

Science Investment Process Broad Direction Setting

Advice to Executive Management Council 12 September 2005

Introduction

The breadth and complexity of challenges and opportunities facing society require us to make carefully considered choices of where to focus our research capability to maximise our contribution to society. The modest size of the Australian innovation system also requires tough decisions on where to invest finite research resources while maintaining the quality and distinctiveness of our science in a globally competitive environment.

CSIRO is taking a long term perspective of global science trends and national research priorities, and considering our investment priorities in this context. Key global science drivers/trends have been identified and will provide a series of platform capabilities applicable across multiple areas of our research over the next 5 years and well beyond. These include, in particular:

- Transformational biology involving the assembly of substantial interdisciplinary teams of biologists, mathematicians, physical scientists, engineers and computer specialists to undertake biological research, linking large amounts of data about biological networks, at the molecular and cellular levels, through to populations and ecosystems, leading to increasingly quantitative and predictive frameworks.
- Advanced materials as supported, for example, by developments in nano-science or by new capabilities in combinatorial and high throughput materials science, providing dramatic increases in the efficiency at which new materials are discovered, processed and their utility optimised.
- Large scale sensor networks which see the convergence of micro- and nano-devices, wireless communications and information technologies. These will deliver cost effective ways to support wider deployment of large scale networks of increased spatial and temporal resolution and accuracy. An example application of these networks will be in the investigation of the dynamics of environmental processes to provide data for credible ecological forecasting and prediction and step-changes in natural resource management.

The Executive Team's Broad Direction Setting process has adopted a "precautionary principle" in 2005, recognising that we are working with a new process, but at the same time has provided an indicative set of priorities and challenges with which Group Executives, Flagship Directors and Chiefs can shape a Theme-based response to these longer term priorities.

CSIRO has a strong and credible science base which must be maintained. The proposed changes in focus and emphasis are designed to build on existing capabilities and position our science for the future.

The dual “lenses” of relevance and impact are being applied to the ways in which CSIRO can respond to community and industry challenges to benefit society. In support of these decisions, input from government, industry and the community has been considered and indeed will continue to be considered through appropriate consultation and feedback, as our Science Investment Process develops further and matures.

Consistent threads throughout the ET’s discussion, and in the assessment of outcomes, have been:

- Prominence of the need to harness cross-CSIRO capability (scale and assembly of complementary capabilities), leveraging the significant strategic differentiation from cross-discipline and cross-boundary activities in line with our chosen strategic direction, as articulated in our 03/07 Strategic Plan
- Support for excellence and talent through identification of track record
- An Australian focus to major “BHAG”-like challenges and opportunities and our differentiated capabilities/capacity to deliver against these
- Adoption of a 5+ year perspective; we are setting the scene for our next strategic planning cycle, culminating in the delivery of our 2007-2012 Strategic Plan in late 2006.
- Challenging existing business models for engagement with our industry and community partners in light of the impact delivered - currently and potentially - to those sectors
- Recognition of the core (and other) roles CSIRO plays (as described in “the house”) and the appropriate migration over time to higher impact activities.

This document is a summary of the key outcomes of the Broad Direction setting process. It provides a basis for discussions between Group Executives, Chiefs and Leadership Teams, and as such does not seek to convey the substance of the detailed discussions and assessment of all indicators supporting a criteria-based view of investment choices. It is important feedstock to the refinement of our Theme-based investment proposals and the investment recommendations coming forward into the next phase of the Science Investment Process in late November 2005.

Flagships

CSIRO remains committed to grow the National Flagship Programs to 30-40% of the organisation’s appropriation funding, and build its collaborative linkages facilitated by the wise investment of the Flagship Collaboration Fund.

In identifying the total Flagship funding envelope and priorities within it, for 2006-07, guidance is provided to development of the theme portfolio, involving close partnerships between the Flagship Directors and Chiefs.

