

The Changing Nature of Research and Development Inputs in the South African Higher Education Sector: Findings from the National Research and Experimental Development Survey

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1. Introduction

Over the last decade, Higher Education Sectors throughout the world have been exposed to numerous transformatory forces, largely brought about by processes of globalisation and the increasing dominance of neoliberal discourse. In South Africa, these forces have been further impacted by processes of democratisation and the ANC government's commitment to social and economic reconstruction (Kraak, 2000: 146). *The Education White Paper 3: A Programme for the Transformation of Higher Education* (DOE, 1997) asserted that the South African Higher Education System was no longer able to adequately meet the political, social and economic needs of the new South Africa and recommended the transformation of the South African Higher Education System. Broad principles upon which this transformation would be based included:

- Increased and broadened participation
- Responsiveness to societal interests and needs
- Co-operation and partnerships in governance.

The South African government subsequently launched a number of policy initiatives that included the planned expansion of the system; the development of a single coordinated system of higher education provision; the development of a national Higher Education Plan that would require institutions to develop rolling 3 year institutional plans; the development of a new goal-orientated performance related funding system and the inclusion of Higher Education programmes in the National Qualifications Framework (Cloete, 2002: 8).

Ntshoe (2004: 215) argues that in responding to these systemic level changes, the South Africa Higher Education System has facilitated a move to Mode 2 knowledge production¹ characterised by “problem-solving or strategic research as opposed to disciplinary research” (Ntshoe, 2004: 215). Accompanying this shift towards Mode 2 is the steady infiltration of market values into the process of knowledge production and a resultant increase in partnerships between industry and Higher Education in the pursuit of knowledge production. Policy planners in the South African government have favourably accepted this shift towards Mode 2 knowledge production, since it is predominantly assumed that the emergence of Mode 2 knowledge production in South

¹ For an examination of the debates surrounding Mode 2 Knowledge Production in South Africa, see Ravjee, N. 2002. “Neither ivory towers nor corporate universities: moving public universities beyond the “mode 2” logic.” *South African Journal of Higher Education*, Vol.16(3), pg 82.

African HE institutions will render the system increasingly responsive to national needs and goals. (Ntshoe, 2004: 216).

This shift towards mode 2 knowledge production within the South African Higher Education system seems in line with global trends. According to Gibbons (as cited in Jansen, 2000: 159), the traditional university can be described as a “closed system that infrequently engages with knowledge producers and institutions outside its academic borders.” Universities that have traditionally been the main producers of disciplinary-driven research (Mode 1 research) are now forced to engage in transdisciplinary research that is largely problem-orientated and applications-based (Jansen, 2000: 156). Global trends suggest that the shift towards Mode 2 knowledge production is accompanied by an increase in “applications-driven research addressing critical national needs” (Jansen, 2000: 156). According to Gibbons et al (1994: 9) Mode 2 knowledge production results from a broader range of consideration than the disciplinary knowledge originally created by the traditional university. Such knowledge is intended to be useful to someone whether in industry, government, or society and is always produced “under an aspect of continuous negotiations” until “the interests of the various actors are included.” (Gibbons et al, 1994: 9). Similarly, Weingart (1996: 602) argues that numerous political, social and economic criteria are used to evaluate research and that knowledge produced by the university should be “socially accountable and reflexive and orientated towards social values and political objectives.”

Since 1994, various policy instruments aimed at aligning research with the ANC’s Reconstruction and Development Program have been implemented. Within the Higher Education system, these initiatives have largely included funding mechanisms that aim to bring research in line with the “six pack” (Kahn, 2004) of goals that include job-creation, enhanced competitiveness, human resource development, the promotion of safety and security, improved quality of life and a gradually rising floor of social support systems (Kahn, 2004). In addition to the 5 percent slice of the Science Vote that was allocated as a steering mechanism, an innovation fund was established to “promote the economic competitiveness of South Africa through investments in technological innovation that leads to the establishment of new enterprises, and the expansion of existing industrial sectors to the benefit of all South Africans.”

Accompanying this shift towards applications-driven research are a number of systemic and institutional consequences that could change the nature and scope of Higher Education Research in South Africa. The first of these consequences is the increased integration of industrial and political interests into the “evaluation, organisation and performance of university research, changing the collegial control of research” (Benner and Sandstrom, 2000: 292). Knowledge practitioners in Higher Education Institutions now have to take into account how research will be implemented, and, as a result, must take into account the values, needs and preferences of groups that have traditionally not been part of the science and technology system (Weingart, 1996: 602). This will undoubtedly also have an impact on the type of research performed within Higher Education institutions. Due to the interdisciplinary nature of Mode Two research and an increase in the pressures of global competitiveness, universities are also required to share

their resources with other kind of knowledge-producing institutions through collaborative research (Jansen, 2000: 160). The funding base of the university has therefore become increasingly diversified and governments around the world are instituting a number of programs to foster university-industry relationships (Clark, 1998). Coupled with this trend is an increase in the number of sites where research is performed (Gibbons et al, 1999), prompting scholars to argue that the “traditional role of the university has evaporated, leaving the house of knowledge in a state of crisis” (Kraak, 2000: 33).

Gibbons et al (1999: 76) argue that the massification of the Higher Education sector is also characteristic of mode 2 knowledge production. Increased global competitions within the field of specialised knowledge has resulted in the growth of numerous private higher education institutions, forcing public universities to extend their curricula to new social strata. In South Africa, however, the massification of research is primarily driven by the policies of equity and redress aimed at overcoming the inequalities of the apartheid era.

Policy imperatives in South Africa are clearly in favor of supporting an environment in which Mode 2 knowledge production will flourish. The National Council for Higher Education envisages a system that is increasingly responsive to national social and economic needs; actively seeks and is open to collaboration with other knowledge-producing partners and increasingly engages in applications-driven research. But to what extent has the South African Higher Education system become more responsive to Mode 2 knowledge production and what are the implications of this change for Research and Development Inputs in South Africa?

