anticipated future) circumstances, of the scope of the mandate allocated to CSIR.*
19. *To assess the factors which have lead the CSIR to select its current priorities and to allocate its available resources in the way in which it has chosen to do so, and its capacity to reallocate its resources as necessary in the face of changing external needs.*
20. *To assess the design and performance of the strategic management function within CSIR, and in particular to assess the actual performance of that system in decision-making relating to either the addition or subtraction of areas of emphasis in the work program of CSIR within the context of the national system of innovation.*
21. *To assess and advise government on the appropriateness, in today's (and anticipated future) circumstances, of the institutional placement of specific core competence clusters within the national system of innovation.*

Specific Terms of Reference

To review and assess

22. *the approach of CSIR to remaining sensitive to national needs while operating in an increasingly competitive globalizing context.*
23. *the competence of CSIR to play a role as a global technology source, and to analyse the possible contributions to South Africa of CSIR playing such a role.*
24. *the management strategies adopted by CSIR as it moved from a research and development mandate to a technology transfer and service provision orientation over the last 10 years.*
25. *the results of CSIR's deliberate market-orientation, which has been focused on technology and service provision rather than the creation of technology start-ups, in the light of other international experience with commercial models for technology transfer.*
26. *CSIR's commercialisation strategy in the light of the White Paper on S&T's policy on avoidance of unfair competition between the public and private sector in technology development.*

29. *whether models such as the retention of equity in operating companies by CSIR be explored to promote the transfer of technology to the private sector.*

The review team will be invited to make recommendations to government on all matters within its terms of reference.

The CSIR's Core Competencies and Capabilities

The concept of a 'core competence cluster'

Each SETI, within its mandate, is intended to provide outputs that benefit client and stakeholder groupings. In order to create capacity to ensure the provision of such outputs, government funds are used to create, inter alia:

Infrastructure	(Research facilities)
Technology	(Knowledge, skills and intellectual property)
Capability	(Systems and practises for effective knowledge transfer)
Platforms	(Core services and products that can serve many markets)

A core competence cluster is an effectively functioning set of infrastructure, technology, capabilities and platforms which provide offerings to clients and stakeholders which they can appropriate and evaluate. These offerings are, therefore, the outputs of the SETI mediated through the core competence cluster.

It is therefore possible to assess a SETI's contribution in terms of the level to which resources have been deployed in core competence clusters. Such competence is extended, maintained and renewed by capacity building utilising (in the present environment) government grant funding.

Capacity building, when optimally performed, is a strategic investment process to create future offerings by the judicious development of new infrastructure, technology, capabilities and platforms. Such capability becomes part of the core competence cluster when clients and stakeholders are themselves willing to fund the offerings developed in order to appropriate the benefits to themselves and their constituencies.

Characteristics of core competence clusters include:

- they possess the ability to create a competitive edge, increasingly in global markets;
- they are sustainable;
- they are difficult to emulate in the short to medium term;
- they have multi-product applications which add value
- they can attract investment from outside the organisation
- they are the product of long-term strategic thinking, planning and investment.

Specific core competence clusters for this review

It has been provisionally proposed by CSIR to DACST that the core competence clusters of CSIR activity be taken to be the existing technical divisions of the Council which, as listed in the CSIR Business Plan and Budget for 1996/97, are as follows:

Aerotek	Boutek	Environmentek	Foodtek
Integrated Initiatives	Mattek	Mikomtek	Miningtek
Textek	Transportek		

**Appendix 2:
Short Curriculum Vitae of Panel Members**

RESUMÉ OF DR. ING. GERD DEUSTER

Dr. Ing. Gerd Deuster, Chairman, Fraunhofer Management GmbH, Munich, Germany

- 1957 - 1963 : Technical University, Darmstadt
Technical University, Clausthal
Studies of economic and mechanical engineering
- 1963 - 1972 : Otto Wolf AG
Rheintovhe AG
DEMAG AG
Industrial Engineering & Research
- 1969 : PhD in Metallurgy
- 1972 - 1990 : Conception, establishment and leadership of the Fraunhofer Institute for non-descriptive testing, Saarbrücken. Leader and German Co-ordinator of large projects on Nuclear Safety (OECD, Paris, EU, Brussels, BMBF, Bonn, Baulle Northwest, Richmond (USA)
- 1990 - today : Conception, establishment and leadership of the Fraunhofer Management GmbH, Munich
Main business: Technology Transfer and Innovation Processes