- The target funding envelope for 2006/07 will be \$158.1 million of our appropriation, an increase of \$30.1m or 24% over 2005/06. This includes the collaboration fund investment of \$12m in 2006/07.
- This increase is to be primarily directed towards broadening and deepening Divisional involvement in Flagships, including the incorporation of ICT and mathematical sciences - as key enabling and cross-cutting platforms - into the portfolio where their contributions are clearly directed at the Flagship goals.
- Flagship theme development will need to observe the directional signals from the broad direction setting workshop as reflected in the following paragraphs.
- The Flagship Oversight Committee will develop a recommended investment in Flagship theme portfolios facilitated by Flagship Director, Chief and Group Executive consultations
- The Executive Team will determine individual Flagship funding based on the themes presented and forward plans (including roadmaps), performance to-date, FOC's recommendations and alignment with the thematic investment criteria.

Environment

Australians have stewardship of a beautiful, diverse and frequently unique environment. At the same time the cumulative consequences of the last 200 years of development of natural resources leaves us with a legacy of environmental challenges. A positive CSIRO response to these challenges must involve systems understanding, development and application of new technologies and careful balancing of economic development with environmental sustainability.

Firstly, therefore, our R&D needs to contribute new capabilities for managing natural and man-made systems for sustainability. Nobody else will look after the natural assets that give us our sense of being Australian; nobody else in the world will undertake the R&D necessary for their maintenance. Second, our R&D must simultaneously aim at supporting the development of production sectors that are dependent upon those natural assets, so as to minimise their adverse environmental footprints.

In firmly supporting the maintenance of our investment in environmental R&D, ET noted the following points:

- A desire to achieve even greater impact by not only defining problems but also providing solutions across the spectrum of individual resource managers to the policy domain.
- Support for continued development of partnerships and strong relationships with resource users and managers to create desired impact.

ET suggested the following developments:

- Careful consideration of how best to make our contributions in this policy-sensitive domain
- Even greater efforts to integrate with agricultural R&D to reduce environmental impacts, and better inform Natural Resource Management more broadly

- Further development of large-scale sensor networks for application in integrated environmental management, such as in water resource and ocean observing systems.

Plant based agriculture

CSIRO plays an important role in the National Innovation System, having particular capability in modern bioscience and its application to plant based industries. The bio/life science revolution has significant relevance for Australia and the world, and CSIRO has had considerable impact in this area due to its world-class capabilities, quality of its science and the high level of adoption by industry.

However, a careful rethink is needed about the way in which CSIRO best enhances and engages its capability in support of existing agribusiness industries and their necessary migration to new and emerging bio-based businesses. This has begun to be articulated in the Group's strategic intent by focusing on the broader 'bioeconomy' which covers not only traditional food and fibre commodity production but significantly enhanced opportunities offered by modern bioscience for the production of higher value materials and chemicals across various and wide ranging industries.

Specifically, going forward, there will be a need to:

- Place a greater emphasis on matching agricultural productivity with environmental sustainability and its use of valuable natural resources such as water and land.
- Focus on differentiated agricultural products and/or raw materials directed towards higher utility in the value chain.
- Recognise the close relationship of food production with nutrition and longer, healthier and more productive lives of Australians.
- Focus on enhanced investment in the critical and cross cutting area of biosecurity in relation to supply chain integrity, biological diversity and the security of Australia from external invasive species.
- Reduce over time research supporting small incremental changes in agriculture.

To achieve this goal we will continue to build our systems biology capability through greater collaboration and integration with ICT, mathematics and engineering capabilities. While overall resource levels in the area are envisaged to remain constant, investment in plant and forest based agriculture is likely to decrease as the outputs manifest themselves in a number of other areas (for example, further processing, manufacturing, health and the environment). Specific areas of increase in this domain are anticipated to come through growth in the Food Futures and P-Health Flagships.