2. The South African Context

Prior to 1994, the higher education system in South Africa was highly fragmented. Institutional research agendas developed disparately due to poor communication across the system and failed to take cognizance of the challenges for development. In 1994, the higher education system was structured along racial lines and consisted of 36 institutions (21 universities and 15 technikons). The universities comprised: 4 English medium and 6 Afrikaans medium universities reserved for white students, 6 universities located in the “Bantustans” reserved for African students; 2 urban universities reserved for Indian and Coloured students; 2 urban universities reserved for African students and 1 distance university. The technikons were comprised of: 7 technikons reserved for white students; 5 technikons located in the ‘Bantustans’ for African students; 2 technikons reserved for Coloured and Indian students and one distance technikon.

In September 1996, the National Commission on Higher Education, established by presidential proclamation at the end of 1994, launched its report: *A Framework for Transformation*, which advocated the need for 3 “pillars” upon which a transformed Higher Education system would rest. These included a policy of increased participation; greater responsiveness of the higher education system to the social context and increased co-operation and partnerships between HEI’s, the HE system and the state, and HEI’s and civil society. In July 1997, the Department of Education launched its education *White*

Paper 3: A Programme for the Transformation of Higher Education, which advocated the “development of a programme-based higher education system, planned, funded and governed by a single-co-coordinated system” (CHE, 2004: 26). In 2001, the National Plan for Higher Education criticized the “implementation vacuum” which had been created through the incremental application of policy instruments and which, in turn, had resulted in a number of unintended consequences for the system. The plan proposed a number of goals and objectives to be put in place within the system, including targets for the size and shape of the system, the diversification of institutional mission and programme differentiation; the restructuring of the institutional landscape² and a new approach to research funding. Following the National Plan, policy developments within the HE system have focused on a number of areas, many of which have had an impact of the nature of research within the South African Higher Education system.

As mentioned in previous sections, the fourth goal of the National Plan for Higher Education is to “secure and advance high-level research capacity which can ensure both the continuation of self-initiated, open-ended intellectual inquiry and the sustained application of research activities to technological improvement and social development” in order to “promote the kind of research and other knowledge outputs required to meet national development needs, and which will enable the country to become competitive in a new global context.”(DOE, 2001: 5.1). Implicit in this statement, is the imperative to align capacity and output of the higher education system in South Africa with the needs of industry and social reconstruction and hence, the promotion of socially accountable research.

To further this goal within the higher education system, various new funding drivers have been instituted in order to improve synergy within the National System of Innovation and increase the production of applications orientated research. The Innovation Fund has been established to facilitate the financing of problem-orientated research involving participants from many different disciplines. Similarly, the Technology and Human Resources for Industry (THRIP) programme implemented by the Department of Science and Technology and administered by the National Research Foundation (NRF) attempts to “bring together the best of South Africa’s researchers, academics and industry players in funding partnerships that enable participants to improve the quality of their products, services and people”. The programme challenges companies to “match” government funding for innovative research and development in South Africa. Together, firms and THRIP invest in research projects led by academic staff of South African Higher Education Institutions (www.nrf.ac.za/thrip).

In the wake of decreasing government appropriations between 1986 and 1994, Higher Education institutions have been pressurized into generating private funding sources and increase student fees. Although government appropriations for Higher Education increased threefold during the period, growth in real rands (deflated by the consumer

² The new institutional landscape of the SA Higher Education System comprised 8 separate and incorporated universities, 3 merged universities, 2 separate and incorporated universities of technology, 3 merged universities of technology, 2 separate comprehensive institutions and 2 National Institutes (CHE, 2004:50).

price index) reached a mere 3%, due to the high inflation rate at the time. At the same time, student enrolments increased by 73% resulting in a decrease in government spending per student during the period. As a result, the proportion of institutional income derived from government appropriations fell across most institutions for the period. The White Paper of 1997 suggested the application of goal-orientated and performance related funding within the system, rendering public funding of higher education institutions conditional on HEI's providing strategic plans and reporting performance across a number of institutional goals every three years. In 1999/2000 the proportion of government expenditure to higher education peaked at 3.05%, but has since declined to 2.72% in 2003/04 and is projected to decline even further in 2005/06. Similarly, expenditure on Higher Education as a proportion of GDP has declined since 1999/2000 (CHE, 2004).

This proportional decrease in government subsidy to higher education, coupled with an increase in policies promoting the application of funding drivers could result in universities having to diversify their funding bases considerably through an increased reliance on private funding sources for research. According to the Council for Higher Education (2004: 201):“the latest indication of trends from the Ministry is that government grants cover on average 50% of public higher education funding, with 25% from fee income and 25% from other private income sources.” But an increased reliance on private funding sources, and possibly the resultant increase in applications-driven research derived there from could have number of unintentional consequences for higher education research in South Africa.

A first potential consequence of this shift towards application-driven/mode 2 knowledge production is a shift in the type of research performed by the Higher Education Sector away from basic research towards applied research and experimental development. According to the Department of Education (as cited in the National Plan for Higher Education in South Africa, 2001) research outputs have declined considerably between 1997 and 1999 –a trend which may largely be ascribed to the shift in research focus towards strategic and applied research with an emphasis on socio-economic and industry related issues and the subsequent decline in basic research. Consequently, the National Plan raises a number of concerns regarding the ability of the Higher Education system to meet the development needs of the country, since the White Paper for Science and Technology calls for both basic and applied research to be prioritized across all disciplines. The challenge exists therefore to “increase strategic knowledge or problem-solving research, while maintaining, and if possible, strengthening the system’s core knowledge base in basic science” (DOE, 2001).

