Part One

INTRODUCTION

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Chapter 1

SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS: THE CONTEXT OF CHANGE

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1.1. Introduction

The second OECD Blue Sky Forum took place in Ottawa in September 2006 to examine science, technology and innovation (STI) indicators for use in policy in the 21st century. The context for indicator development, and use, had changed considerably from the first Blue Sky Forum in Paris in June 1996 and this book looks at those changes and how they are influencing indicator development.

1.1.1. A decade of change

It is an appropriate time to look back, and to the future, as 2007 is the 50th anniversary of the first OECD expert group dealing with science and technology indicators (OECD 2002: 151) and it occurs at a time when the OECD is considering expanding its membership and when other international organizations are looking at the role of STI indicators in their policies. If there is a word that summarizes what is going on in 2007 as this book is being written, it is 'interconnected' and the interconnection of various indicators, policies and programmes is a recurring theme in the book.

In the early days of indicator development at the OECD, the focus was on indicators related to research and development (OECD 1963), but the last 20 years have seen work on innovation, intellectual property, technological balance of payments and S&T personnel. While this has been going on, the Berlin wall fell, opening up Central and Eastern Europe, and Brazil, Russia, India and China, the BRICs, have emerged as economic powers. These changes have been chronicled by Thomas Friedman (2006) in his book, *The World is Flat*, and the OECD has contributed a handbook on indicators for globalization (OECD 2005a).

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When experts gathered for the 1996 Blue Sky Forum, crude oil was below $20 a barrel, compared with more than $60 in 2006 and 2007 when it reached $70. The Internet was in place, but the impacts of the Web and e-commerce were yet to be felt. Wireless telephones existed but had yet to include broadband and the powerful computer applications of 2007 and the impacts of biotechnology were not as pervasive as they are now. Analysts were aware of the aging population in most of the industrialized countries but the concern about the loss of knowledge through retirement, the cost of healthcare and the impact on social programmes were not as high. Climate change, biodiversity and availability of water, were emerging issues.

What came out of the first Blue Sky Forum were discussions and papers on knowledge, intellectual property protection, innovation, and on government programmes of direct and indirect and indirect support for technology and R&D (OECD 2001). As well, there was discussion of the need to take a systems approach to the development of indicators.

The intellectual property discussion let to the OECD work on the triadic families of patents and on-going analysis (OECD 2006a, 149), the knowledge discussion resulted in new indicators used by the OECD in its publications (OECD 2005b), as well paving the way for work on measuring knowledge management (OECD 2003). Work on innovation continued and contributed to the 2nd and 3rd editions of the *Oslo Manual* (OECD/Eurostat 1997; OECD/Eurostat 2005). Tax treatment of R&D is still a current topic at OECD as more countries adopt various forms of tax incentives. The 1996 discussions of a systems approach to STI indicators inspired work in member countries (Statistics Canada 1998) which is still going on.

As the decade progressed, the need to continue to take a systematic look at indicator development became more widespread. In 2004, the China Society for Science and Technology Indicators met to review the need for indicator development. The OECD Global Science Forum brought indicator and policy experts together in Finland in July 2006. The 32nd Seminar of the European Advisory Committee on Statistical Information in the Economic and Social Spheres (CEIES) discussed 'Innovation Indicators – More than Technology' in February 2007 and the *Red Iberoamericana de Indicadores de Ciencia y Tecnologia* (RICYT) met in May in Brazil in 2007 to consider new science and technology indicators.

More broadly, the OECD held its second OECD World Forum on Statistics, Knowledge and Policy in Istanbul in June 2007, which covered, among other topics, climate change, biodiversity, knowledge, human capital, demographic issues and technology. In Europe, the European Union's Seventh Framework Programme (Muldur *et al.* 2006), while not explicitly focused on STI indicators, does cover a wide range of interconnected

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research topics that will require complex indicators for monitoring and evaluation. The same could be said for the UN Millennium Development Goals (MDGs).

In September 2007, the African Union is convening its first Inter-governmental Committee on African Science, Technology and Innovation Indicators in Mozambique and the Russian Federation, with the European Commission and the Italian statistical office, is holding an international indicators meeting in Moscow in November 2007.

