NATIONAL ADVISORY COUNCIL ON INNOVATION
DINNER MEETING

Date: 17 May 2010
Time: 18:00–21:00
Venue: Villa Sterne, Waterkloof Ridge, Pretoria
Chairperson: Dr Steve Lennon

Present:
NACI Councillors
De la Rey, Dr Cheryl
Jammime, Dr Azar
Lennon, Dr Steve (Chairperson)
Mjwara, Dr Phil
Njobe, Ms Khungeka
Petersen, Prof. Francis
Rothschild, Mr Geoff
Van Zyl, Prof. Arnold

NACI secretariat
Boraine, Dr Hermi
Mosenthal, Mr Thabo

Guests
Ahmed Essop Council on Higher Education
Bhengu, Mr Theo HESA
Botha, Dr Anthon Technoscene
Cozzens, Prof. Susan Georgia Institute of Technology
Crewe, Prof. Robin University of Pretoria
Pouris, Prof. Anastassios University of Pretoria
Von Gruenewaldt, Dr Gerhard Expert consultant
Wood, Prof. John European Area Research Board and Imperial College

Professional service providers
Arnold, Ms Robyn Write Connection (Scribe)
Uitenweerde, Mr Laurence Eyescape Photographer

TABLE OF CONTENTS
WELCOME .......................................................................................................................... 1
PRESENTATION: DEVELOPING THE EUROPEAN RESEARCH AREA (PROF. JOHN WOOD) ................. 1
QUESTIONS AND DISCUSSION ...................................................................................... 10
TABLE DISCUSSIONS .................................................................................................... 12
FEEDBACK FROM TABLE DISCUSSIONS ....................................................................... 12
Table 1 (Rapporteur: Mr Geoff Rothschild) ................................................................. 12
Table 2 (Rapporteur: Prof. Arnold van Zyl) ................................................................. 13
Table 3 (Rapporteur: Prof. Francis Petersen) ............................................................... 13
CONCLUSION ............................................................................................................... 14
APPENDIX A: ACRONYMS .......................................................................................... 15
WELCOME

Dr Lennon opened the meeting and welcomed everyone to the dinner meeting. He particularly welcomed the speaker, Prof. John Wood, as well as the Director-General of the Department of Science and Technology, Dr Phil Mjwara.

Dr Lennon introduced Prof. John Wood, Chair of the European Research Area Board (ERAB), which had been established in 2008 to give independent advice to the European Commission on research and science policy. ERAB has 22 members drawn from science, academia and business. Prof. Wood is also principal of the Faculty of Engineering at Imperial College, London.

PRESENTATION: DEVELOPING THE EUROPEAN RESEARCH AREA (PROF. JOHN WOOD)

The presentation would address the direction of the European research agenda as well as issues related to doctoral training.

The European Research Area Board Conference was held in Seville on 6–7 May 2010. At that conference, Mr Daan du Toit, South Africa's Senior S&T Representative to the European Union (EU), spoke on behalf of South Africa. The ERAB 2030 Strategic Plan was presented for discussion and comment to an audience that included the Chinese Academy of Scientists. Nineteen young researchers from around Europe were invited to give their views. This had been a very stimulating exercise, which had elicited much discussion.

The European Research Area Board was set up just less than two years ago with 22 members selected in their personal capacity. They do not represent nation states. Prof Woods is chairperson. One of the members of the European research area board is originally South African, Sir David King.

The European Commissioner for Science and Research, Janez Potočnik of Slovenia, had asked the ERAB to initially look at the following issues:

- Modernisation of European universities to be fit for purpose, including considering how many can be supported at international level. The commissioner believes that many of the 4000 universities in Europe were dysfunctional. The question was how to support the universities at a truly international level.
- Optimising the relationship between public and privately funded research, including the notion of ‘open innovation’.
- Getting public and private innovation to work together more coherently. (At Imperial College, one third of the funding comes from public companies, which is an exception in Europe.)
- Engaging the citizen in the excitement and purpose of research and justifying research to the taxpayer. It is important for taxpayers to appreciate what research is doing for them and to engage the public. Many scientific processes have received negative media attention, including GM crops and measles and rubella inoculation. The media are quick to stir up a campaign that may be counter to all the evidence.
- Role of the European Research Area (ERA) in the global environment, including how to position Europe in the global and international environment. Prof. Wood noted that this issue is pertinent to South Africa, which faces similar issues.
- Freedom of Knowledge: The Ljubljana Process determined that the Fifth Freedom is the Freedom of Knowledge. The concept is that publicly funded knowledge in future will be publicly available. Smart people will have to know how to use it. The former Minister of Finance of Sweden, emphasised that in future, the use of knowledge, rather than the protection of knowledge, would become important (although for companies the issues might be slightly different). Research councils of the European Union are moving to make research knowledge available to everyone in the country. Other issues then arise of ensuring that the knowledge is accessible by everyone. There should be freedom of ideas across boundaries by breaking barriers between member states. Social inclusion is pertinent to both South Africa and Europe. Vast areas of Europe feel socially isolated, particularly in Eastern Europe. The concept of a European research passport is being developed. This would facilitate the mobility of pension and social security. At present, there are different pension arrangements for researchers in every member state, which makes it very difficult for a family to move from one state to another either permanently or semi-permanently.
The concept of open innovation is an aspect of the freedom of knowledge. Henry Chesbrough has written about the concept of open innovation (Open Innovation: The New Imperative for Creating and Profiting from Technology). The issue is how to get industry involved. One of the ERAB members (Dr Jan van den Biesen) is a vice-president of Philips; the Philips technical campus at Eindhoven in the Netherlands is a good model of open innovation and the way in which universities, big companies and supply chain can work together in one location.

