Policy Note
The Importance of Basic Research

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Key Points
- In the context of a government eager to find budget savings, it is not surprising to see questions arise about the efficacy of funding basic research.
- However, in reality, the relationship between basic research and applied research is symbiotic in nature; both are necessary for the creation of breakthrough discoveries.
- But the value of basic research goes beyond just the potential for commercial gain. It extends our curiosity, develops our understanding of human nature and helps us arrive at insights that can have practical significance in areas such as law, politics, or any form of decision making.

Introduction
Over recent months a debate has been emerging on how the government can best allocate its funding support for research. Though research projects themselves vary considerably, Australia’s efforts to develop new knowledge can be classified into two broad streams:  

1. **Basic**: experimental and theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. The Australian Bureau of Statistics further divides this into *pure* (conducted with no specific outcome in mind other than the advancement of knowledge) or *strategic* (intended to provide the broad base of knowledge necessary for the solution of recognised problems); and

2. **Applied**: original work undertaken to acquire new knowledge with a specific practical aim or objective in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new ways of achieving some specific and predetermined objectives.

In the context of a government eager for savings, it is not surprising to see questions arise about the efficacy of funding basic research. Why support curiosity-driven investigations when there are many already identified problems that could provide significant commercial and economic returns if solved? Cynicism about the relevance of basic research projects, such as investigations into the morality of climate change or medieval emotions in Europe, might make for popular news articles, but they also reveal a lack of understanding of how blue sky exploration and practical discovery are inextricably linked. As noted recently by Professor John Rice:

> In both the European and US contexts, universities that harbour pure researchers often form the anchor of important industrial districts. It is in pure research that academics and applied scientists develop the skills that they will later apply to develop innovations. It is impossible to sustain the suggestion that applied research and patenting can occur in the absence of the technical literacy that pure research engenders…
> The notion that you can skip to the commercialisation stage in the absence of a supportive knowledge base is nonsense.

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1. Frascati Manual, 2002, p.30; Australian Bureau of Statistics (2010). Both sources also recognise a third category of research, *experimental development*, which draws on existing knowledge gained from basic or applied research to create new materials, products, services or systems.
2. Karvelas and Perpitch (2012)
3. Rice, 2014
And this is not only recognised by academics. In 1996, a group of Chief Executive Officers of some major US companies pleaded with President Clinton not to cut back on university research (see Attachment 1), even though the pathway from basic knowledge to commercial outcomes is rarely simple or linear, and short term results cannot be guaranteed.4

But basic research also brings many more significant contributions to Australia’s social and economic success than just discoveries with commercial potential. This paper aims to explore some of these issues, with the intention of making explicit the importance of basic research to Australia’s ongoing prosperity.

Basic and Applied Research: A Symbiotic Relationship

The relationship between basic and applied research is essentially symbiotic in nature. In the same way that bees rely on pollen to produce honey, and plants rely on bees to spread their pollen, applied researchers rely on basic research for the discoveries with which to create new products, and basic researchers rely on applied work to make use of what they find.

In recent years Australia has seen several breakthrough findings of national and international significance which had their origins in little more than the curiosity of researchers. Examples include:

The Gardasil Vaccine
Professor Ian Frazer came to Australia in 1980 to pursue studies in viral immunology and autoimmunity. From an initial, curiosity-driven interest in exploring virus-like particles, Frazer and colleagues were able to develop the Gardasil and Cervarix vaccines against HPV related cancers.5 These have the potential to save 250,000 lives annually, and have been distributed to 120 countries around the globe.6

Locusts and Human Obesity
In investigating why locusts swarm, Professor Stephen Simpson noticed that the insects were unexpectedly refined eaters. Further research into this sideline observation led to the discovery that separate appetites exist for protein, fat and carbohydrate, and that protein appetite ‘wins’ over other nutritive types. From here, Professor Simpson established that a lack of protein in the diet will result in a tendency for many creatures, including humans, to over-eat until this is satisfied, even if a surfeit of carbohydrate or fat is already being consumed. This leads to an excess energy intake and weight gain, giving greater insight into human obesity and how it might be treated and prevented.7

Helobacter Pylori and Stomach Ulcers
Barry Marshall’s school grades “always suffered because I was continually mucking about with irrelevant side issues which I often found to be more interesting”.8 But it was precisely this chance to investigate “previously undescibed bacteria living in the acid-filled stomach”, which struck him at the time as nothing more than an “interesting thing to study”, that resulted in co-discovery of the critical role of Helicobacter pylori in stomach ulcers and a Nobel Prize in Medicine.