Animal agriculture

The general recommendations for plant based agriculture are also pertinent to animal agriculture. This area is similarly sensitive to the significant opportunities from the modern quantitative bioscience capabilities across CSIRO which can be leveraged for Australia to compete in the broader bioeconomy. This will be achieved through:

- Redirection towards greater bioscience capability and capacity in animal science
- research to reduce regional biosecurity risks around animal agriculture
- systems biology approaches to new animal based functional materials and chemicals for the wider industry
- research to reduce the environmental impact of animal agriculture and better utilise scarce natural resources.
- alignment of animal based foods with increased knowledge of diet, nutrition and health.

To achieve these goals, building our systems biology approach will require greater collaboration and integration with ICT, mathematics and other related capabilities. Whilst overall investment in the traditional livestock domain will decrease over time, it is envisaged that outputs of animal based science outlined above will manifest themselves through other areas eg food, health and the environment. Specific areas of growth in these domains are also envisaged to come through growth in the Food Futures and P-Health Flagships.

Food, Fibre and Textile manufacturing

Consistent with the framework of the precautionary principle operating in the 2005/06 Science Investment Process round, investment in Fibre and Forestry will be maintained while strategies are being developed over the next 12 months as new leadership teams and structures establish themselves.

Food is an area with increasing significance for Australia and the world. Of particular importance is the relationship between food, diet and health and the relevance of diet in mitigating obesity and preventing or protecting against certain chronic diseases. CSIRO has significant capabilities in materials and biology which both have impact in this domain.

It was felt that whilst no additional appropriation investment would be targeted at this area, there would be an increase in the proportion of CSIRO activity as it integrates capabilities in other areas and with even greater support from industry partners. Specific areas of growth will also come through an increased focus on value-add products through growth in the Food Futures and P-Health Flagships as well as in applications of biosecurity.

Human Health

While it was recognised that this area is very important to our national interests and the vital role R&D plays, there were issues raised concerning the impact and scale of our activities in the context of the large body of expertise and prevailing medical and therapeutic research residing in other agencies both here in Australia and overseas. It was felt that continued focus on areas of strength is required to maximise impact.

With many other R&D players locally and internationally supported by huge investments from the major pharmaceutical companies involved, it is considered that our world class structural biology skills be redeployed to further develop our

bioscience and materials platforms. Therefore our efforts in drug discovery should be exited over an appropriate timescale.

Our central focus in the area should be preventative health, which will be increased in the portfolio.

- The portfolio should also maintain work in diagnostics, vaccines and materials for medical devices.
- Health informatics remains an important area.
- The P-Health Flagship should be increased but its portfolio must be even more focused.

Overall investment in the areas is to be maintained or grown modestly facilitated by the P-Health Flagship.

Chemicals and Materials

This is an important contributor to the Australian manufacturing industry and an area (particularly in polymers) where CSIRO has had success in the past and has excellent capability and capacity across a number of Divisions. Materials research is widely acknowledged as one of the current “hotspots” of science and as a result, there is considerable competition world wide for breakthroughs in this domain. Australia and CSIRO have to carefully select and focus on areas of high potential. We need to;

- Better integrate, coordinate and refocus of our materials capability across the breadth of CSIRO to leverage our advantage in the confluence of physics, biology and chemistry
- Review and improve the delivery mechanisms.

It is likely that overall investment in the area will increase due to application of materials capabilities and platforms from other areas, subject to the outcomes from our Manufacturing Review.

Security is an issue which spans a large number of the impact areas discussed, from instrumentation to biosecurity. ET continued to support our current coordinating response to the Safeguarding Australia National Research Priority through the Secure Australia MXDP. Investment levels are dependent upon collaboration with other members of the NIS.

Minerals and Metals

Clearly, this domain forms a critical part of Australia's economy; its role in maintaining our balance of trade is pivotal. R&D has had a significant role in supporting this success.

At present the industry is enjoying record profits as a result of the resources boom. Our relationship with this truly global industry is at a watershed and we need to

continue to develop new business models with early engagement, higher levels of transformational R&D in the portfolio and higher levels of industry investment to ensure higher levels of Australian capture of benefits.