One of Prof. Wood’s stock phrases is: “The future is not what it used to be.” Researchers have to be empowered to own responsibility for the future, not just work on their own particular interests. I

- Research is global. In this context, what can ‘little Europe’ do? How can researchers work together more effectively?
- The Grand Challenges are pressing (including water, health and energy). In this context, what is the role for small-scale research? There are too many sub-critical units researching these issues. It is not possible to rely on bottom-up research alone to solve the issues (although bottom-up research is needed).
- There are too many sub-critical universities. Consideration has to be given to how many can be supported at international level.

The ERAB had considered what Europe could do to address the issues that member states were not in a position to address. It should be noted that the European Union has only 5% of the research funding in Europe; 95% of research funds remain with member states.

We cannot afford to bury our heads in the sand; the status quo is not an option. In this regard, it should be noted that the world of research is changing. There is still a need for bottom-up ideas but:

- The challenges before the world are so immense that we need to look at how we train people to fit into large teams in the public environment, yet retain their own individual identity and depth of knowledge and allow room for individual creativity.
- Is the idea of the conventional PhD past its sell-by date? The concept of the PhD in its modern form is about 150 years old. It not well formulated, and is used in different ways in different countries. How should we train and conduct research in this environment?
- Electronic infrastructure enhances global cooperation. Prof. Wood explained, for example, that he is able to operate equipment at Oakridge National Laboratory in the USA as well as in China in real time from his laboratory at Imperial College.
- Consideration must be given to how to increase investment in both public and privately funded research.
- The impact of international research infrastructures, both physical and dispersed, must be taken into account.
- Consideration must be given to how to achieve ownership for changes in lifestyle by citizens, which must inevitably occur.

The spotlight is on the research community because:

- Politicians and society want answers to global challenges. Science and researchers are seen as a major part of the solution.
- Whole-body approaches require several different disciplines to work together.
- It is necessary to ensure a better understanding by funders and policy-makers of the implications of the evidence. In the UK, there have been difficult situations regarding evidence given to politicians that did not find favour, and incidents when the chairman that spoke out against the politician was sacked. The social dimension must not be too subservient to political influence.
- Consideration must be given to how to develop in-depth training while integrating across disciplines.
- Europe cannot ‘go it alone’ but must integrate into the international effort. Europe has just over 400 million citizens, which is roughly equivalent to the USA, but very small compared with India and China.

This situation has a number of implications for doctoral training in the future, including:

- Students should be trained to participate in the international context. The ERAB view is that only about 30% are up to this challenge, and efforts should be focused on those.
• The implications of research for global challenges need to be fully understood by PhD students. The previous model of PhD training, in which students were left very much to their own devices, is not very effective.
• It is essential that researchers understand from an early stage the link between evidence, policy, regulations and implementation so that they can have an impact.
• How much can be shoe-horned into a PhD programme or do we need another model – possibly with a one year add on to achieve a “European Research Passport” (PhD plus)
• Consideration should be given to whether there is a need for an internationally accredited PhD.
• The question should be posed whether academics are fit to successfully address the challenges. Most academics are not interested in pursuing new kinds of models. Only about 20% of PhD supervisors have a wider vision, and those that have, do very well.

The disconnect between the researcher and his/her experiment is growing. The researcher does not have to be physically present. For example, a biologist will send protein crystals to Genoble by courier. The samples are taken out by robot and go on to the cyclotron, where they are exposed to the x-ray beam. Analysis is done at Grenoble by physicists and computer scientists, and the results come back to the laboratory.

Prof. Wood was head of the Rutherford Appleton Laboratory outside Oxford for several years. Along with 20 other laboratories, they could operate equipment in CERN in real time using the access grid. This has implications for whom one can trust, where one places one’s trust and whether one can trust the results. Interoperability between different pieces of equipment becomes important. About 7000 users from around the world visit the Rutherford Appleton Laboratory. They will no longer have to visit physically in future, because they will be able to use the research facilities remotely in real time. For example, a chemist can do neutron diffraction in Oakridge on the SNS (spallation neutron source) equipment, x-rays in Grenoble on the ESRF (European Synchrotron Radiation Facility) and NMR in Tokyo.

The European Commissioner asked the ERAB to develop a strategic vision for research in Europe. The ERAB 2030 strategic vision was published in October 2009 as Preparing Europe for a New Renaissance: A Strategic Vision for the European Research Area. The instructions from the Commissioner were to think out of the box, think like a venture capitalist and think in terms of high risk, without being dissuaded by what can and cannot be done. The report was written not by a scientist but by a journalist – the former editor of the Wall Street Journal in Europe.

The presentation highlights some aspects of the vision that are important for South Africa and the global intention.