RESUMÉ OF MR JOHN HALL

Public positions held

Chairman	Business South Africa
Vice Chairman and Board member	MINTEK
Board Member	CSIR
Chairman	Ferro Alloys Producers' Association
Member	Mineral Advisory Council
President	SA Chamber of Business
Chairman	Peace Steering Committee
Chairman	National Peace Committee
Chairman	National Peace Accord Trust
President	British Chamber of Business
Member	Wits Business School Advisory Council

Business Appointments

Chairman	Middelburg Steel and Alloys
Chairman	Rand Mines
Chairman	Pretoria Portland Cement
Chairman	Rand Mine Properties
Chairman	Rand Coal
Chairman	Otis South Africa
Director and Executive Member	Barlow Rand (1967 - 1993)
Director	Ingwe Coal
Director	BOE/National Bank
Director	Commercial Union Insurance Company
Director	E L Bateman
Director	Grinaker Shipping

Honorary Awards

C.B.E.	
Honorary Doctorate	University of Cape Town

RESUMÉ OF ASSOCIATE PROFESSOR DAVID KAPLAN

David Kaplan was born in Zimbabwe and educated at the University of Cape Town where he graduated with a BA and BComm. He then did his graduate studies in the UK where he obtained an MA in Economics at the University of Kent and a DPhil in Development Economics at the University of Sussex.

He taught Economics at the University of Massachusetts before returning to South Africa in 1980 to teach in the Department of Economic History at UCT. He undertook academic research and was also engaged in research projects supported by the Union movement. In 1991, together with some colleagues, he established the Development Policy Research Unit (DPRU). The DPRU has undertaken a number of significant research projects, particularly in the area of industrial policy, and has had a significant impact on government policy. It currently works closely with a number of government departments, particularly the Department of Trade and Industry.

In 1995, David Kaplan established the Science and Technology Policy Research Centre (STPRC) and is currently its Director. The STPRC is recognised as a national centre by the Centre for Science Development (CSD). It has contributed to the formation of government S&T policy and is currently engaged in a variety of research projects in this area.

David Kaplan is the author of two books; a recently published national survey of innovation in South African Manufacturing Industry and a number of other academic publications. His current research concerns focus on the issue of innovation, scientific migration and industrial and technology policy.

RESUME OF PROFESSOR JOHN MARTIN

John Martin was born in 1937 in Durban, South Africa, and obtained the degree of B Sc (Eng) in Civil Engineering at the University of Natal. He continued his studies at Cambridge after a brief period as a Lecturer at the University of Natal, and received his Ph D in 1962.

He then spent ten years at in the Division of Engineering at Brown University, Providence, RI, where he was successively Visiting Assistant Professor, Assistant Professor, Associate Professor and, from 1969, full Professor.

John Martin took up the Corporation Chair in Civil Engineering at University of Cape Town in 1973. In 1983 he became Dean of the Faculty of Engineering, and in 1996 Deputy Vice Chancellor with responsibility for research. From 1984 to 1991 he held the additional post of Director of Information Technology.

In research, John Martin has directed a group since 1981 known successively as the Nonlinear Structural Mechanics Research Group, the Applied Mechanics Research Unit (AMRU) and the Centre for Research in Computational and Applied Mechanics (CERECAM). He has been A rated by the Foundation for Research Development since the evaluation system was introduced in 1984, and is the author of a monograph on Plasticity published by MIT Press in 1976. He is also the author of about 120 papers and 70 technical reports and conference papers.

Professor Martin is a Fellow of the South African Institution of Civil Engineers, the American Society of Mechanical Engineers, the American Society of Civil Engineers, the University of Cape Town, the Royal Society of South Africa and the Academy of Science of South Africa. His awards include the John F W Herschel Medal of the Royal Society of South Africa (1990), the Fox Foundation Annual Award (1992), D Sc (Eng) hc from the University of Natal (1995) and the South African mathematical Society Award for Research Excellence (1996).

He has been a member of the Council for Nuclear Safety since 1982, and Chairman since 1986.

RESUMÉ OF MR PETER MASEMOLA

Peter Masemola is the Managing Director of Tru-South Group, a holding company of Tru-South Management Services. He was a General Manager of Nampak Polyfoil, Gauteng and a Board member of Nampak Polyfoil division. He was in charge of 2 Manufacturing Operations in Gauteng, and serviced Free State, North West, Mpumalanga Province, Gauteng Province, Zimbabwe, Botswana, and Mozambique.