It was decided to do further work on the implications of different models for industry engagement prior to any decision to change investment levels in the minerals and metals domain.

Energy

Energy is a key determinant of Australia's future economic growth. On a world scale, Australia has abundant reserves of coal and natural gas, although our oil reserves are declining. We have among the lowest energy costs in the developed world - but we also have the highest greenhouse emissions per GDP for what we produce. Recognising this, energy reform is high on the agendas of both Federal and State Governments.

Major elements of CSIRO's research focus beyond exploration and extraction include raising the efficiency of clean coal electricity generation technologies to develop low-emission energy technologies and systems that lead to the widespread use of hydrogen as an energy carrier across the economy. This will require transformational science in areas as diverse as coal gasification, membrane gas separation and gas processing leading eventually to large scale hydrogen production along with capture and sequestration of CO₂ to provide low emissions electricity.

ET recognised the following points:

- Solutions to challenges in energy extraction, generation and processing inevitably involve substantial capital expenditure and engineering constraints through infrastructure development
- The policy environment must be carefully taken into account
- There are many public and private interests world-wide making far greater investments than CSIRO in energy R&D; hence, our distinctiveness and competitiveness must be carefully examined, particularly in energy generation, conversion and renewables.

ET concluded the following:

- We should maintain our investment in research into upstream exploration, extraction and processing of coal, gas (methane economy) and oil
- We should maintain our investment in electricity generation, distribution, and end use efficiency, subject to performance, and our commitment to longer-term transformational science through the Energy Transformed Flagship contributing to the development of the hydrogen economy.
- We should reduce our effort in intelligent transport systems
- We should reduce our effort in renewable energy restricting our activities to those in which we have competitive advantage and can have significant impact

Information and Communication

Information and Communications Technology (ICT) is central to the development and growth of all industry sectors. However, in delivering to the information and communication industry (ICI) per se, it is clear that global competition is intense and scale is a factor. It is recognised in Australia that a number of universities and other research agencies (e.g. NICTA) are very active in this sector. To support continued productivity growth more broadly, we in CSIRO will:

- Focus progressively our ICT efforts in applications that link with other industry and community areas, building particularly on CSIRO's expertise and domain knowledge in other key sectors.
- Shift away from the current approximate 50:50 ratio of generic ICT research:other industry by increasing support of applications in other sectors.
- Deploy additional resources in line with increased demand for ICT input from close partnerships in other sectors.
- Our core leadership advantage in wireless is recognised and will continue to be supported.

The net effect will be to decrease our specific contribution to generic ICI products and services, but increase more our ICT contributions in other areas. It is anticipated that during the process of Theme development within a number of Divisions, ICT requirements will be explicitly identified and developed in partnership with the ICT Centre and others contributing to ICT initiatives.

As previously mentioned, the Flagships in particular will present important growth opportunities here. A similar philosophy also applies to more broadly leveraging our capabilities in mathematical analysis, modelling and simulation and large data set management.

Radio Astronomy

The importance of Radio Astronomy as a leading science initiative in Australia was recognised. Support of the Australian Telescope National Facility (ATNF) as a research facility, and the world class research that CSIRO undertakes using the ATNF, are intimately interlinked

The Square Kilometre Array (SKA), and its forerunner the xNTD, are seen as key planks of Australia's determination to remain at the forefront of radio astronomy. It was noted that progressing the SKA proposal will require significant input from existing resources, and if ultimately successful, additional investment.

Equipment & Instruments

Elaborately Transformed Manufactures (a term that covers for example fabricated metal products, machinery, cars, planes) has one of the highest growth rates in the economy and continually demands technology innovation. CSIRO can contribute to

this innovation, however we must recognise the massive investments being made globally by others (e.g. in the automotive industry). Therefore in areas where we are non-competitive or have little chance of impact, we will reduce investment, and where we remain active to meet local industry demand, we will seek greater co-investment and early partnering.