The European Research Area was set up under the Lisbon Agenda ten years ago; very little happened, although there was much talk. The Commissioner intended that the vision should take ERAB beyond simply being a political concept so as to deliver solutions for the future to citizens, although facing the challenges is likely to be uncomfortable. The Commissioner wrote in his introduction to the strategic vision:

The European Research Area is not just a political concept; it has to be a reality to deliver solutions for the future of all our citizens and for the future of the world as we know it. Future generations will see this as a pivotal moment and the penalties for ignoring what is before us are immense. There are uncomfortable challenges facing us and it is vital that we take notice of them.

This holistic thinking and approach epitomized the first ‘Renaissance’, where scholars and artists moved relatively freely around Europe among the centres of learning and culture. While this privilege was the domain of a few at that time, it should be our ambition, in the new ‘Renaissance’, that this should be the expectation of all citizens,

Our world is changing.

We face mounting challenges: of global warming, scarce water, energy shortages and healthcare, to name a few. Their solution will require new ideas, discoveries, talents and innovations – the fruits of research. To achieve them, we must start by changing the way we do research. We must
reorganize, to create a truly open European Research Area marked by free movement of people and ideas. We must rethink the way science interacts with politics and society, so our governance is based on best-available evidence.

We must rewrite the social contract between the researcher and society, so that freedom of thought is balanced by responsibility for action. We must open our markets, our companies and our knowledge institutions so they work together more productively. Above all, we must create an environment in which the best ideas thrive, the brightest people prosper, and our excellence is rewarded – while at the same time improving the cohesion of our society.

The vision proposed six strategic approaches for the ERA:
1. A united ERA across Europe
2. An ERA driven by societal needs to address the ‘Grand Challenges’
3. An ERA based on a shared responsibility between science, policy and society
4. An ERA of open innovation between all public and private stakeholders
5. An ERA to deliver excellence
6. An ERA of cohesion across the continent

Seventy-six recommendations were subsequently proposed in order to realise the strategic approaches. In the following sections, the milestones of each of the six strategic approaches are discussed, together with some of the more specific recommendations and associated initiatives and activities.

Strategic approach 1: A united ERA to permit ideas and people to move freely across a dynamic, open society

We will know the ERA is a united market for research in 2030 when we see:
- The EU’s share of ERA-wide public, non-military research funding doubles to 10%.
- A significant increase in the coordination of scientific research grant programmes across the ERA, to at least 10% of funding from a very low base today.
- Mobility triples, with up to 20% of EU doctoral candidates working outside their home country.
- The fiscal regime for R&D and innovation incentives is optimised across the EU.

Specific recommendations to meet the milestones include:
- There is a significant increase in the coordination of scientific research grant programmes across the ERA, to at least 10% of funding:
  - Strengthen EIT (European Institute of Innovation and Technology) in coordinating grant programmes in specific fields
  - Increase investment on European research infrastructures,

Prof. Wood noted that increasing investment in European research infrastructure is key to innovation. Prof. Woods was chair of the European Strategy for Research Infrastructure (ESRI), and was responsible for the first Roadmap, which brought together 35 transnational projects (since increased to 44 projects, one of which is the Square Kilometre Array).

A number of South African researchers are beneficiaries of the European Framework Programme. Prof. Woods view was that this was dysfunctional, undermined by bureaucracy and duplication.

As at 2009 ESFRI for the environmental sciences brought together EURO-ARGO, IAGOS-ERI, SIOS, Aurora Borealis, EMSO, EISCAT-3D, EUFAR-COPAL, LifeWatch, EPOS and ICOS.

**CLARIN (Common Language Resources and Technology Initiative)**

One of the transnational projects is CLARIN (Common Language Resources and Technology Initiative). The aim of the project is that the meaning of words can be understood in context, both historically and within the present social context in which the word is used. Governments find the project invaluable in that it enables an understanding of international treaties in any language, and companies use this for interpreting legal
documents. CLARIN is a federation of digital archives with language data and tools (text, speech, multimodal, gesture). The target audience is humanities and social sciences scholars with uniform single sign-on access to the archives and access to language and speech technology tools to retrieve, manipulate, enhance, explore and exploit data. All languages are treated as equally important, and the project aims to cover all countries (including the diverse South African indigenous languages). The project is based on a Grid-type infrastructure using Semantic Web technology.

The estimated costs of the CLARIN project are:

Humanities and social science scholars need scientists to run the project. The project is headed by Peter Wittenburg, a plasma physicist at the Max Planck Institute for Psycholinguistics in the Netherlands.

There are many challenges of different kinds:
- Technical challenges:
  - Interconnecting existing archives that may use very different ways to encode and describe data
  - Ensuring that existing language technology tools made for material in archive A will also work for material in archive B, and will work together
  - Addressing the need for common standards
- Linguistic challenges:
  - Ensuring that all languages are sufficiently covered
  - Ensuring that the approach adopted fits all languages
  - Addressing the need for broad consultation (e.g. about standards) and verification (for each language)
- Take-up by target audience:
  - Aimed at humanities and social sciences scholars who have no technical background and who have very little tradition in using technological tools
- Special challenges:
  - Discovering what they need
  - Making them aware of the potential benefits of the infrastructure (e.g. to speed up or innovate their research)
- Legal challenges:
  - Making a light access and licensing system for users
  - Protecting owners’ rights and interests
  - Respecting national IPR legislation
- Special problems:
  - Transnational access and diversity of national IPR and data legislation
  - Repurposed data, particularly live data (e.g. using novels or TV news for linguistic studies)
  - Ethical and privacy considerations (e.g. using recorded phone calls to train speech recognition systems).