The meeting in Ottawa in 2006 was part of this global interest in the intersection of indicators and policy. The 2006 forum was different from that of 1996, both in content and in its collective sense of urgency to produce indicators needed to address the issues of the day and to support evidence-based policy development. It recognized the interconnection of indicators and the need to address multiple issues, as well as individual ones. Luc Soete and Chris Freeman in Chapter 15 note that what was important in 20th century development of STI indicators may not be as important in the 21st century, but the information may now be misleading when not connected to the activities of other actors in the economic and social system. This point is also made by John Marburger in Chapter 2 who observes that ‘in the face of rapid change, old correlations do not have predictive value’. It is the need to understand the dynamics of change that drives the development of STI indicators in the 21st century.

1.1.2. Evolution of indicators

STI indicators, their development, interpretation and use, are the province of the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) which reports to the Committee on Scientific and Technological Policy (CSTP). NESTI has been in place for over 40 years and its roots in the organization go back half a century. It systematically reviews the need for indicators, encourages experiments in their production and use, and codifies the knowledge in the form of manuals. Then, it manages the revision of the manuals.

The manuals allow the ‘routines’ of data collection, interpretation and indicator development to be shared by thirty member countries and by non-member countries that wish to produce indicators that can be compared internationally. This is not a static process as the economy and the society change, as they have done significantly over the last decade, and the manuals are revised in light of the experience. Two examples are the emphasis on R&D in service industries in the 6th edition of the *Frascati Manual* (OECD 2002) and the addition of a chapter on linkages in the 3rd edition of the *Oslo Manual* (OECD/Eurostat 2005) that deals with innova-

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tion. The manuals, the tacit knowledge held by the experts, and the formal language used to discuss the measurement and interpretation issues are equivalent to a technology and, like machine-based technologies, they do not always behave, or diffuse, as expected.

Richard Nelson (2003) has made the point that it is 'more difficult for a technology to advance if learning is limited to what can be acquired by doing or using' and that does raise a question about how indicators, and their use, advance the understanding of the subject, and whether there is a science underlying the evolution that helps with the advance. Over the last decade, there have been examples of transferring the practices of NESTI to other groups, some more successful than others.

By 1996, NESTI had produced manuals on R&D (OECD 1994a), patents (OECD 1994b), technological balance of payments (OECD 1990), innovation (OECD 1992) and S&T personnel (OECD/Eurostat 1995). All of these had come out of the same process of experiment, comparison of country experience, and consensus on best practice. However, in 1996 the OECD Committee on Information, Computer and Communications Policy (ICCP) recognized the need for statistical support and indicator development describing the information society. The subject matter was quite removed from that involved in knowledge creation, protection, transmission and delivery to the market so a new ad hoc panel was established in 1997 to develop indicators for the information society, chaired initially by a Vice-Chair of NESTI to maintain the network and to transfer the working practices. The ad hoc panel became the Working Party for Indicators of the Information Society (WPIIS) in 1999 and now has an agenda at least as full and complex as that of NESTI and produces its own guidelines for indicator development (OECD 2005c).

In 2000, the need for comparable statistics on biotechnology was recognized by both NESTI and the Working Party on Biotechnology (WPB) and an ad hoc group was established which was managed by NESTI and informed the agendas of the two Working Parties. By 2004, it had achieved its initial objectives of developing definitions for statistical purposes, models surveys for data collection, and the collection and dissemination of statistics and indicators (OECD 2006b). After a period of working virtually, it has been reconstituted to serve WPB.

In 2007, with the creation by CSTP of a Working Party on Nanotechnology, once again an ad hoc group of experts has been established to follow the same programme as in biotechnology. What this demonstrates is that the practices are transferable and help the subject to advance. A consequence is that NESTI has had to become a broker and co-ordinator, as well as a subject matter committee.

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These examples illustrate the ability to transfer the practices of NESTI into different groups dealing with different subjects, but they do not address the question of the underlying science that could support experiments and advance the development of indicators. John Marburger does look at this question in Chapter 2 when he introduces the science of science policy.