He joined Nampak as a World Class Manufacturing and Services Consultant for Nampak Management Services where he was involved in WCM&S strategy formulation. He initiated the process of manufacturing culture change at 20 Nampak operations through the TPM manufacturing technique. This also involved setting up pilots, which stopped some Nampak plants from Capexing their problems.

In 1990, at the height of industrial unrest, he joined Mercedes Benz S.A., as Manager of the Honda Bodyshop. He later joined S.A. Breweries as PA to the Regional Director - Coast, and was involved in numerous projects in Production, Quality Control, Human Resources and in strategic alignment of the company to being a good corporate citizen in the new South Africa. His portfolio of responsibility included outsourcing and setting up black business suppliers to the SAB Group.

He also serves on the SABS Council and is Chairman of the SABS Audit Committee. He has a degree in Mechanical Engineering as well as a Diploma in Business Management. Because of his passion for the improvement of educational standards in our country, he has served on the Executive of Mamelodi Education Project, and also teaches Mathematics and Physical Science to Grade 11 and Grade 12 pupils on a voluntary basis.

RESUMÉ OF DR. R.A. MASHELKAR

Born in 1943 in Goa, Dr. Mashelkar did his B.Chem. Eng. (1966) and Ph.D.(1969) in chemical engineering from University of Bombay. He held academic positions in the U.K., and USA before returning to India.

Dr. Mashelkar joined National Chemical Laboratory, (NCL) in 1975 as Assistant Director and rose to the position of its Director in 1989. During his tenure as Director of NCL, he made it a global R&D platform, offering NCL's technologies and services worldwide. NCL's client list today includes some of the leading multinational giants such as General Electric, Du Pont, Unilever, etc.

Dr. Mashelkar took over as the Director General of Council of Scientific and Industrial Research in July 1995. He is the youngest Director General of this largest chain of Laboratories in the world (40 laboratories with 25,000 employees).

The Mashelkar's Committee Report (1993) gave a refreshing new market and user orientation to the CSIR. He had the enviable task of implementing his own report, after taking over as DG, CSIR! Dr. Mashelkar enunciated a White Paper CSIR 2001 : Vision and Strategy, which was major effort to create a performance driven, accountable, user focussed organisation, which creates wealth and social good out of its science. He has been propagating a culture of innovation and creativity with a strong intellectual property regime in India.

Dr. Mashelkar has been an active consultant in research and technology to Indian industry as well as to leading companies in USA and Europe. He has been on the Board of Directors of IPCL, MPCL, TDICI, IVS, etc. He has been consulted to World Bank on restructuring of industrial R&D.

Dr. Mashelkar was a Member of the Science Advisory Council (SAC) to the Prime Minister of India (1988-90) and presently he is a member of the Science Advisory Committee to Union Cabinet.

Dr. Mashelkar is an active researcher. His contributions in non-Newtonian fluid mechanics, polymer reaction engineering and gel science and technology have won him many laurels. He set up a world class polymer science & engineering school in NCL. Dr. Mashelkar has published over 200 research papers in international journals and he has edited 19 books. Dr. Mashelkar has won many awards, which include the prestigious SS Bhatnagar Prize (1982), KG Naik Gold Medal (1985), FICCI Award (1987), Viswakarma Medal (1988), OP Bhasin Award (1991), Pandit Jawaharlal Nehru Award for Technology (1991), GD Biria Award (1993), Raj Kristo Memorial Award (1995), Goyal Award (1996), etc.

In 1991, the President of India honoured him with Padmashri in recognition of his contributions to Science.

Dr. Mashelkar has received a number of international honours. In 1993, University of Salford (U.K.) honoured him with an Honorary Doctorate of Science honoris causa and in the same year he was elected a Fellow of Third World Academy of Sciences in Trieste, Italy. He delivered the prestigious Danckwerts Memorial Lecture in London in June 1994. In 1995, he was elected a Foreign member of Royal Academy (U.K.)