**LifeWatch**

Prof. Wood believed that LifeWatch is the best example of transnational research, using large-scale e-infrastructures for biodiversity research. The premise is that the biodiversity system is complex and cannot be described by the simple sum of its components and relations. Experimentation on a few parameters is not enough. There are limitations to scaling up results for understanding system properties. LifeWatch adds a new technology to support the generation and analysis of large-scale datasets on biodiversity in order to find patterns and learn processes. Environmental biologists bring the data together from diverse sources. CERN is used to conduct the analysis, and the European Space Agency is used to bring the results together as the basis for collaboration among environmental biologists. The results are brought together to inform the environmental science policy of governments.
Other specific recommendations for meeting the milestones include:

- Mobility triples, with up to 20% of EU doctoral candidates working outside their home country:
  - Funding for Marie Curie-type programmes increases.
  - English is the standard for PhD and other postgraduate studies whenever relevant.
  - Barriers to the cross national movement of scientists and families no longer exist. Financial incentives are there for researchers willing to be mobile.
  - A European research passport/visa for successful non-European researchers exists which enables them to move easily around Europe and which encourages non-Europeans to come to ERA centres of excellence.

Young researchers will develop a truly European career in research and innovation in order to strengthen the ERA and Europe's competitiveness. At least 30% of young researchers will come from outside of Europe.

**Strategic approach 2: An ERA driven by societal needs to address the ‘Grand Challenges’**

We will know the ERA is driven by societal problems in 2030 when we see:

- A third of public, non-military research is geared to grand societal challenges, with a multidisciplinary approach.
- 30% of all scientists, including humanities and social sciences, are trained in research fields relevant to the Grand Challenges.
- Multidisciplinary academic training is generalised to educate our research community into the complexity of the Grand Challenges, without diminishing the importance of discipline-based expertise.
- The tools of ‘e-science’ are deployed throughout the ERA, permitting international collaboration so that all researchers will see themselves as part of the global research system.

Specific recommendations for meeting the milestones include:

- A third of public, non-military research is geared to grand societal challenges, with multi- and transdisciplinary approaches.
  - European funding for Masters and PhD training focuses on the Grand Challenges, including attendance at cross-disciplinary summer schools.
  - Internships in the business and public sector are part of the standard research curriculum.
- 30% of all scientists, including those in the humanities and social sciences, are trained in research fields relevant to the Grand Challenges.
  - European funding for Masters and PhD training focuses on the Grand Challenges, including attendance at cross-disciplinary summer schools.
  - Internships in the business and public sector are part of the standard research curriculum.
- The tools of ‘e-science’ are deployed throughout the ERA, permitting international collaboration so that all researchers will see themselves as part of the global research system.
  - EC funds prioritise on-line, postgraduate inter-university programmes as well as on-line joint research programmes. In this context, SKA is important.

Prof. Wood proposed the concept of the European city of innovation, with 20 billion euros each year as an incentive for cities to become carbon neutral. Large-scale projects that capture the imagination are needed to drive the innovation agenda.

The information infrastructure is changing. The researcher acts through ingest and access. The researcher should not have to worry about the information infrastructure. There are 50 million hits per day on the firewall at Rutherford, trying to corrupt data. Data come from all sorts of different sources, including sensor networks, global databases, local databases, desktop computer, laboratory instruments, observation devices, etc. Researchers have to be trained to question the veracity of the data to which they have access. Data processing, analysis and visualisation entails working with legacy codes, workflows, data mining,
indexing, searching, graphics, screens, etc. Archiving involves digital repositories, libraries, preservation, etc. Curation of data is big business but it is not yet taken seriously enough.

The EU information society feels responsible for creating a network for underpinning the data infrastructure, which brings together different disciplines. The scientific data infrastructure is underpinned by the computing/data grid infrastructure, which is in turn underpinned by the GÉANT network infrastructure.

PARSE (Permanent Access to the Records of Science in Europe)

PARSE was a European-funded pilot project for two years from 2008–2010. The project looked at data storage in Europe into the future. Prof. Wood chaired the research committee. The project was closely linked with the European Alliance for Permanent Access. It developed a Roadmap of Science Data Infrastructure based on UK’s Digital Curation Centre and considered whether there is a need for a common European Data Storage Standard. The project is likely to be extended beyond the pilot phase, and the outcome will be important to South Africa.

National grid initiatives

A European national grid initiative has recently been funded, bringing together a number of national grid initiatives so as to grid-enable the EU member states. This will be vital to the virtual research environment.

The SKA will be important in extending the global reach of GÉANT.

FEAST study

The FEAST study looks at what is necessary in southern Africa from the European perspective for funding in the future. Full connection to GEANT-2 is important, possibly on a bilateral basis. AfricaConnect is needed to create the regional backbone, and concrete applications (such as the SKA) are needed to drive it (e.g. participation in international research infrastructures).

It is furthermore essential to ensure that universities and research institutes have the technical capability to operate in this environment. Managers of research need increased awareness of the potential that the infrastructure offers. It is essential to move from a high-price low-volume commercial business model to high-volume low-price public one.