The Nature of Discoveries Made from Basic Research

The work of Simpson and Marshall stand as clear examples of the unpredictable and maverick nature of discovery. As Simpson states “If I was a young graduate student going to a funding agency and I was to sit down and say I’m really interested in trying to uncover something really new and important about the obesity epidemic, I want to study locusts, I would have been out the door within seconds”.9

Similarly, Marshall experienced resistance even from within the academic community:10

1984 was a difficult year… When the work was presented, my results were disputed and disbelieved, not on the basis of science but because they simply could not be true… I was told that the bacteria were either contaminants or harmless commensals.

6 Go8 Newsletter, July 2014
Yet it is this very unpredictability that lies at the heart of revolutionary discovery; by their very nature, breakthroughs would not be breakthroughs if they were predictable on the basis of current knowledge. As Simpson explains: “an unconventional beginning can lead to an unconventional but important solution to a problem that more conventional approaches have perhaps failed to solve”. 11

And this is the problem with basic research from an economic perspective: it is maverick in nature. It is often impossible to predict at the outset where the results will lead, and not every project that is funded will reflect the results of Marshall, Simpson and Frazer. This can leave it open to accusations of wastefulness and irrelevance. However, what is certain is that without basic research efforts there will be no fundamental findings from which such breakthroughs can occur.

Attempts have been made to increase public awareness of the importance of basic research. In the United States, the Golden Goose awards were established to satirise the Golden Fleece, a prize created by Senator William Proxmire to poke fun at studies he considered to be a waste of taxpayer’s money.12 Far from lampooning such work, the Goose awards “demonstrate the human and economic benefits of federally funded research by highlighting examples of seemingly obscure studies that have led to major breakthroughs and resulted in significant societal impact”. 13 Recipients include:

- Mathematicians David Gale and Lloyd Shapley: their initial work into “College Admissions and the Stability of Marriage” examined optimal models for pairing couples into stable relationships. Economist Alvin Roth used their findings to design a kidney matching program that optimised the matching of donors and recipients and won him a Nobel Prize in Economics;14

- Thomas Brock and Hudson Freeze, whose curiosity as to how certain types of bacteria survive in the volcanic geysers of Yellowstone National Park led to “accurate genetic tests for a wide variety of diseases and conditions, advanced forensic science to analyse crime scene evidence, and helped make possible the sequencing of the human genome”15 and

- John Eng, whose interest in studying animal hormones eventually led to the discovery of a compound in Gila Monster venom that can be used to regulate insulin levels in diabetes sufferers.16

Similarly, the Ig Nobel awards use humour to explain how research projects that might seem frivolous at first can play an important role in advancing the sum total of human knowledge. As the website states: 17

Our goal is to make people laugh, then make them think. We also hope to spur people’s curiosity, and to raise the question: How do you decide what’s important and what’s not, and what’s real and what’s not – in science and everywhere else?

To help promote the significance of these projects, the Ig Nobels are hosted each year at Harvard University, with recipients invited to give public lectures on their work at MIT. 18

### Commercialisation Opportunities

The significance of basic research in the innovation and discovery process does and should not undermine the importance of applied research. When Industry Minister Ian Macfarlane mused recently that commercialisation measures such as patents could be included in the research funding formulae, his focus was squarely on producing marketable products that could lead to jobs.19 But trying to encourage innovative, breakthrough products without the basic knowledge required to create them, however well intentioned, is like trying to build a cathedral without first laying the foundations.

Recently released statistics from the Department of Industry show trends in expenditure on research and development activities in Australia over recent years. Though spending on pure and strategic research has increased in dollar amounts since 1992-93, in percentage terms there is a clear trend away from basic research and towards applied or experimental (Figure 1). In 1992-93, basic research accounted for around 28% of gross

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12 Malakoff, 2012
13 http://www.golden gooseaward.org/about-us/
14 http://www.golden gooseaward.org/portfolio-view/2013-social-science/. Roth and Shapley also received a Nobel Prize in economics on this basis of this work: http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2012/press.html
17 http://www.improbable.com/about/
18 http://www.improbable.com/about/
19 Bita, 2014
expenditure on research and development; by 2010-11 it is estimated to have fallen to 20.6%. If this balance
tips too far opportunities to capitalise on the findings of research may suffer, potentially limiting the very
commercialisation opportunities and potential for jobs growth that the minister wishes to pursue. In contrast, in
2012 South Korea announced plans to increase total expenditure on research from 4% of GDP in 2011 to 5% by
2017, with 40% of that amount to be invested in basic science by the same date.