A second consequence of an increased reliance on strategic/applications driven research is a shift in the main research fields pursued by the HE system. Applications-driven research is inherently more focused on fields associated with the Natural Sciences, Technology and Engineering at the expense of the social sciences and the humanities. In an article examining the link between globalisation and higher education restructuring Waghid (2001:460) asserts that as long as “corporate concerns” continue to shape higher education and as long as increased capital and knowledge production and services is

regarded as a precondition for global competitiveness, the humanities and the social science departments in the higher education system will remain under threat. This potential shift in research focus may be further exacerbated by the Department of Education's plans to shift the balance of higher education enrolments between the humanities, business and commerce and science, engineering and technology from the current ratio of 49:26:25 to 40:30:30 over the next 10 to 15 years. (For a discussion on the role of the humanities and social sciences in the SA context see Van der Merwe, 2004).

The third potential consequence of this shift towards applications driven research within the higher education system is a change in the conditions of work for the South African academic and a possible decrease in researcher Full Time Equivalents (FTE's) within the system. Throughout the course of the decade, the academic profession has undergone some drastic changes, which may have caused a decline in research FTE's. Academic staff are now demanded to display expertise in a range of new areas, such as academic development, quality assurance assessment, strategic planning, contract management, networking, recruitment and marketing –all areas that were previously seen to fall outside the domain of academic work. This increase in the intensity and range of work is also coupled with the fact that academic staff must now deal with more students that are not adequately prepared for academic work, greater pressure to publish and fewer support staff (Gibbon and Kabaki, 2002: 224).

A fourth implication of an increased reliance on applications driven research and the subsequent infiltration of the higher education system by industry is the decreasing role of the university as knowledge producer (Kraak, 2000). According to Gibbons et al (1999) as the funding base of the university becomes increasingly diversified, the number of sites where research is performed increases. As a result, the university is faced with increasing competition, prompting scholars to argue that the “traditional role of the university has evaporated, leaving the house of knowledge in a state of crisis” (Kraak, 2000: 33).

After a brief description of the Research and Experimental Development Survey conducted for the Department of Science and Technology by the Knowledge Management Group of the Human Sciences Research Council, the paper will employ data from the survey to review the extent to which the changes in the research and experimental development inputs in the South African Higher Education system have changed in direction of Mode 2 knowledge production over the last 10 years. Specific attention will be given to the diversification of the Higher Education funding base and the changes in the types and kinds of research that are being pursued. The paper will also employ data from the survey to assess the implications of transformation. Specific areas that will be considered include the role of the university as knowledge producer in the new economy, the possible declining role of research in the life of the SA academic, and the massification of research in South African Higher Education Institutions.

3. The 2001/02 National Research and Experimental Development Survey:

In April 2002, the Department of Arts, Culture, Science and Technology (now the Department of Science and Technology, DST) contracted the Knowledge Management Group of the Human Sciences Research Council (HSRC) to carry out a survey of Research and Experimental Development Inputs according to the guidelines laid down in the OECD Frascati Manual³ of 1993. The first survey, conducted in 2003, measured R&D inputs in South Africa for the fiscal year 2001/02. The second, abbreviated survey, was completed in 2004, and measured R&D inputs for the fiscal year 2003/04.

The Frascati manual of 2003 defines R&D as “creative work undertaken on a systematic basis in order to increase the stock of knowledge of humanity, culture and society and the use of this stock of knowledge to devise new applications.” It is concerned with measuring only R&D inputs which cover three activities: basic research⁴, applied research⁵ and experimental development⁶ (OECD, 2002: 30). The manual suggests the measurement of statistical units that can be grouped by sectors of the economy, in order to facilitate the description of institutional flows of R&D (OECD, 2002: 54). As a result, the South African Survey universe was decomposed into 5 R&D performers. The Survey separately covered the business enterprise sector⁷ of large, medium and small enterprises, including state-owned companies. All government⁸ departments with an R&D component were surveyed, including government research institutes and museums. The 8 science councils plus the Africa Institute of South Africa were included in the sample along with non-governmental and other organisations formally registered as not-for profit institutions (DST, 2004).

As a Frascati sector, the Higher Education sector is well-defined and surveyed at saturation point. The Frascati Manual (OECD, 2002)¹ describes the Higher Education Sector as composed of

- “All universities, colleges of technology and other institutions of post-secondary education, whatever their source of finance or legal status.
- It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.”

³ As a result of initiatives by the OECD, UNESCO, the European Union and various other organisations, the Frascati Manual has become the standard for R&D Surveys worldwide. (OECD, 2002: 13).

⁴ Experimental and/or theoretical work conducted primarily to acquire new knowledge without a particular use or application in mind.

⁵ Research undertaken to acquire new knowledge directed towards a specific aim or activity.

⁶ Systematic work using existing knowledge previously gained through research in order to devise new materials, processes, systems etc.

⁷ The business sector includes: “all firms, organisation and institutions whose primary activity is the market production of goods or services (other than Higher Education) for sale to the general public at an economically significant price” (OECD, 2002: 54).

⁸ The government sector comprises all “departments, offices and other bodies which furnish, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community.

The core of the sector in all countries surveyed is largely made up of universities and colleges of technology. Countries differ however, with the treatment of other post-secondary education institutions and institutes linked to universities and colleges. These include other post-secondary teaching institutions, university hospitals and clinics and “borderline” research institutions. University hospitals and clinics are generally included in the HES because they are both post-secondary educational institutions and because they are research units associated with higher educational institutions. If all or nearly all activities in the university hospital or clinic have a teaching or training component, the entire institution should be included as part of the HES. When only a few of the departments within the university hospital or clinic have a higher education component, only those should be classified within HES. As far as “borderline” research institutions are concerned, those that have been set up through the use of special funds and managed by agencies that award grants to universities and have their own research institutions, are included in the higher education sector. If, however, the research conducted serves predominantly government’s needs, the country may decide to classify the institution as a government sector. As far as the statistical unit is concerned, the Frascati manual recommends the research institute, center, department, faculty and hospital or college (OECD, 2002).