Supercomputers

Europe is looking at the development of a supercomputer, PRACE, which will probably be located in Spitzberg, because it is cold. Central London already has insufficient power to run the cooling system necessary for the supercomputer at Imperial College.

The problem of data storage is growing as new large-scale facilities are being planned and built around the world, producing hundreds of petabytes of data per year (a petabyte is equal to a stack of CDs one kilometre high). A researcher in the Elixir project has estimated that if Moore’s Law is followed, the storage space in the world will be exhausted by 2020.

Infrastructures will be operated remotely and will have to interact in real time with high-performance computing (HPC) simulations, each informing the other. What will be the role of the researcher once the experiment starts? For example, a project Prof. Wood is working on in Germany will use one million data points on seven detectors every million billionth of a second. Data storage needs to be planned from the start.
Strategic approach 3: An ERA with shared responsibilities for science, policy and society

We will know the ERA is a shared responsibility when we see:

- The EU has a fully functioning, independent Chief Scientific Advisor, supporting its decision-making with the best available evidence, horizon-scanning and future scenario planning.
- A more educated citizenry is trained in science and technology issues to be able to participate in policy debate.
- All outputs of public, non-military funded research will be available via ‘open access’ to all concerned and interested.
- Half of all scientists and research policy makers, across all disciplines and at all levels of the science system, are women.
- The EU spends up to three times as much as in 2005 on its higher education, or 3.3% of GDP.
- A universal code of scientific ethics is adopted by the whole European research community, enunciating social responsibilities as well as intellectual freedom.

Specific recommendations for meeting the milestones include:

- A more educated citizenry is trained in science and technology issues to be able to participate in policy debate:
  - All outputs of public funded research are available via ‘open access’ to all interested and universities undertake a broader role in science communication
  - Open up universities to the public by promoting life-long membership.
- A universal code of scientific ethics is adopted by the whole European research community, enunciating social responsibilities as well as intellectual freedoms.
  - As part of the contract between science and society, a code of ethics is in place akin to the Oath of Hippocrates for medical practitioners.

It is proposed that all scientists sign this ethical code when starting their graduate studies and that the code of ethics forms part of the EU treaty. The code of ethics would relate to rigour in decision-making, respect for fellow people and responsibility for actions. A researcher that contravened the code would lose their status as an international researcher. The ERAB intends to drive this hard as part of all research programmes.

Strategic approach 4: An ERA of open innovation between all public and private stakeholders

We will know the ERA is a common market and thriving place for open innovation in 2030 when we see:

- A pan-European ‘Open Innovation’ charter is signed by all major stakeholders.
- A pan-European label ‘Open Knowledge Institution’, for higher education and research acts as a gold standard for excellence in innovation in the ERA.
- Overall R&D funding rises to 5% of GDP, of which industrial R&D accounts for two-thirds.
- 2% of public procurement ERA-wide is earmarked for innovative and pre-commercial technologies, and is open to European-wide competition.
- Mobility of researchers between the public and private sector is high, and industrial funding of academic research accounts for one third of the overall research budget.
- Risk capital available for early-stage technology development triples, to 0.15% of GDP.

Specific recommendations for meeting the milestones include:

- A pan-European Open Innovation Charter is signed by all major stakeholders:
  - The Open Innovation Charter is in place and is a reference in the selection criteria and guides for applicants in Framework Programme 8. Key enablers for open innovation are the guidelines of the Responsible Partnering Handbook.
  - A pan-European label, “Open Knowledge Institution”, for higher education and research, acts as a gold standard for excellence in innovation in the ERA.
  - A single, strong and credible European patent is established by 2015. (At present, Europe has 27 patent offices.)
- Mobility of researchers between the public and private sector is high:
  - Marie Curie schemes are expanded to support professional or industrial doctorates.
Industrial achievements are fully taken into account for academic career paths. A code of best practice is there to monitor this.

Legal and fiscal barriers no longer disadvantage the movement between public and private sectors. (At present, pension rights are a big obstacle to mobility.)

**Strategic approach 5: An ERA of excellence where risk-taking will be the guiding principle for ERA research policies.**

We will know ERA is a place of excellence in 2030 when we see:

- 50% of EC research funding is going to frontier, high-risk research and development
- Europe increases its share of top-ranked universities up to 40% of the top 20 and top 100 rankings and increases its most-cited research world wide by a third.
- Funding for public, non-military research is increasingly concentrated in research-intensive institutions.
- At least 50 of our innovation clusters, out of about 2000 clusters large and small today, are world leaders in scale and quality.
- The governance system for European research funding will be based on a set of arms-length agencies, as part of an ERA of agencies.

Excellence should apply to research, innovation, applied research, infrastructure and mobility.

**Specific recommendations for meeting the milestones include:**

- 50% of EC research funding is going to frontier, high-risk research and development:
  - Develop a pan-European Training Programme, that helps reviewers, auditors and researchers to identify and select promising high impact research even if there is an associated risk

- Europe increases its share of top-ranked universities to up to 40% of the top 20 & 100 rankings, and increases its most-cited research world wide by a third:
  - The European higher education system is functionally diversified (teaching, research, technical skills). Fact-based metrics flag those groups that have high impact in R&D specifically in Grand Challenges. The EC supports this accordingly.
  - Member States revisit the statutes/governance of their universities with a perspective to contribute to a competitive and excellent ERA.
  - To achieve a European-wide increase of standards, collaboration between higher and lower ranked universities is supported in all areas.