RESUMÉ OF MR JOHN MOALUSI

Qualifications

B.Proc Law Degree	:	Unisa - 1984
Executive Development Programme	:	UCT Business School - 1987
Post Graduate HR Management	:	WITS Business School - 1988
Executive Development Programme	:	Kellogg University - USA - 1989

Employment History

2 months	:	Group Executive : Marketing, -Persetel - Q.Data
3 yrs	:	Group Executive Director : HR - P.G. Bison
3 yrs	:	General Manager : Corporate Service - Development Bank of S.A.
5 years	:	HR Director - Adcock Ingram Pharmaceuticals
8 years	:	HR Manager - Lipton (S.A.) - Unilever
5 yrs	:	Quality Control Manager - Irvine & Johnson

Professional Membership

IODA	-	International Organisation Development Association
IPM	-	Institute of Personnel Management
BMF	-	Black Management Forum

Competencies

- Management at strategic / operational level
- Business strategy formulation
- Organisation Development & Design
- Industrial Relations - Labour Legislation & IR practice
- HR system (Performance Management, Remuneration, Benefits, Succession Plan, HR plan)
- Organisation Transformation
- Conflict Management
- Negotiation
- Team Facilitation

RESUMÉ OF DR. ALBERT WESTWOOD

Albert R.C. Westwood was born and educated in England, earning his B.Sc. (Hons), Ph.D., and D.Sc. Degrees at the University of Birmingham in Physical Metallurgy and Materials Science.

Subsequently, he emigrated to the U.S. and joined the Martin Marietta Corporation (now Lockheed Martin) as a Research Scientist, becoming successively Associate Director, Deputy Director (Commercial R&D), and Director of the Corporate R&D Laboratories, and then Corporate Director and Vice-President, R&D. In 1990 he was named Corporate Vice-President for Research & Technology. In 1993, he became Vice-President for Research & Emerging Technologies for the Sandia National Laboratories, retiring from this position in 1996.

In April 1998, he will assume the position of Chairman and Chief Executive of the Council for the Central Research Lab's of the U.K.

He has published more than 120 technical papers, and received various honors and awards including the Beilby Gold Medal, the Holloman Prize, the Leadership Award of the TMS, the Campbell Memorial Lectureship, etc.

He is an elected member of the U.S. National Academy of Engineering (1980), the Royal Swedish Academy of Technical Sciences (1989), the Russian Academy of Engineering (1995), and the Royal Academy of Engineering (U.K.) (1996).

He has served as President of the Industrial Research Institute and The Metals, Minerals & Materials Society, and as Chairman of the National Research Council's Commission on Engineering & Technical Systems (1992 - 1997). He serves, or has served, on numerous government and academic advisory committees, and also on the Boards of such civic organisations as the New Mexico Symphony Orchestra (President) and the Santa Fe Opera.

RESUMÉ OF DR. WILLIAM G. HOWARD, JR.

Dr. William G. Howard, Jr., now an independent consultant, was senior Vice President and corporate Director of Research and Development at Motorola and senior fellow of the NAE.

Dr. Howard joined Motorola in 1969 as Manager of Linear Integrated Circuits Research. In subsequent years he advanced through a series of positions, becoming corporate director of research and development in 1983. He holds three patents for electronic circuits and devices.

Dr. Howard is a member of the NAE, a fellow of the IEEE and the AAAS, and he belongs to Sigma Xi, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi professional societies. He serves as chair of the U.S. Department of Defense's Advisory Group on Electron Devices and is a member of the Defense Science Board. Additionally, Dr. Howard serves on the boards of directors of BEI Technologies, Credence Systems, Inc., Lockheed Martin Energy Research Corporation, Lockheed Martin Idaho Technologies, RAMTRON International Corporation, Sandia Corporation, and Xilinx, Inc.; he is also a governor of the Research Triangle Institute.

Dr. Howard received his bachelor's and master's degrees from Cornell University and a doctorate from the University of California at Berkeley.

Appendix 3:
Itinerary (Summary) for the Review of the CSIR

Programme Overview/ Itinerary

Date & Day	Venue	Activity
11/11 Sun		Arrival Welcoming - Cocktails at hotel
11/11 Mon	DACST CSIR	DACST meeting (briefing session) Programme Review CSIR Executive Presentation Dinner with CSIR Board
11/11 Tue	CSIR	FOODTEK (Divisional presentation) Management Systems MININGTEK (Divisional presentation)
11/11 Wed	CSIR, SAC evening	MIKOMTEK (Divisional presentation) BOUTEK (Divisional presentation) Client/Stakeholders Interviews Satellite Application Centre Visit and Braai
11/11 Thu	CSIR, fly out	AEROTEK (Divisional presentation) Client/Stakeholders Interviews TRANSPORTEK (Divisional presentation)
11/11 Fri	Port Elizabeth (Group 1) Stellenbosch (Group 2)	MATTEK (Divisional presentation) ENVIRONMENTEK (Divisional presentation) TEXTEK (Divisional presentation) Client/Stakeholders Interviews
11/11 Sat	Stellenbosch	Work time panel Meeting with Parliamentarians
11/11 Sun	Cape Town fly back	Panel Time
11/11 Mon	DACST CSIR DTI	DACST DTI -meeting with Minister Alec Erwin Tour 1: Foodtek/Environmentek facilities tour Advanced Leadership Programme group meeting
11/11 Tue	CSIR	Tour 2: Mattek facilities tour Client/Stakeholders Interviews
11/11 Wed	CSIR	Client/Stakeholders Interviews Meeting with CSIR Fellows Management Systems Executive Interactions
11/11 Thu	CSIR	Meeting with Union - NEHAWU Clients/S'holders Work time panel
11/11 Fri	CSIR	Report writing
11/11 Sat	CSIR	Report writing