In both the 2001 and 2003 surveys, the Higher Education Sector was surveyed at saturation level, although private higher education institutions were included in the universe for the 2003 survey⁹. In 2001, higher education institutions were classified according to high, growing and low research intensity, but in 2003 such classifications were rendered meaningless due to the mergers¹⁰ that had taken since the previous survey.

In considering the variation in organizational structures and the location of Frascati capable accounting capacity, the Unit of Measure (UOM) during the 2001 survey comprised the Research Institute, Research Centre, Department or equivalent. The 2003/04 project team decided, however, to designate only faculties or entire institutions as UOM’s, due to the low response rates from departments during the 2001 survey. In accordance with the Frascati manual, use of secondary data sources¹¹ was used to supplement the survey data where satisfactory returns were not forthcoming.

In both 2001 and 2003 the questionnaire and methodology were compliant with the Frascati Manual and in accordance with Frascati, also took the particular South African

⁹ In 2001, all 21 universities and 15 technikons were surveyed. In 2003 a total of 35 Higher Educations were included in the survey of which 18 were universities, 8 technikons, 3 Universities of (Science) and Technology, one Institute of Technology and 5 private higher education institutions. For the purposes of the current paper, private institutions will be excluded from the analysis.

¹⁰ The National Plan for Higher Education of February 2001, proposed the restructuring of the HEI’s into 21 higher education institutions and 2 National Institutes for Higher Education. As a result, the HEI’s were under extreme pressure at the time of the survey and therefore suffered capacity constraints during the fieldwork (DST, 2004).

¹¹ Data was requested from the Department of Education, (HEMIS data for student and staff numbers, CESM field and time spent on research), NRF, THRIP and MRC (research grants and postgraduate bursaries given to institutions), and academic staff salary scales were obtained from a number of HEI’s.

policy and demographic concerns into account, such as gender, race equity and age profiles of R&D workers. In 2003, however, the questionnaire was abbreviated slightly and excluded the classification of R&D workers in terms of race, age and educational qualification. Both questionnaires covered various areas relating to R&D input, including the functional distribution of R&D, the measurement of R&D personnel and the measurement of expenditures devoted to R&D.

4. Changes in the nature of R&D inputs in South Africa

4.1. Diversification of Funding Mechanisms in SA

The increased reliance on applications-driven research has resulted in an increase in the number of sites where research and development is performed. As a result, universities are being infiltrated by industry; think tanks and consultancies in seek of collaborative partnerships (Gibbons, 1999: 6).

As mentioned previously, the South African government has implemented a number of top-down programs to foster university-industry relations. According to an HSRC audit of the THRIP and Innovation Fund, both projects had incentivised the establishment of partnerships across 423 projects; had involved 573 industry partners in 2 or more projects, produced 35 patents and 296 artifacts and an increase in publications (CHE, 2004).

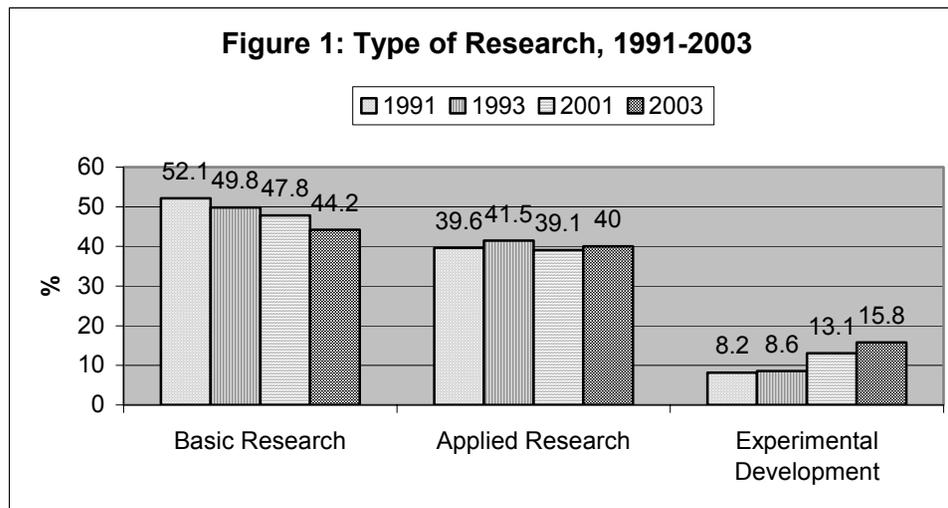
Data from the 2001 and 2003 R&D surveys suggest that government funding (including General University Funds) allocated to research has decreased from 63 percent of R&D expenditure within the HE sector in 2001 to 58 percent in 2003. Funding from South African businesses has remained relatively unchanged, while funding from foreign sources and other South African sources have increased for the period. The decrease in the percentage of R&D expenditure sourced from government and university funds may be explained through an increase in sources of funding from foreign and other South African sources, or by the fact that higher education institutions in South Africa are allocating less government funds towards research (**Table 1**).