At present, there are 4000 universities in Europe. Only a few are in the top 100 (most of which are in the UK). Other European universities need to be brought into the top rankings, including ETH in Zürich. The higher education package needs to be diversified. Judgements will have to be made about which universities to promote as world-class institutions. Lower-ranking universities will also have to be supported, possibly through a system of partnering.

Most European universities have a poor governance model. Tenure was abolished in the UK thirty years ago, which was a very positive move. It has facilitated the mobility of academics. All the other member states have a tenure system, which tends to promote inefficiency.

**Strategic approach 6: ERA of cohesion across the continent**

We will know the ERA is cohesive in 2030 when we see:

- The share of the EU budget devoted to research triples to 12%.
- At least 30% of the structural funds are used exclusively for research and technology development (including fostering partnerships, supporting pre-commercial procurement and investing in large-scale research infrastructure where needed) – double the current allocation.
- More than 75% of the overall EU budget is oriented towards investing in its future as a knowledge-based society.
- The major research institutions of the well-developed regions of Europe work in partnerships, based on excellence, with those of lesser developed regions.
National Advisory Council on Innovation

- Half of the adult population has achieved tertiary education – double today’s rate.

With respect to cohesion, a number of the EU member states are disadvantaged, for example, Bulgaria and other parts of Eastern Europe. The problems have to be addressed if social unrest is to be avoided. Some of Europe’s problems are thus similar to those of South Africa. The idea is that less developed institutions will be twinned with more sophisticated ones. Structural funds will be used to enable one or two institutions per member state to come up to standard, with the ambition of becoming globally excellent.

Specific recommendations for meeting the milestones include:
- Funding for public, non-military research is increasingly concentrated in research-intensive institutions:
  - A restricted number of European research institutes with enough critical mass for research and an ambition of global excellence is agreed on
  - The potential of locating infrastructures in countries that have a deficit of representation in top-ranked institutions should be explored also through the use of structural funds.

Conclusion
- ERA should look to where it adds value in the global environment. Member states control 95% of the arch spend.
- Research training in the virtual research environment needs urgent attention if the Grand Challenges are to be effectively addressed.
- An international ‘Davos’ type meeting (of research decision-makers) is proposed to agree global research activity, including investment and the location of international research infrastructures.
- Researchers, politicians and the general public must own the benefits.

Urgent action is needed to address the Grand Challenges.

“The world’s great day is growing late!” (One Foot in Eden, Edwin Muir)

Top-class research infrastructure inspires the younger generation.

QUESTIONS AND DISCUSSION

Dr Lennon thanked Prof. Wood for his presentation and remarked on the similarities between Europe and the challenges facing South Africa.

Prof. Pouris: It was stated that large resources are allocated to excellent universities. Is that not considered anti-democratic in Europe?

Prof. Wood: Sometimes it is not possible to be completely democratic. We are looking to cluster universities, with one dominant university linked to others in the form of a hub and spoke model in order to raise the standards of others. In the US, only a few universities train researchers. The University of California, for example, has ten campuses, but not all conduct research. We cannot continue to spread funding thinly. Each university should decide what it is good at and what its mission should be, which might be at the local, national or international level. We do not have enough money not to follow this approach.

Prof. van Zyl: In light of the need to integrate the very asymmetric scientific environment in Europe, I am interested in your views on the ethics of collaboration, which prevents one partner from being denigrated to a collector of samples while another conducts the research. This is particularly relevant to South Africa in North–South as well as South–South collaboration.

With respect to rankings, are you considering moving away from a system based on subjective evaluation by peers to something that is more measurable, not only in terms of research output but also in terms of teaching and community engagement?
Prof. Wood: One metric does not fit all institutions. Alain Pompidou, former head of the European Patent Office, who is on the ERAB Board, has particular views on this. There is an example of senior members of staff of a university being sacked after the university's ranking on the Shanghai Index dropped, and the ranking system may drive an institution to 'buy' a Nobel prize-winner for example, to increase its ranking. There is a need for multidimensional metrics, which gives the university the opportunity to decide what its metric will be and then benchmark against its peers. If a university's priority were teaching, for example, it could be evaluated as excellent in that area. The current metrics are not fit for purpose.

With respect to the ethics of collaboration, the proposed ethical code for researchers would play an important role. A project proposal to the last round of the European Framework Programme was turned down because the project would not have served to aid the developing country partner, which would simply have been reduced to collecting samples. The proposed Davos type agreement would come into play in determining the nature of collaborative relationships.

Dr Mjwara: One of the comments was based on the assumption that knowledge would be freely available and the challenge would be how to use it. However, you cannot exploit what you do not understand.

Prof. Wood: I used to chair a charity, which made records of science available to emerging countries. The issue is to ensure that people know what information is available, as well as that it should be accessible in a way they understand. Political will is required for this. However, researchers can always hide their data by using a format or code that makes it difficult to access. The Wellcome Trust makes it a condition of awards that data should be made available, but the onus is on the university to provide the access, and most are not taking steps in that direction. We are looking at a European data store to ensure that data are available and the portal is known. The issues are openly debated, but some are reluctant to allow other countries such as China to access the data. The UK is talking of training data scientists, who are different from librarians. At present, people get into such positions by chance, rather than being trained. We are considering masters degree programmes in this area.