Date & Day	Venue	Activity
Sun	CSIR	Report writing - own discretion
Mon	CSIR	Leadership Day Delivery Departure
Tue	CSIR	CSIR internal de-brief

Appendix 4:
EQUITY POLICY STATISTICS

Transforming CSIR - Progress to date and future planning

	HISTORY		CURRENT		PLANNED				
	1994*	1995	1996	SEPT 1997	1997	1998	1999	2000	2001
BLACK STAFF	751	913	1039	1016	1069	1139	1252	1372	1488
% OF TOTAL STAFF	24.4	28.7	33.0	34.0	35.2	36.7	39.3	41.9	44.3
BLACK PROFESSIONALS	68	103	132	156	188	275	371	455	528
% OF PROFESSIONAL STAFF	5.7	8.4	11.0	13.3	14.9	21.1	27.4	32.5	36.4

* December data unless otherwise indicated



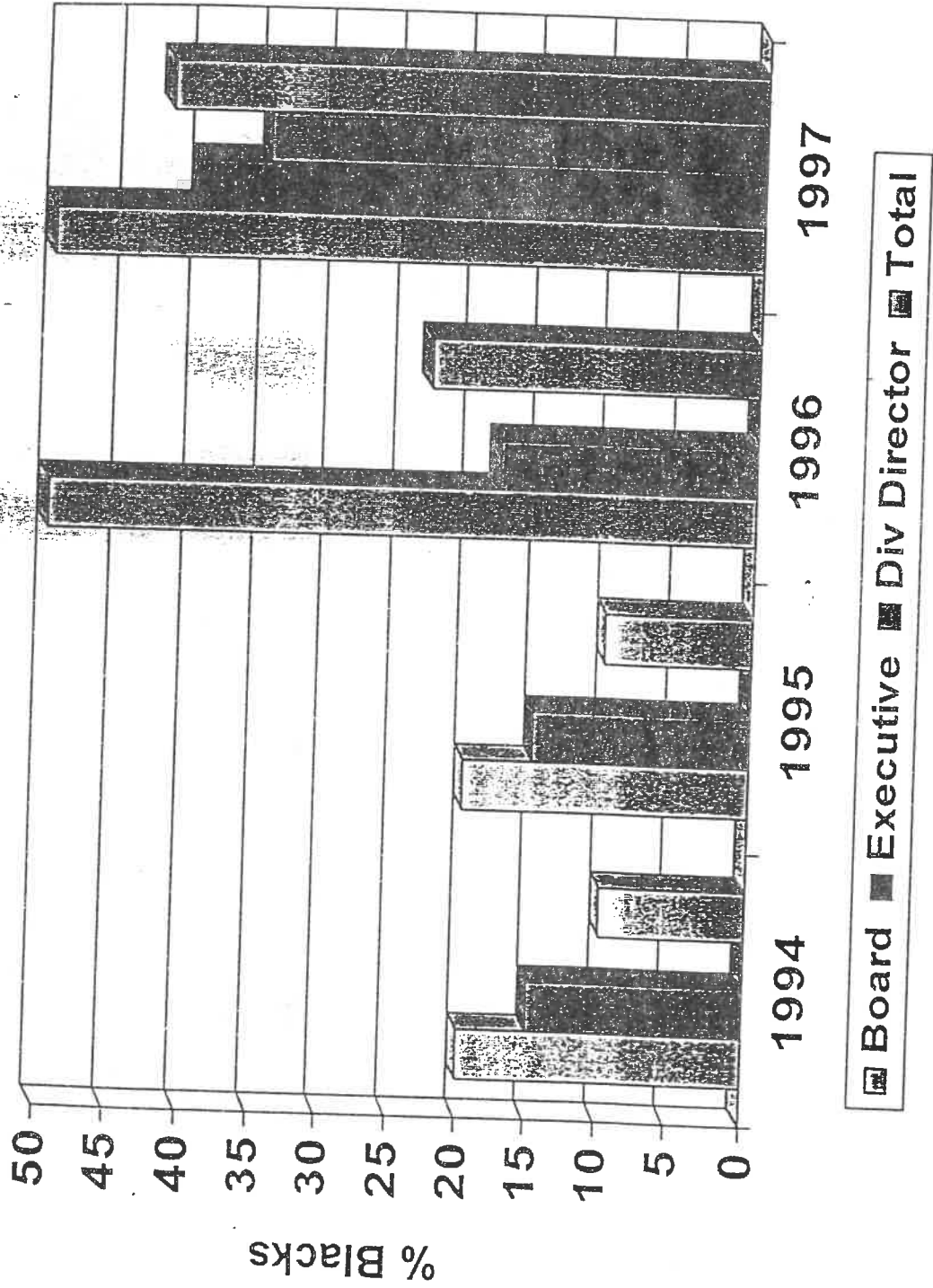
Transforming CSIR - Progress to date and future planning