Table 1: Sources of Funds, 2001 & 2003

SOURCE	2001	%	2003	%
Government	1,187,075	63	1,194,686	58
Business	455,081	24	478,734	23
Foreign	173,865	9	224,031	11
Other SA Sources	80,137	4	173,900	8
TOTAL	1,896,158	100	2,071,351	100

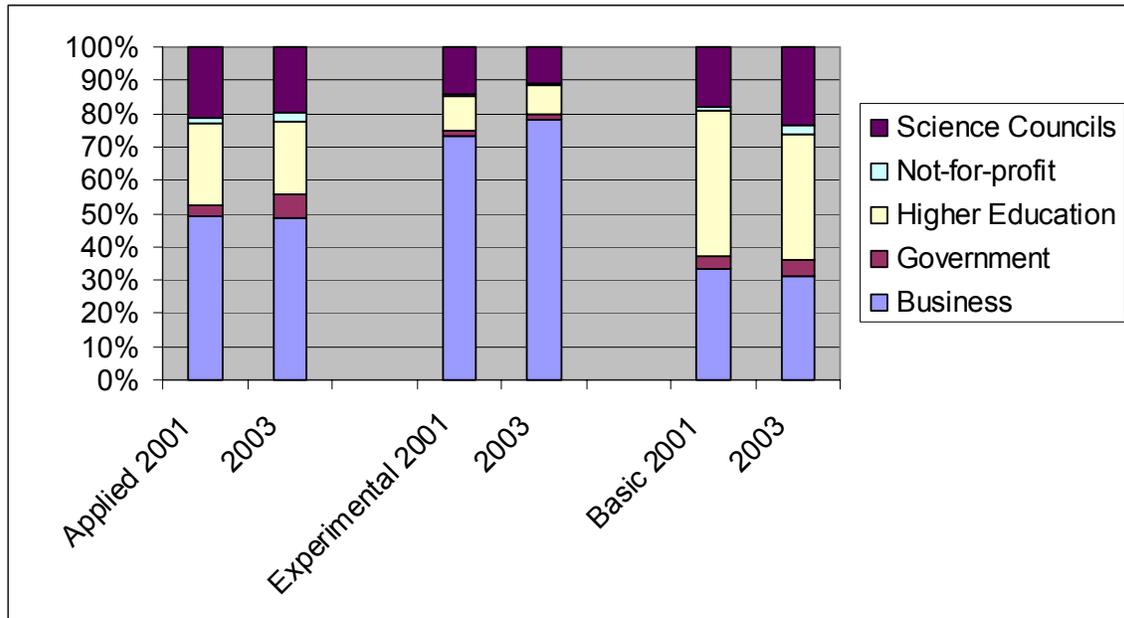
4.2 Type of Research in South Africa

When considering the shift towards applications-driven research in SA, the effect it may have on the type of research performed in SA becomes paramount. Data from the 2001/02 survey suggests that the largest percentage of expenditure of R&D in the HE sector was still devoted to basic research (47.8%). But Between 1991 and 2001 there appears to have been a steady decrease in the percentage of expenditure devoted to basic research, while expenditure devoted to experimental development increased slightly. When comparing the 2001 data with that of the 2003 survey data a further decline in research expenditure devoted to basic research becomes evident. In 2003, only 44 percent of R&D expenditure within the HE system was devoted to basic research. Between 2001 and 2003, expenditure devoted to applied research within the Higher Education Sector remained relatively unchanged, while expenditure devoted to experimental research and development increased from 13 percent to 15.8 percent (Figure 1).



In 2001, 27 percent of South Africa's Gross Expenditure on Research and Development was devoted to basic research. Even though Higher Education expenditure on R&D constituted 25% of National R&D expenditure for the year, the sector accounted for 39 percent of the country's R&D expenditure on basic research. The 2003 survey indicates that expenditure on basic research has declined nationally to 24 percent of GERD. Higher Education's proportion of that share has also declined, to 37.5 percent (Figure 2).

Figure 2: Type of Research by Sector, 2001 & 2003



The fact that the Higher Education sector continues to be the largest performer of basic research in the country points to the important role that the higher education sector does, and should continue to play in conducting basic research in South Africa. This is especially important, since basic research is “crucial in nurturing a national intellectual culture generating high level discipline specific to human resources, and providing opportunities for keeping in touch with international developments –all of which facilitates innovation.” (DOE, 1997).

This change in the nature of research has also resulted in a change in the organizational forms of Higher Education in South Africa. As Cooper (2003) asserts “the academic and discipline-based departments as we know them today, rooted in the early 19th century first university revolution are becoming surrounded or interpenetrated by a new set of structures of more inter-disciplinary research groupings based on a late 20th century ‘second university revolution’ of application orientated research emerging out of global capitalist forces associated with the knowledge society.” In South Africa and internationally, a number of research groupings called centers or units are forming, focusing on more “application-orientated research largely funded by industry and national departments.” The technikons are particularly well-placed via their history of direct links with industry, to undertake research work that focuses on national development problems and projects submitted to them by firms, government organizations and NGO’s.

Data from the survey suggests that basic research still accounts for the largest expenditure in R&D in universities decreasing from 48.5 percent in 2001 to 45.6 percent in 2003. Within the technikons, however, expenditure on applied research accounts for

the largest proportion of R&D, decreasing slightly from 55.8 percent to 55.2 percent between 2001 and 2003.

This increase in the percentage of research and development expenditure devoted to applied research within the higher education sector may also have an impact on the type of research fields pursued during the course of research and development.

When comparing data from the 2001/02 R&D survey with data from the 1991 survey on Resources for Research and Development (DOE, 1991) there appears to have been a 6% decrease in the percentage of R&D expenditure allocated to the social sciences and humanities. When comparing the 2001 survey data with that of 2003, expenditure on the social sciences and the humanities appears to have decreased again-albeit only slightly. In 2001, 67.6 percent of R&D expenditure within the HE sector was devoted to the Natural Sciences, Technology and Engineering fields, while 32.4 percent of R&D expenditure was devoted to the social sciences and humanities. In 2003 the proportion of HE expenditure devoted to the Natural Sciences, Technology and Engineering increased very slightly to 68.7 percent while the proportion of expenditure devoted to the social sciences decreased marginally to 31.2 percent (**Table 2**).

Of particular concern in the South African context is the fact that in 2001 only 11.8 percent of national expenditure devoted to research and development took place within the fields of the social sciences and the humanities, of which the Higher Education comprised 74 percent. In 2003, this national figure dropped slightly to 10.6 percent.