Figure 1: GERD by Type of Activity, 1992-93 to 2010-11. *2010-11 data are estimated based on data sourced
reportsandstudies/Documents/AustralianKeyInnovationIndicatorsDataCard.pdf

Addressing the Issues

An additional danger of using funding formulae as a lever to preference applied over basic research is that
universities could end up simply taking over or replicating activities that are better performed by industry. While
it is certainly important to facilitate the transfer of knowledge from researchers to businesses, publicly funded
research institutions have a responsibility to perform the type of research that has broad public benefit but that
does not fit neatly within the remit of the private sector. As noted in the recent Commission of Audit:

…not all of the benefits from research can be captured by the innovator, with some benefits ‘spilling over’
to later researchers or adopters. These positive spillovers mean that some research that would benefit
the overall economy may not be undertaken by business, as each individual business would not receive a
sufficient return… Basic research has wider benefits and is less likely to be undertaken by the private sector.

Without the discoveries that arise from curiosity-led, blue sky research new products and industries can’t evolve
to create the jobs and businesses of the future. And without these jobs and businesses, Australia will struggle to
compete in a global knowledge economy.

The Benefits of Basic Research: Beyond the Commercial

Basic research also produces many important outcomes, often of considerable economic importance, that have no
direct commercial significance. Discoveries in seismology, vulcanology and meteorology, for example, can provide
the understanding needed to reduce the impact of natural hazards, saving billions of dollars (and thousands of
lives) globally. Lifestyle changes resulting from health research can mean people live longer, happier lives and
are able to stay productively in the workforce for longer (and be more effective while they are working) adding to
national productivity and decreasing national expenditure on health interventions. Studies of history, languages
and comparative theology provide the background and intelligence that can help understand local and global
conflicts and provide insights about possible ways to intervene. They also, along with the creative arts, generate
and present the narratives that help create social cohesiveness and the tolerance that comes from being able to
look at issues through perspectives different from one’s own.

20 Australian Key Innovation Indicators, 2014. “Basic” research is used here to refer to both pure and strategic research.
21 Park, Soo Bin, (2012)
22 Trounsen, 2014
23 Commission of Audit, 2014
24 See the following Go8 Policy Notes for further exploration of these issues: Why Australia needs a Domestic Research Effort,
Where Should Governments Invest Their Research Funding, and Increasing the National Benefit from Higher Education
Research.
Basic research also reflects the fact that inquisitiveness is part of what it means to be human. A sense of wonder, insatiable curiosity and the need to understand – these all contribute to the advance of knowledge and to our ability to manipulate the world, to make it more comfortable, more accessible. Basic research extends our curiosity at the human level as well, developing our understanding of what people do and think, of how they do it, why, of whether it is possible to change behaviours or values, of the ethics of doing this, and so on. Philosophy and history are not idle speculations but ways of arriving at insights that can have practical significance in areas such as law, politics or any form of decision making. History can provide a distance and perspective that facilitates a clear-sighted analysis which is not always possible with current issues.

It is tempting, in the current environment of fiscal responsibility, to argue for the importance of basic research on the basis of commercial and economic potential alone. However, it is important to recognise the much broader contributions that basic research makes to human wellbeing, both directly and indirectly. It is also important to recognise that as a developed and prosperous nation, there is an international expectation that Australia will contribute to the generation of knowledge globally. As shown above, the trend is already one of reducing basic research as a proportion of national research effort and the continuation of the trend is likely to impact on Australia's national reputation, making it increasingly difficult to attract the best researchers from overseas. This in turn could limit our research capacity even more.