It is, perhaps, worth noting one case where an indicators programme, similar to those just described, did not result from several years of work and that is the case of indicators of knowledge management. The decision to undertake the work grew out of an OECD forum held in Ottawa in 2000, managed by the OECD Centre for Education, Research and Innovation (CERI), and followed by meetings in Denmark, Germany and Paris. The meetings and the work of participants produced a model survey and descriptions of attempts to measure knowledge management in participating countries. The final outcome was an OECD book (OECD 2003), but there was no ad hoc group or established working party ready to take on this subject. Dominique Foray discusses this further in Chapter 6, but the real outcome was the inclusion of knowledge management issues in the 3rd edition of the *Oslo Manual* (OECD/Eurostat 2005).

A final example is the work on human resources for science and technology (HRST), discussed in Chapter 11. The work has been done within NESTI, but the subject is complex and involves issues of education and training, labour force participation, mobility and life-long learning. The question naturally arises as to whether this work would be better supported by a link with other working parties, much as the work on biotechnology has benefited from its connection with WPB.

1.1.3. A systems approach

The use of a systems approach to indicator development and classification has been growing over the last decade as a way of getting at the dynamics of change. The starting point for the approach is the actor, or the economic agent, such as a firm, a public institution, or an individual. Actors engage in activities and some examples of STI activities are R&D, invention, innovation, diffusion of practices or technologies, and human resource development related to all of these activities. Actors, engaged in activities in the system are linked to other actors and activities. Some examples of linkages are contracts and co-operation agreements, co-publishing, commercialization of intellectual property, and flows of knowledge and capacities through the movement of people. As a result of activities and linkages, there are short term outcomes, such as increased sales, productivity or market share leading, over time to economic and social impacts. The changes in social behaviour, and in industrial organization and practices resulting from wireless communication are examples of impacts.

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Understanding the system requires more than aggregate statistics produced at regular time intervals. The micro-data relating to the actors have to be available for analysis and the analysis is improved if different data sets can be linked together to provide more information. Of course, this pre-supposes that organizations bound by confidentiality agreements, such as statistical offices, are able to provide the access while protecting confidentiality. Following the behaviour of actors over time supports the study of causal relationships, rather than correlations of characteristics from aggregate cross-sectional data. However, to asses impacts, a variety of techniques are needed, including case studies, as there is rarely a clear path from a technological and organization change and economic and social impacts.

While a systems approach is not new in economic analysis (Simon 1996), the contributions to this book demonstrate that it is now being seen in the development of STI indicators.

1.2. Policy: development and application

Indicators are developed to be used and the policy community is the target. However, for this to work, there has to be a dialogue between the two communities about the availability of data, information and knowledge that can be used and about what needs to be developed.

If the dynamics of the system are to be understood, there have to be micro-economic models that can be used to simulate social behaviors and which include boundary conditions, such as the availability of energy, materials or highly qualified people, which constrain the process. Such models could provide scenarios as a basis for the dialogue between the policy and the indicator community as well as input to the more conventional macro-economic models.

The need for micro-economic models is raised by Marburger in Chapter 2 as part of building a new social science discipline, the science of science policy, which could take advantage of econometric methods and model building to provide the science policy makers with the same support now provided by the system of national accounts and econometric research to the makers of fiscal and monetary policy. The U.S. National Science Foundation has moved to support the development of a science of science and innovation policy (SciSIP) by inviting applications for grants in this area (NSF 2007).

The system of national accounts (SNA) has been in place much longer than the current set of STI indicators and it is a system, something STI indicator developers are still working towards. However, the two activities

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are now overlapping after a decision by the UN Statistical Commission in February 2007 to treat R&D expenditure as capital expenditure in the next revision of the SNA. This means that a broader community of users will be involved with R&D data and with the economic and social implications of their change.

Reinhilde Veugelers, in Chapter 3, looks at the link between STI indicators and evidence-based policy in the European Union and makes reference to the Barcelona target of 3% of Gross Domestic Product to be spent on R&D in the EU, initially by 2010. This raises a question of language and interpretation as the target is reported in EU documents as 3% of GDP allocated to R&D, but in the Presidency Conclusions of the Barcelona European Council (2002) the relevant paragraph is the following.