Table 2: Research Fields, 2001 & 2003

	2001	2003
Division 1: Natural Sciences, Technology and Engineering	67.6	68.7
Mathematical sciences	4.4	6.1
Physical sciences	2.7	2.5
Chemical sciences	3.2	3.4
Earth sciences	2.8	4.5
Information, computer and communication technologies (ICT)	4.2	2.8
Applied sciences and technologies	3.4	2.6
Engineering sciences	8.4	9.5
Biological sciences	7.9	7.7
Agricultural sciences	5.4	4.7
Medical and health sciences	20.9	20.9
Environmental sciences	2.7	1.8
Material sciences	1	1.5
Marine sciences	0.6	0.3
Division 2: Social Sciences and Humanities	32.4	31.23
Social science	24.3	21.4
Humanities	8.1	9.7
Total	100	100

4.3 The university as knowledge producer in South Africa

As mentioned in previous paragraphs, the increased reliance on applications-driven research has resulted in an increase in the number of sites where R&D is performed (Gibbons, 1999: 6). As a result, universities are being infiltrated by industry, think-tanks and consultancies that seek collaborative partnerships in pursuit of applications-driven research. In order to remain competitive, universities are now forced to share their resources with these new knowledge-producing institutions (Jansen, 2000: 160).

In light of the above, researchers such as Kraak (2000) argue that the increasing filtration of Higher Education system by industry may result in the decreasing role of the university as knowledge producer. Leydesdorff and Etzkowitz (as cited in Godin and Gingras, 2000: 273), however, argue that the role of the university as knowledge producer will be enhanced, and Gibbons et al (1999: 79) argue that “paradoxically, although higher education has moved towards a mass system of teaching large numbers of students, its fundamental orientation has shifted towards research.” Braun and Guston (2003:302) speak of a principle-agent relationship between university and industry, where the university (agent) accepts appropriate resources from industry (principle) in exchange for furthering the research interests of the principle. Although concerns have been raised that such principle-agent relationships may dilute the universities traditional role as knowledge producer and place them at a disadvantage, Braun and Guston (2003:303) remind us that the agent usually has an informational advantage vis a vis the principle. And as Morris (2003: 359) points out, the essential resource in such relationships is scientific research, not funds.

But to what extent has the South African university maintained its traditional role as knowledge producer in the South African economy?

According to the 2001/02 National R&D Survey, the total Higher Education expenditure on R&D of 1896 million rands constituted 25.3 percent of Gross National Expenditure on Research and Development. This reflects an increase in the percentage of GERD attributed to the HE sector in 1991, which stood at 20 percent. The 2003 survey, however, suggests that the HE sector’s share of GERD (2071 million rands) has declined to 20.5 percent. This decline may, however, be explained due to the greater coverage obtained in the business, not-for-profit and government sector. Although inferences regarding HE’s decreased proportion of GERD are merely tentative, one could safely argue that HE expenditure on R&D comprises approximately 20 percent of national expenditure on Research and Development (**Table 3**).

Table 3: GERD by Sector, 1991-2003

Sector	1991		2001		2003	
	R 000 000	%	R 000 000	%	R 000 000	%
Business, including NPO	1329	47.7	4094	54.7	5800	57.6
Higher Education	554	19.9	1896	25.3	2071	20.5
Government and Science Councils	903	32.4	1498	20	2210	21.9

When disaggregating the data, technikon's (or former technikons) share of Higher Education R&D expenditure seems to have increased from 4.1 percent of HERD expenditure to 8 percent. In 2001, the top 5 universities i.t.o. R&D expenditure comprised 65 percent of total HERD. In 2003, this stood at 66 percent. Historically white universities' share of total R&D expenditure amongst universities has increased from 91 percent in 2001 to 93 percent in 2003, while historically white technikon share of R&D has decreased from 33 percent to 31 percent amongst the technikons. Although one cannot conclude from the expenditure data that Higher Education's share of national research is declining, one can conclude that there has been a shift in R&D expenditure between types of institution.

A further indication as to whether research capacity within the Higher Education system is declining is by examining the increases or decreases in Full Time Equivalent Researchers across the system. According to the 2001 survey data there were approximately 4324 Full Time Equivalent Researchers in Higher Education, from which one can calculate that researchers spent approximately 27,1 percent of their time on R&D. When one compares this data with that of 1991, one can conclude that researcher FTE's declined by 5,7 percent since 1991 (**Table 4**). When comparing the 2001 survey data with that of 2003, we see a slight decline in FTE researchers to 3373. Between 2001 and 2003, however, we have seen an increase in researcher headcounts, which has resulted in a dramatic drop in the percentage time spent on research by researchers within the HE Sector (**Table 5**). Interestingly, this drop is consistent with the drop in researcher FTE recorded by HEMIS.

Table 4: FTE's per Sector, 1991-2001

SECTOR	1991/92	2001/02	% FTE Change
Government (incl. Science Councils)	2428	2134	-8.8
Business (including NPO)	3395	3149	-7.2
Higher Education	3631	3424	-5.7
Total	9454	8707	-8