Therefore in developing themes in this area, it will be important to:

- Focus and bring greater coherence to our existing R&D
- Demonstrate our distinctiveness and impact
- Clearly identify the partnerships and business models through which technology uptake will occur

A small sub-set of this sector is instrumentation. Measurement and instruments are central to our research, and sometimes offer an opportunity for commercial development. There is increased integration in our investment in instrumentation, recognising that servicing our science need does not always translate to success in the market place. Whilst niche opportunities may present themselves it is anticipated that we will maintain our overall appropriation investments in this small element of this sector, with possible increased levels of co-investment.

Infrastructure; and Commercial and Community Services

Each of these sectors represent major components of the Australian economy with significant potential for innovation through science and technology, but there is significant competition overseas. However in the absence of a unifying and clear national challenge there was uncertainty as to CSIRO's relevance and impact.

In the absence of a full analysis, it was agreed to exercise the precautionary principle and maintain current investment levels pending a review of each area within the next few months. Infrastructure Services will be included in the scope of the existing review of manufacturing and will be included for consideration for the forthcoming CMIS Science Review.

In the interim, in developing theme proposals for these sectors it will be important to:

- Focus and bring greater coherence to our existing R&D
- Demonstrate our distinctiveness and impact
- More clearly identify the pathways by which technology uptake would occur
- Identify how existing capabilities (e.g. in mathematics) might be applied to other sectors

In particular for financial services, the impact of supporting this sector needs to be balanced against the opportunity costs of using our valuable mathematical skills to support other initiatives across the organisation, particularly in the context of the many other players supporting developments here and internationally.

In Summary

CSIRO has a strong and credible science base which must be maintained. The proposed direction settings are designed to build on our existing strengths and take advantage of global advances in science areas such as the biosciences, ICT and materials sciences to open up new opportunities for CSIRO.

The following sets the longer term priorities and challenges with which Group Executives, Chiefs and Flagship Directors can shape a Theme-based response.

- Increase flagship funding in 2006/07 to \$158.1 million of our appropriation, an increase of \$30.1m or 24% over 2005/06.
- Systems biology, sensors and materials science were identified as broad platforms that will grow and contribute to many priority areas
- Strengthen our research on the environmental challenges facing Australia, including sensor networks for integrated environmental management
- Greater emphasis on matching agricultural productivity with environmental sustainability, reducing research supporting small changes in productivity
- Refocus on differentiated agricultural products of higher value
- Restrict our research in health to preventative health, including the relationship of food with nutrition and healthier lives for all Australians.
- Enhance our investment in biosecurity and continue our support of broader security issues.
- Maintain investments in Forestry and Fibre research as new leadership teams and structures establish themselves.
- Materials research is a “hotspot” in which we have areas of competitive advantage and we will refocus elements of our physics, biology and chemistry to grow this area
- Further work on the business model and industry engagement is required before any change to investment levels in the minerals and metals area
- Maintain our investment in research into upstream exploration, extraction and processing of coal, gas and oil
- Maintain our investment in electricity generation, distribution, and end use efficiency; and commit to longer-term transformational science through the Energy Transformed Flagship
- Reduce our effort in intelligent transport systems and restrict our activities in renewable energy to those in which we have competitive advantage
- Broaden our ICT efforts in applications that support other industry and community areas, growing investment in areas of increased demand and reducing generic ICT research, except in areas of world leadership, e.g. wireless.
- Our capabilities in mathematics will be more broadly and deeply integrated with science delivering to CSIRO priority areas including Flagships.
- It was agreed to maintain the current level of investment in both the ATNF and our astronomy research, noting a successful SKA proposal will require additional investment.
- Elaborately Transformed Manufactures; Infrastructure; and Commercial and Community Services are major components of the Australian economy. We will review our existing R&D over the next few months, noting the importance of demonstrating our distinctiveness and impact.