> Paragraph 47. In order to close the gap between the EU and its major competitors, there must be a significant boost of the overall R&D and innovation effort in the Union, with a particular emphasis on frontier technologies. The European Council therefore agrees that overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010.Two-thirds of this new investment should come from the private sector (European Council 2002).

The expenditure is to be on 'R&D and innovation' not just on R&D and this is a significant distinction from the perspective of allocating the two-thirds of resources from the private sector. More firms engage in the activity of innovation than in R&D suggesting that the 3% target would have been more accessible had it been interpreted in the way it was originally presented, including both R&D and innovation.

Veugelers goes on to develop the indictor requirements for the European Union and raises the need for a systems approach and for micro-level data and analysis. The systems approach includes the need for linkage measures to help explain the 'European Paradox' (Soete 2006), the apparent inability for the knowledge in the well supported public science system to translate into commercial value.

Both Chapters 2 and 3 present the policy need not just for more indicators, but for indicators which are linked together so that they can tell the story about change in the system. They both stress the need for micro-economic analysis and the implicit requirement for access to micro data if the analysis is to be done.

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1.3. New and better measures

Innovation, which connects to the market, has been a subject for policy and indicator development for more than twenty years and the subject continues to evolve. Anthony Arundel, in Chapter 4, observes that innovation policy in Europe is heavily focused on those firms that do R&D but, as noted above, more firms innovate than perform R&D. If the policy objective is wealth creation, it is important to understand the innovators that do not do R&D. A striking observation is that 41% of innovative firms in the Community Innovation Survey (CIS) data being studied innovate by adopting technology from other organizations. This leads to a question of how that adoption took place (Arundel and Sonntag 1999) and the role of user initiated innovation (von Hippel, see Chapter 8).

Arundel also observes that international comparisons do not always work, even if the relevant manual is followed. He examines some of these problems in Chapter 4 and finds that there are cultural differences in countries that give rise to different interpretation of the same question. This is one of the reasons for doing cognitive testing of survey questions in the language that they are to be administered in, in the region of the respondent. To address the situation, he introduces composite indicators that give more credible international comparisons.

While Arundel makes the case for getting more policy-relevant information out of the CIS data, Tara Vinordrai, Meric Gertler and Ray Lambert in Chapter 5 introduce the importance of the concept of design in the process of innovation. This touches on the importance for industrialized economies to move up the value chain by using the creativity of their labour forces to produce more desirable and usable goods and services. It also establishes the need for new indicators related to the process of innovation, but that also is a call for the engagement of the policy community in this important area.

Dominique Foray, in Chapter 6, argues the case for indicators related to knowledge, and specifically for knowledge management, following the OECD pilot project (OECD 2003) which established proof that such information could be gathered and compared. The chapter shows the difficulty of developing a new class of indicators even when it may seem a reasonable thing to do and the pilot project never yielded an OECD manual or handbook. However, the work on knowledge flows and knowledge management was not lost. As Foray points out, it appears, somewhat transformed, in the 3rd edition of the *Oslo Manual* (OECD/Eurostat 2005), as part of industrial organization and practice. As with non-R&D performing innovators, use of design and a creative labour force, the developing of

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indicators of knowledge practices needs dialogue with the policy community to make the case, and this takes time.

The final chapter in the section, Chapter 7 by Heidi Ertl and colleagues, moves along the innovation chain and proposes indicators of impacts of activities linked to innovation. This includes the importance of commercialization indicators which deal with what has to be done to make the product, once delivered to the market, successful. This enhances the information about innovation which just deals with putting a new product on the market or finding better ways of producing or delivering it.

Chapter 7 covers indicators for a number of technologies and makes points raised by others such as the need to use micro-data, to do longitudinal analysis, to link data sets to enhance their value for analysis, to use a variety of methods for indicator development and insight, such as case studies, as well as aggregate statistics and micro-economic simulation modeling, and the importance of understanding the behaviour of the firm over time to study the dynamics of survival and growth characteristics.