Table 5: Higher Education Headcount and FTE, 2001 & 2003

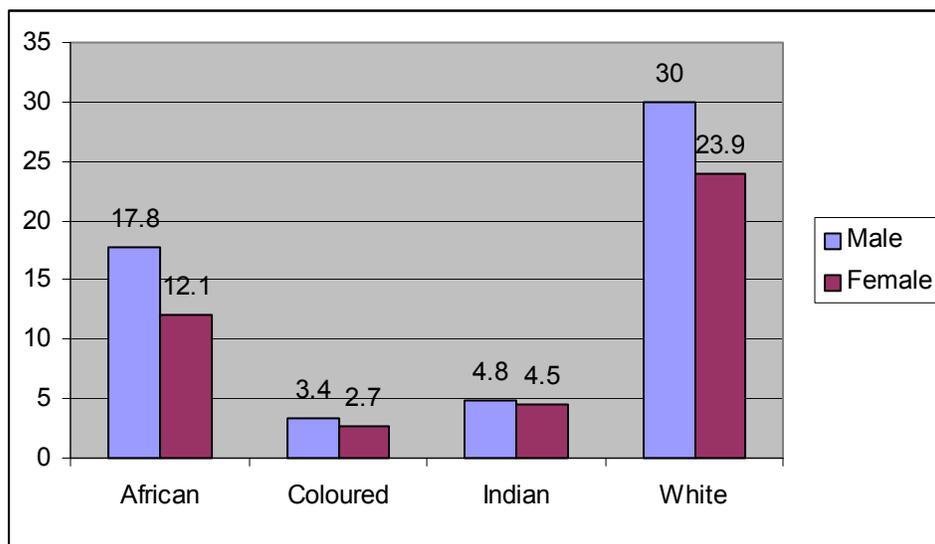
	2001			2003		
	Headcount	FTE	% Time	Headcount	FTE	% Time
Researchers	12626	3424.6	27.1	14054.5	3373.7	24
Technicians	827	216.8	26.2	2594	763.3	29.5
Other Support Staff	2314	400.6	17.3	2728.5	416.8	15.3
Total R&D personnel	15767	4042	25.6	19377.04	4553.9	23.5
PHD students (incl. post doc)	7507	5474.8	72.9	7947	3960	46.4
Masters students	34140	14507	42.5	18468	6411	34.7
Total Students	41647	19983	48	26415	10101	38.2

4.4. The massification of Higher Education in South Africa

In 1990, the National Plan for Higher Education proposed to expand access to Higher Education by increasing the participation rate of 15% to 20% over a period of 15 years. Other plans suggesting to increase the enrollments of students included the recruitment of workers, mature students, the disabled and women on the basis of recognition for prior learning. It was also envisaged to increase participation through the recruitment of students from SADC countries (Ishengoma, 2002:4). Between 1990 and 1994 enrolments in all universities and technikons grew. Based on the National Council for Higher Education report in 1996, the White paper set out to increase participation in Higher Education in order to improve the fragmentation, inequality and inefficiency of the past. But between 1998 and 1999, all universities and technikons experienced a decline in enrolments. These declines in enrollments were particularly sharp amongst the historically disadvantaged institutions.

The enrollments data, does, however suggest that the Higher Education Sector has moved towards the equity goals laid down in the White Paper. In 2000, 73 percent of students in the public higher education sector were black and 53 percent female. Black and female students are, however, underrepresented in postgraduate programs. To what extent are these trends echoed with regard to post-graduate students involved in research? The Research and Experimental development Survey shows that 54,4 percent of all post-graduate students involved in research are white, while women constitute 43,3 postgraduate students. Interestingly, African women students show the lowest representation (**Figure 3**).

Figure 3: Post-graduate students in HE by race and gender, 2001



Unfortunately, population group questions were not included in the 2003 survey. As a result, comparisons between 2001 and 2003 can only be made on the basis of gender. As Table 6 shows, female representivity amongst post-graduate research students has increased only slightly between 2001 and 2003.

Table 6: Post graduate students by gender, 2003

	2001			2003		
	Female	Male	Total	Female	Male	Total
Post Doctoral Fellow				37.0	63.0	100.0
Doctoral Students	38.8	61.2	100.0	40.2	59.8	100.0
Masters Students	42.3	57.7	100.0	43.6	56.4	100.0
TOTAL	41.6	58.4	100.0	42.5	57.5	100.0

In 1990, the National Commission on Higher Education expressed concern over the recent gender inequalities present within the staff profiles of Higher Education Institutions:

“The Higher Education sector in South Africa is highly stratified in terms of race and gender. The trend is that the greater the prestige, status and influence particular positions have, the greater the extent to which they are dominated by whites and men. Positions which, on the other hand have a lower status and prestige and which wield little influence, tend to be filled primarily by blacks and women. Most African staff are concentrated at the bottom of the employment ladder. Most are employed as service staff, whereas most whites are employed as academic staff or in senior administrative posts. These disparities in the overall employment structure of universities and technikons increase with rank” (National Commission on Higher Education as cited in Gibbon and Kabaki, 2002: 38).

After 1994, however, 4 labour policies were instituted to address the inequalities evident from the apartheid era.¹² The Employment Equity Act (No.55 of 1998) prohibits the unfair discrimination of any person on the grounds of race, gender, sex, pregnancy, marital status etc. As a result, institutions were required to draw up employment equity plans and set equity targets against which their future employment profiles would be measured.

The percentage of Africans in the Higher Education workforce increased from 30 to 38 percent between 1988 and 1998, with the percentage of Whites dropping from 55 percent to 47 percent. The percentage of women in the sector rose from 37 percent to 45 percent over the period.

Data from the 2001 R&D survey showed that 74 percent of Researchers in the sector were white. Similarly, white technicians and other personnel continued to dominate

¹² See Portnoi, L. 2003. “Implications of the Employment Equity Act for the Higher Education Sector.” *South African Journal of Higher Education*. 17(2).

support staff positions. Women account for 44,7 percent of R&D personnel in the sector and were especially poorly represented within the African population group where they constituted 37,6 percent of African R&D personnel (**Table 7**). Although the data suggests that whites still dominate researcher positions in South Africa, there has been an improvement in the racial composition of researchers in South Africa. In 1991, 88 percent of research positions in universities were filled by whites (DACST, 1993).