Dr Mjwara: This raises the issue of whether we need to retrain PhDs by adding a year for training in other skills. PhD training has evolved over time. In the past, doctoral students would have spent considerable time designing and manufacturing equipment and getting it to work, whereas now they only have to do the analysis. This leaves more time for training in other skills.

Prof. Wood: There is still room for individual small-scale science at PhD level. Only about 20% would operate on an international level in the global environment. The European University Association is looking more at doctoral training in graduate schools.

Prof. Petersen: What are your views on how public–private partnerships are integrated into university research? It was argued that research should have far more impact, as required by stakeholders. In that context, there is still room for bottom-up research, but to a lesser extent, and research should be more directed. How would the work of research institutes be integrated into university research agendas?

Prof. Wood: We are seeing the doubling of funding for basic research that is curiosity driven. We are not arguing for more funding for more integrated research but for the redirection of funding. High-risk individual research is being supported to a greater extent.

Researchers in research councils get guaranteed funding and tend to become too comfortable. There is only a 2.5% staff turnover at the Rutherford-Appleton laboratory, for example, which is unhealthy.

I favour the US model, where good project management companies are used to run projects in association with universities, with a consortium of shareholders.

In order to encourage public–private partnerships, pension, career and promotion barriers have to be broken down. If an academic takes five years off from university to work in industry, their promotion prospects are harmed.
I used to tell my staff that when approaching a company as a potential partner, they should know the share price as well as the CEO’s hobby, and they should approach the marketing department, which controls large funding and is concerned with the credibility of the product line.

Another crucial issue is to know the strategic direction of any company with which one wants to form a partnership, even if this requires the signing of a confidentiality agreement. Students need to understand what is important. Commercial research can be exciting, as it delivers what is useful, but mutual trust between the partners is important.

**TABLE DISCUSSIONS**

Each table was asked to consider the following questions:
- Increasing the quantity, quality and relevance of South African PhD and moving South Africa to the PhD plus
- Transitioning the Grand Challenges to grand actions
- Key enablers with respect to innovation infrastructure.

**FEEDBACK FROM TABLE DISCUSSIONS**

Table 1 (Rapporteur: Mr Geoff Rothschild)

*Increasing the quantity, quality and relevance of South African PhD and moving South Africa to the PhD plus*

South Africa does not do have enough PhDs teaching at universities. Universities lack on PhDs on their staff. There is a desperate need not only to train staff to supervise but to get their PhDs. The country should embark on a national programme to upgrade academic staff. There was a strong feeling that PhD programmes need to change.

Institutions should be suitable for doing PhD work. The university structure was discussed, as well as whether certain universities should be fulfilling different roles from those which they undertake today, in other words, whether some should be feeder institutions to bigger research universities.

An international dimension is needed. Institutions should not be static. People grow by moving around, both internationally as well as within the country. A static teaching profession is destructive.

It was suggested that ten top researchers be brought together, and that a champion should be found to promote how the structure should change. Perhaps an upcoming catalytic event (possibly the SKA) should be used to bring about a change in mindset.

It was noted that South Africa has many top researchers, but they do not have the opportunity to speak to the president, as was done in the UK. If this were to be done, it would show the government that South Africa has top researchers and give young people the passion and enthusiasm to do even better.

The first step in moving towards the PhD plus is to address the issues that affect the PhD.

*Transitioning the Grand Challenges to grand actions*

Transitioning Grand Challenges to grand actions should be approached by getting people together and working out how to do it with the people that actually work at the ‘coalface’.

*Key enablers with respect to innovation infrastructure*

Innovation infrastructure should be addressed by structuring universities differently in a way that is acceptable to the government authorities so that it is not perceived as a barrier or as reverting to the apartheid era.
Table 2 (Rapporteur: Prof. Arnold van Zyl)

**Increasing the quantity, quality and relevance of South African PhD and moving South Africa to the PhD plus**

The centres of excellence and SARChI research chairs are good initiatives for focusing research at universities, which have brought together good students in areas that are unique to South Africa, and for which South Africa has a very special laboratory in its back yard, for example, tuberculosis, biodiversity and catalysis. The good PhDs in South Africa are coming from institutions where there are centres of excellence, which are drawing in an international cohort of researchers.

It was suggested that every new PhD student should be assessed with respect to his/her research needs, and that generic research training be provided through a doctoral academy, where students’ generic needs in research methodology and statistics can receive attention before the student starts his/her detailed PhD studies. This would take students out of libraries and give them the necessary tools. It would also give them a sense that they are not alone, since doing a PhD is a very lonely endeavour. A doctoral academy would provide an important social space and network where students could meet and engender transdisciplinarity. The idea of exposing cohorts of students of different disciplines to the doctoral academy was also suggested.

**Transitioning the Grand Challenges to grand actions**

**Key enablers with respect to innovation infrastructure**

It is important to converge the goals of the Grand Challenges, which are a DST-specific set of goals, with the Mid-Term Strategic Framework goals set by the Presidency so as to lift awareness of what researchers and academics, as innovation workers, can contribute nationally.