1.4. Actors and linkages

Technological and related organizational change activities are initiated by actors which could be firms, public institutions or people. The actors are tied together by linkages in the economy and the society and these linkages raise questions and offer opportunities for a better understanding of the dynamics of the system.

Eric Von Hippel, in Chapter 8, looks at the role of the user in the innovation process and poses some challenging questions about intellectual property protection and about how innovations are transferred from the innovative use to others in the community of practice or back to the suppliers of the original product. This leads to discussion of an 'information commons', open source software, and methods of free revealing.

One of the questions coming out of this work is whether intellectual property protection instruments are achieving the intended purpose of disclosure in return for a temporary monopoly or whether they are being used strategically by firms to inhibit other firms from gaining the economic benefits of invention and innovation. A second question is whether the current intellectual property regime is appropriate for a world where more and more users of goods and services are able to change them to their advantage and may then wish to share these changes with others.

The use of intellectual property and its protection form part of the business strategy of the firm, for those firms with the capacity to develop and manage a business strategy. With the 3rd edition of the *Oslo Manual*

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(OECD/Eurostat 2005), attention is turning more to the organization of the firm, including the use of business practices and strategies, as well as the development of new or existing markets for the goods or services produced. Developing STI indicators of business practices or strategies is a relatively new activity and it carries with it the question of how successful these activities have been.

Richard Fabling, in Chapter 9, presents evidence from surveys in New Zealand which shows that management practices, as well as innovation, can be measured and related to outcomes. This introduces the concept of a panel survey to the discussion and the importance of making the same set of observations of the same firm over time. Such longitudinal analysis provides an opportunity to see the effects over time of changes in the practices of the firm or in the environment in which it operates.

Institutions can be observed at different points in time and they can also be observed as they interact with other institutions. Richard Hawkins, Cooper Langford and Kiranpal Sidhu, in Chapter 10, examine the role of the university in an 'innovation society' and how it transfers knowledge to the private sector. This leads to an exploration of knowledge pathways and a call for statistical measurement of the transfers, an issue that appears later in Chapter 13.

The chapter by Laudeline Auriol deals with highly qualified people as stores of knowledge and as vectors of knowledge flow. The specific interest is in the international mobility of doctorate holders and the chapter demonstrates that measuring mobility is not easy, but it is important if there is to be better understanding of temporary mobility, such as the taking of a post-doctoral fellowship for a few years and returning home, and 'brain drain' which may involve migration and the taking of a permanent position. In Chapter 11 she stresses the importance of collecting information on the intentions of doctorate holders and on the motivation for their mobility. The indicator development that follows from Chapter 11 is essential for the understanding of the dynamics of the STI system.

The role of doctorate holders in the STI system is part of a larger question which related to the education and training and mobility of the labour force. The European Commission (2007) has proposed a coherent framework of indicators and benchmarks for monitoring progress towards the Lisbon objectives in education and training. Eurostat reports on the mobility of human resources in science and technology (Meri 2007) and the U.S. National Science Foundation reports every two years on the science and engineering labour force and its education (National Science Board 2006).

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1.5. Connections and impacts

The interest in indicator development in the 21st century is moving from indicators of activities and linkages to indicators of outcomes in the short term and longer term impacts. Chapters 12 to 14 deal with outcomes and impacts from three different perspectives: biotechnology; the funding of health research; and, sustainable development. Impacts in these and other areas are sure to be on the agenda of the next OECD Blue Sky Forum.

Antoine Rose and Chuck McNiven, in Chapter 12, tackle the need to establish impact measures of biotechnology as it grows in importance, much as the generic information and communication technologies (ICTs) have done. This draws upon work of the ad hoc group on biotechnology at the OECD (OECD 2006b) and points the way to development of the agenda of that group as it starts to meet again.

Alan Bernstein, and colleagues, in Chapter 13, look at how the impact of the funding of health research can be measured and a framework and a process, which is still being developed is presented. Given the demands on government funding the question of what the government gets for funding health research, or any other research, cannot be avoided. The development of the framework and its application by the Canadian Institutes of Health Research provides a laboratory for others trying to do the same in support of evidence-based choice on the part of government, followed by ex-post justification based on impact analysis. As an example, the importance of such evidence for evaluation is raised by Sarewitz (2007) in relation to the doubling of the budget of the U.S. National Institutes of Health (NIH).