Table 7: R&D personnel by race and gender, 2001

Qualification and category	<i>African</i>		<i>Coloured</i>		<i>Indian</i>		<i>White</i>		<i>Total</i>	
	<i>Male</i>	<i>Female</i>	<i>Male</i>	<i>Female</i>	<i>Male</i>	<i>Female</i>	<i>Male</i>	<i>Female</i>	<i>Male</i>	<i>Female</i>
Researchers	7.6	4.8	2.4	1.9	4.9	3.7	45.7	29.1	60.5	39.5
Technicians	7.7	3.8	9.7	3.8	1.4	2.1	31.2	39.8	50.2	49.7
Support Staff	18.7	10.5	4.8	4.4	1.1	1.7	8.4	50	33	66
Total	9.5	5.7	3.2	2	4	3.2	38	33	55	44

When comparing gender representivity of Higher Education Researchers between 2001 and 2003, slight improvements in female representivity are apparent (**Table 8**).

Table 8: R&D personnel by gender, 2003

	Female	Male	TOTAL	Female	Male	Total
Researchers	39	61	100	41.1	58.9	100
Technicians	43.7	56.3	100	41.0	59.0	100
Other Personnel	65.8	34.2	100	57.1	42.9	100
TOTAL	43.3	56.7	100	43.3	56.7	100

5. Conclusion

Although the use of data obtained from the survey on Research and Development is not exhaustive in its application to the Mode 2 thesis, it provides us with a bird's eye-view of the system and allows us to draw tentative conclusions regarding the movement of the system towards one characterized by a dominance of Mode 2 research. From the data provided above, it is clear that there has been a shift towards applications driven research. Care must be taken, however, not to marginalize the social sciences and the humanities in the process, since the higher education sector is the largest performer of such research in South Africa. Furthermore, evidence suggests a tentative decline in research capacity in the HE sector. It does, however, remain the task of future research endeavors to ascertain the nature of such a shift and the impact that it may have on the nature of R&D and Innovation in South Africa.

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References:

Benner, M. and Sandstrom, U. 2000. "Institutionalising the triple-helix: research funding and norms in the academic system." *Research Policy* 29. pg. 291-301.

Braun, D. and Guston, H. 2003. "Principal-agent theory and research policy: an introduction." *Science and Public Policy*. Vol.30(5). Pg. 302-308.

Clark, B. 1998. *Creating Entrepreneurial Universities: Organisational Pathways to Transformation*. IAU Press.

Cloete, N. 2002. "Policy Expectations." in Cloete et al (Eds). *Transformation in Higher Education: Global Pressures and Local Realities in South Africa*. Cape Town : Juta and Company.

Cooper, D. 2003. "Two Faces (Creativity and Chaos) of Application-Orientated Research Centers at Higher Education Institutions in South Africa." Paper presented at the Association for the Study of Higher Education Conference, Portland, Oregon, USA.

Council for Higher Education. 2004. *South African Higher Education in the First Decade of Democracy*. CHE Pretoria

Department of Arts, Culture, Science and Technology. 1993. *Resources for Research and Development 1991*. Pretoria.

DOE, 1997. *The Education White Paper 3: A programme for the Transformation of Higher Education*.

Department of Education. 2001. *National Plan for Higher Education*. <http://education.pwv.gov.za>.

Department of Science and Technology (2004). *2001/02 National Survey of Inputs into Research and Experimental Development*. Department of Science and Technology: Pretoria

Gibbon, T. and Kabaki, J. 2002. "Staff" in Cloete et al (Eds). *Transformation in Higher Education: Global Pressures and Local Realities in South Africa*. Cape Town : Juta and Company.

Gibbons, M.; Limoges, C.; Nowotny, H.; Schwartzman, S.; Scott, P.; and Trow, M. 1997. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Sage Publications.

Godin, B. and Gingras, Y. 2000. "The place of universities in the system of knowledge production." *Research Policy* 29. 273-278.

Jansen, J. 2000. "Mode 2 Knowledge and Institutional Life: Taking Gibbons on a Walk Through a South African University." In Kraak, A. (Ed.) *Changing Modes: New Knowledge production and its Implications for Higher Education*. HSRC Press, Pretoria.

Kahn, M. 2004. "Then and Now: An Innovation System in Transition."

Kraak, A. 2000. "Changing Modes: A brief overview of the Mode 2 knowledge debate and its impact on South African Policy Formulation." In Kraak, A. (Ed.) *Changing Modes: New Knowledge Production and its Implications for Higher Education in South Africa*. Pretoria: HSRC.

Morris, N. 2003. "Academic Researchers as 'Agents' of Science Policy." *Science and Public Policy*. October 2003, pg. 309.

Ntshoe, I. 2004. "The Politics and Economics of Post-apartheid Higher Educations Transformation." *Comparative Education Review*. 48(2). Pg. 202.

OECD, 2002. *The Frascati Manual 2002: proposed Standard Practice for Surveys on Research and Experimental Development*.

Ravjee, N. 2002. "Neither Ivory Towers nor Corporate Universities: moving public universities beyond the 'mode 2' logic." *South African Journal of Higher Education*. Vol. 16(3), pg. 82.

Van der Merwe. 2004. "The Humanities in a Changing South Africa: Challenges and Opportunities." *South African Journal of Higher Education*. Vol 18(1), pg. 127.

Waghid, Y. 2001. "Globalisation and Higher Education Restructuring in South Africa: Is Democracy Under Threat?" *Journal of Education Policy*. Vol.16(5) pg. 455.

Weingart, P. 1007. "From Finalization to Mode 2: old wine in new bottles?" *Social Science Information* 36(4) 591-613.

www.nrf.ac.za/thrip

ⁱ OECD: 2002 Organisation for Economic Cooperation and Development (2002). *Proposed Standard Practice for Surveys of Research and Experimental; Development, "Frascati Manual 2002."* (Also known as the Sixth Edition –HT) Paris: The Measurement of Scientific and Technological Activities Series.

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