Conclusion

In an era of increased fiscal constraint, it is all too easy to dismiss basic or blue sky research as frivolous or unnecessary. However, without the curiosity-led research of Ian Frazer, Barry Marshall or Stephen Simpson, Australia would have missed out on the economic, social and medical benefits that resulted from their work. Australia already has a research framework in which both basic and applied research can be conducted, through the existing mix of public and privately funded organisations; the challenge now is to ensure that we maximise linkages between the people and organisations involved in these, rather than realise far too late that we have prioritised one at the expense of the other.

25 For further exploration of these issues see the Go8 Policy Note: Why Australia needs a Domestic Research Effort.
HON. CONSTANCE A. MORELLA of Maryland in the House of Representatives Monday, September 30, 1996

Mrs. MORELLA.

Mr. Speaker, as the Chair of the Technology Subcommittee of the House Science Committee, I am responsible for the technology and competitiveness policy of the United States. A top priority of mine, in that role, is to foster the breakthrough of new technologies and to encourage innovation development, thereby enhancing our Nation’s ability to compete in the global marketplace.

It is clear to me that one of the wisest investments the Government can make is our Federal investment in university research and education. It has been clearly demonstrated through the years that a small investment in the basic research conducted at our Nation's universities reaps large rewards in technological discovery. As we move toward a balanced budget—and we must continue to do so to provide vigorous economic prosperity for our children—we must also maintain our Nation’s leadership in basic research and technology preeminence.

A number of chief executive officers of some of the most prominent U.S. corporations recently sent as open letter to President Clinton echoing these sentiments. This simple letter speaks volumes about the importance of university research and development. I am submitting their letter into the Record and I ask all of my colleagues to read it, so that we can give our Nation’s research and development enterprise the priority it deserves as we consider its funding in future Congresses.

An Open Letter to President Clinton

Dear Mr. President, as you achieve the fundamentally important goal of balancing the federal budget, we respectfully urge you to sustain the government investment in university research and education. We believe these goals are closely related.

Mr. President, as you well know, America’s leadership position in an ever-increasing globally competitive economy has its basis in our technological prowess. Our universities, and the research programs pursued therein, have played a pivotal role in continually advancing our technical knowledge. Equally important, they have produced the very scientists and engineers that allow American industry to compete with nations and cultures throughout the world. The standard of living we enjoy today has, in large part, been made possible by our ingenuity and creativeness and our ability to continually advance and apply technology.

Many organizations within the federal government support the country’s universities. We believe these agencies deserve your personal attention and commitment to modest, but sustained, real growth in programs which invest selectively in university science and engineering research. These programs are essential to our future. History has shown that it is federally sponsored research that provides the truly “patient” capital needed to carry out basic research and create an environment for the inspired risk-taking that is essential to technological discovery. We maintain that the federal government is, and must remain, the primary steward of our national trust in university research.
We know that you face politically difficult choices as you deliberate and ultimately decide which federal programs merit continued support. As you make those choices, we urge you to achieve the deeply entwined goals of a vital and productive society, world leadership in science and engineering, and a balanced budget.

Respectfully,

W.W. Allen, Chairman & CEO, Phillips Petroleum Company;
C. Michael Armstrong, Chairman & CEO, Hughes Electronics Corporation;
Norman R. Augustine, President & CEO, Lockheed Martin Corporation;
John L. Clendenin, Chairman & CEO, BellSouth Corporation;
Robert J. Eaton, Chairman & CEO, Chrysler Corporation;
George M.C. Fisher, Chairman, President & CEO, Eastman Kodak Company;
Robert W. Galvin, Chairman, Executive Committee, Motorola, Incorporated;
Louis V. Gerstner, Jr., Chairman & CEO, IBM Corporation;
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John A. Krol, President & CEO, DuPont;
Edward R. McCracken, Chairman & CEO, Silicon Graphics, Inc.;
Lars Nyberg, Chairman & CEO, NCR Corporation (formerly AT&T Global Information Solutions);
R.B. Palmer, Chairman & CEO, Digital Equipment Corporation;
John E. Pepper, Chairman & CEO, The Procter & Gamble Company;
Lewis E. Platt, Chairman, President & CEO, Hewlett-Packard Company;
Randall L. Tobias, Chairman & CEO, Eli Lilly and Company;
Alex Trotman, Chairman of the Board, Ford Motor Company; and
P. Roy Vagelos, M.D., Former Chairman & CEO, Merck & Company, Incorporated.
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