Michael Bordt, Julio Rosa and Johanne Boivin open up the issue of STI and sustainable development and make some proposals for how to integrate the two. This was also the subject of a conference sponsored jointly by the OECD and the government of the Republic of South Africa in 2005 (OECD 2007), the outcome of which is still influencing OECD agendas.

Dealing with sustainable development is both important and timely as the linkages in the economic system become more evident. Concern about climate change, energy costs and security have led to the use of food crops for the production of bio-ethanol which is intended to reduce the dependence on fossil fuel. As result, the growing demand for bio-fuel is underpinning higher agriculture prices (OECD-FAO 2007). The impact of this goes beyond the increasing cost of popcorn in cinemas. When combined with increased food demand from China and India, and the cost of energy needed for transport, the UN World Food Programme now needs more money to feed the hungry. To deal with this requires many technologies, practices and policies to work together and to reinforce one another to

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achieve a common objective. Providing the STI indicators to inform this work is a major and important challenge.

1.6. What have we learned and where are we going?

Christopher Freeman and Luc Soete bring the book to a close by warning the indicator and the policy communities about using 20th century thinking in the 21st and they broaden the debate to include developing as well as developed countries, which is essential in an interconnected and interdependent world. A shift is suggested from the importance of the formal creation of knowledge to the combination of existing knowledge to make new knowledge that can be used to create value. However, this raises questions, already discussed, about the functioning of intellectual property policy in the 21st century.

Along with other contributors to the book, they stress the importance of organizational and cultural factors in relation to technological impact in a development context which gets back to the need to understand the framework conditions within which development takes place and opportunities for sustainable growth appear.

In the final chapter, Alessandra Colecchia presents what the OECD and its committees could aim to do in the short and medium term. This will determine the outcomes and the longer term impacts of the second Blue Sky Forum and set the stage for the third.

1.7. Conclusion

In summary, the 2006 OECD Blue Sky Forum, and the contributions to this book, make the point that STI indicators, whether new or established, are needed to tell the story of economic and social change. To do this, their emphasis must shift from activity measures to impact measures to observe the consequences of activities, such as innovation, and to support the monitoring and comparison of policy interventions. However, this does not mean that measures of activities and linkages should be forgotten.

Making this happen requires co-ordination, focus and synthesis within organizations like the OECD, and across international and supranational organizations. For the analysis to address the issues of the 21st century, there has to be access to the micro-data on individual actors in the STI system, so long as the confidentiality of the respondents is protected.

Developing a science of science policy as a social science discipline paves the way for a theoretical underpinning for STI indicator development,

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which will allow this 'social technology' to advance more quickly and effectively.

Within the subject of STI indicator development, human resource measures require attention before the next Blue Sky Forum as it is the highly qualified people that create, transmit and use knowledge to create value.

In a global economy that links together the developed and the developing countries, understanding the role of STI in sustainable development is a challenge for the next decade.

Not to be forgotten are classifications and guidelines that are needed to collect and interpret data on the STI system and to produce indicators that can be compared over time, across geography and national boundaries. This is the work that expert groups like NESTI have been doing for half a century.

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* All of the papers presented at the Blue Sky meeting in 2006 are available on the OECD website at *www.oecd.org/sti/blueskyconference*.