One way that has worked well in Europe to transition Grand Challenges into grand actions is by funding consortia that look at problems or challenges, rather than funding excellence at a university or industry level. From the EU experience, one of the outputs of such collaborative projects would be to serve policy goals and address the way in which knowledge is transformed into policy. Funding large consortia would also address the issue of innovation infrastructure, because in that way the three layers of government, academia and industry would be forced together.

Table 3 (Rapporteur: Prof. Francis Petersen)

**Increasing the quantity, quality and relevance of South African PhD and moving South Africa to the PhD plus**

Issues of quantity and quality were discussed in relation to the PhD plus. Supervisory capacity is an issue that could be addressed by means of co-supervision from institutions other than universities, such as the science councils. By being novel and innovative, it might also be possible to utilise industry for co-supervision.

A more fundamental question is the need for a bold intervention. With respect to the issue of affordability, differentiation in higher education might need to be considered, and whether those institutions that have high numbers of PhDs on their staff and are strong in research should focus on producing PhDs, while other higher education institutions focus on different areas in which they are strong.

With respect to the PhD plus, co-supervision with industry, particularly multinational industries, would introduce an international dimension and ideas from outside South Africa.

**Transitioning the Grand Challenges to grand actions**

Various approaches should be tried, although not all would work. On the issue of converting research results into policy, it was noted that this is an area of weakness in South Africa and other countries. It is difficult to get politicians to appreciate the implications of research findings.
Policy in itself does not guarantee action or implementation. From that perspective, it is important to understand who the stakeholders are that will absorb the outcomes of research. It is important to try to work with them rather than for them, whether they are industries or communities. Science action research with stakeholders is critical.

Key enablers with respect to innovation infrastructure

The key issue is to share, share, share. Government interventions in the form of centres of excellence, centres of competence and research chairs have contributed extensively, although in limited areas, to researchers sharing with one another. Such approaches need to be extended, so that by bringing researchers together to share equipment, they create value for their research and innovation.

CONCLUSION

Dr Lennon thanked participants for their useful ideas, some of which could be further developed. NACI could feed these ideas into its work on innovation infrastructure, the atlas of excellence and alignment with the strategic priorities of the country, as well as innovation and development.

Dr Lennon thanked Prof. Woods for sharing his experience in a way that was both informative and entertaining, as well as for and catalyzing rich discussions. He thanked the NACI secretariat for the arrangements and all participants for their ideas and suggestions towards making a difference in South Africa.

Prof. Woods expressed his support particularly for the idea of a doctoral academy.
### APPENDIX A: ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>CD</td>
<td>Compact disc</td>
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<tr>
<td>CEO</td>
<td>Chief executive officer</td>
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<tr>
<td>CERN</td>
<td><em>Organisation Européenne pour la Recherche Nucléaire</em> (European Organisation for Nuclear Research)</td>
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<tr>
<td>CLARIN</td>
<td>Common Language Resources and Technology Initiative</td>
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<tr>
<td>DST</td>
<td>Department of Science and Technology (South Africa)</td>
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<tr>
<td>EISCAT</td>
<td>European Incoherent Scatter Scientific Association</td>
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<tr>
<td>EIT</td>
<td>European Institute of Innovation and Technology</td>
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<tr>
<td>EMSO</td>
<td>European Multidisciplinary Seafloor Observatory</td>
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<tr>
<td>EPOS</td>
<td>European Plate Observing System</td>
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<tr>
<td>ERA</td>
<td>European Research Area</td>
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<td>ERAB</td>
<td>European Research Area Board</td>
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<td>ERI</td>
<td>European Research Infrastructure</td>
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<td>ESRF</td>
<td>European Synchrotron Radiation Facility</td>
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<td>ESI</td>
<td>European Strategy for Research Infrastructure</td>
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<tr>
<td>ETH</td>
<td><em>Eidgenössische Technische Hochschule</em> (Swiss Federal Institute of Technology)</td>
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<td>EU</td>
<td>European Union</td>
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<td>EUFAR</td>
<td>European Facility for Airborne Research</td>
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<td>FEAST</td>
<td>Feasibility Study for Africa–European Research</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>HPC</td>
<td>High-performance computing</td>
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<tr>
<td>IAGOS</td>
<td>In-service Aircraft for a Global Observing System</td>
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<tr>
<td>ICOS</td>
<td>Integrated Carbon Observation System</td>
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<tr>
<td>IPR</td>
<td>Intellectual property rights</td>
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<tr>
<td>NACI</td>
<td>National Advisory Council on Innovation</td>
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<td>NMR</td>
<td>Nuclear magnetic resonance</td>
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<tr>
<td>PPP</td>
<td>Public–private partnership</td>
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<tr>
<td>PRACE</td>
<td>Partnership for Advanced Computing in Europe</td>
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<tr>
<td>R&amp;D</td>
<td>Research and development</td>
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<tr>
<td>S&amp;T</td>
<td>Science and technology</td>
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<tr>
<td>SARChI</td>
<td>South African Research Chairs Initiative</td>
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<td>SIOS</td>
<td>Svalbard Integrated Arctic Earth Observing System</td>
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<td>SNS</td>
<td>Spallation Neutron Source</td>
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