	HISTORY		CURRENT		PLANNED				
	1994*	1995	1996	SEPT 1997	1997	1998	1999	2000	2001
TOTAL FEMALE STAFF	919	993	1049	1009	1059	1101	1154	1218	1281
% OF TOTAL STAFF	29.8	31.2	33.3	33.8	34.8	35.5	36.2	37.2	38.1
FEMALE PROFESSIONALS	216	240	282	273	323	355	413	442	483
% OF PROFESSIONAL STAFF	18.1	19.6	23.5	23.2	25.6	27.3	30.5	31.6	33.3

* December data unless otherwise indicated



CSIR Board and Top Management



Bursary Statistics

	1991	1992	1993	1994	1995	1996	1997
Number	174	135	115	82	76	90	127
% Black	4%	10%	24%	40%	51%	63%	68%
% Female	22%	21%	22%	22%	30%	30%	27%

New Bursars, 1997

	Number	%
Black	47	81%
Female	15	26%



Adult Basic Education Programme

	1994	1995	1996	1997
Number	35	45	75	75

Courses offered:

- English Level 1
- English Level 2
- Mathematics N1
- Mathematics N2
- Mathematics N3
- Mathematics N4
- Engineering Science N2 & N3
- Physical Science
- Industrial Communications
- Literacy Classes

* Additional Information



Internship Programme

	1995	1996	1997 (to date)
Number	4	47	54
% Black	75%	98%	98%
% Female	-	55%	43%

* Additional Information



Appendix 5:
CSIR CLIENTS CONSULTED

Technology Leadership Programme (TLP)

	1996	1997	1998 (planned)
Number	11	13	20
% Black	45%	54%	60%
% Female	55%	46%	50%

Advanced Leadership Programme (ALP)

	1995	1996/1	1996/2	1997/1	1997/2
Number	10	9	17	18	22
% Black	30%	33%	47%	28%	40%
% Female	40%	44%	53%	50%	32%

* Additional Information



CSIR CLIENTS CONSULTED

1. J. W. Klokow : Gold Fields SA
2. D. Diering : Anglo American
3. R. Wedlake : Anglo American
4. J. Wesley : SANDF
5. L. Mallane : Department of Housing
6. J. Gieselbach : Cape Wools
7. M. Claasen : Cape Mohair Spinners
8. F. Loots : Mohair Board
9. P. Nel : ARMSCOR
10. P. Gilbert : Industrial Liaison
11. G. Preston : Ministry Water Affairs
12. A. Marshall-Smith : Federal Marine
13. W. Barnes : Marine Products
14. M. Louw : SANDF, CSL
15. F. Beyers : ARMSCOR
16. P. Kruger : SASOL
17. D. Jacobson : Altech
18. J. van Wyk : Haggie Rand
19. S Semenya : Agreement Board
20. M. Mitchell : Department of Transport
21. N. Diadla : Department of Health
22. E. Kruger : Department of Trade and Industry
23. J. Stewart : Chamber of Mines
24. F. Hanekom : Department of Environmental Affairs
and Tourism
25. R. Marcus : Educational Technologies
26. R. Plumbridge : Gold Fields SA
27. L. Marryatt : South African Police Services
28. E. Taylor : SANDF – Air Force Base, Waterkloof