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Annex A

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Acronyms and Abbreviations

AIDC	Automotive Industry Development Centre
AIDS	Acquired Immune Deficiency Syndrome
AMTS	Advanced Manufacturing Technology Strategy
Armscor	Armaments Corporation of South Africa
ASGISA	Accelerated and Shared Growth Initiative for South Africa
ASSAf	Academy of Science of South Africa
BEE	Black economic empowerment
BERD	Business Enterprise Expenditure on Research and Development
BPO	Business process outsourcing
BRIC	Biotechnology Regional Innovation Centre
CeSTII	Centre for Science and Technology and Innovation Indicators
CHE	Council on Higher Education
CIDAUT	Research and Development Centre in Transport and Energy, Spain
CIS	Community Innovation Survey
CRI	Crown Research Institute, New Zealand
CSIR	Council for Scientific and Industrial Research, South Africa
CSP	Customised Sector Programme (a DTI initiative)
DACST	Department of Arts, Culture, Science and Technology (now the DST)
DEAT	Department of Environmental Affairs and Tourism
DEEM	Design, engineering, entrepreneurial and management
DEET	Department of Environmental Affairs and Tourism
DESA	Development Bank of Southern Africa
DoE	Department of Education
DST	Department of Science and Technology
DTI	Department of Trade and Industry
Eskom	Electricity Supply Commission
EU	European Union

FDI	Foreign direct investment
FEST	Foundation for Education, Science and Technology
FFG	Austrian Research Promotion Agency
FRAM	Norwegian entrepreneurship training programme
FTE	Full-time equivalent
GDP	Gross domestic product
GEM	Global Enterprise Monitor
GEAR	Growth, Employment and Redistribution
GERD	Gross domestic expenditure on research and development
GTS	Advanced Technology Group, Denmark. A network of research institutes.
HBT	Historically black technikon
HBU	Historically black university
HEI	Higher education institution
HERD	Higher Education Expenditure on Research and Development
HIV	Human immunodeficiency virus
HSRC	Human Science Research Council
HWT	Historically white technikon
HWU	Historically white university
ICT	Information and communications technology
IDC	Industrial Development Corporation
IKS	Indigenous knowledge system
IMEC	Interuniversity Microelectronics Centre, Leuven, Belgium
IMS	Integrated Manufacturing Strategy
IP	Intellectual property
ISI	Institute for Scientific Information, Philadelphia
IT	Information technology
IWT	Institute for the Promotion of Innovation by Science and Technology in Flanders, Belgium
JIPSA	Joint Initiative on Priority Skills Acquisition
KIBS	Knowledge-intensive business services

MEC	Minerals-energy complex
Mintek	Council for Mineral Technologies
MiTech	Missions in Technology
MPE	Multotec Process Equipment
MNC	Multinational Corporation
MRC	Medical Research Council
MSDS	Metals Sector Development Strategy
NACI	National Advisory Council on Innovation
NCTC	National Casting Technology Centre
NECSA	Nuclear Energy Council of South Africa
NFTCC	National Fibre, Textile and Clothing Centre
NRF	National Research Foundation
NSTF	National Science and Technology Foundation
NTCCD	National Technology Transfer Center
PBMR	Pebble Bed Modular Reactor
PPP	Purchasing power parity
PRI	Public research institute
R&D	Research and development
RANNIS	The Icelandic Centre for Research
RCN	Research Council of Norway
RDP	Reconstruction and Development Programme
RISA	Research and Innovation Support and Advancement division of NRF
S&T	Science and technology
SAASTA	South African Agency for Science and Technology
SAAVI	South Africa AIDS Vaccine Initiative
SADC	South Africa Development Community
SEDA	Small Enterprise Development Agency
SETA	Sector Education and Training Authorities

SINTEF	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
SME	Small, medium and micro enterprise
SP	SP Technical Research Institute of Sweden (formerly the State Testing Authority)
SPII	Support Programme for Industrial Innovation
STI	Science, technology and innovation
STU	The Swedish National Board for Technological development
TAP	Technology Advancement Programme
TEKES	Finnish Funding Agency foe Technology and Innovation
TFP	Total factor productivity
THRIP	Technology and Human Resources for Industry Programme
TNO	Netherlands Organisation for Applied Scientific Research
UNISA	University of South Africa
VAT	Value-added tax
VINNOVA	Swedish Governmental Agency for Innovation Systems
VTT	VTT Technical Research Centre of Finland

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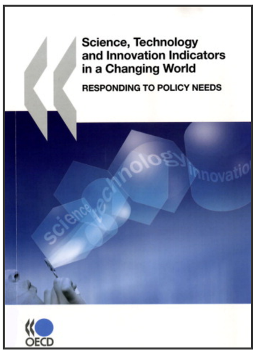

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