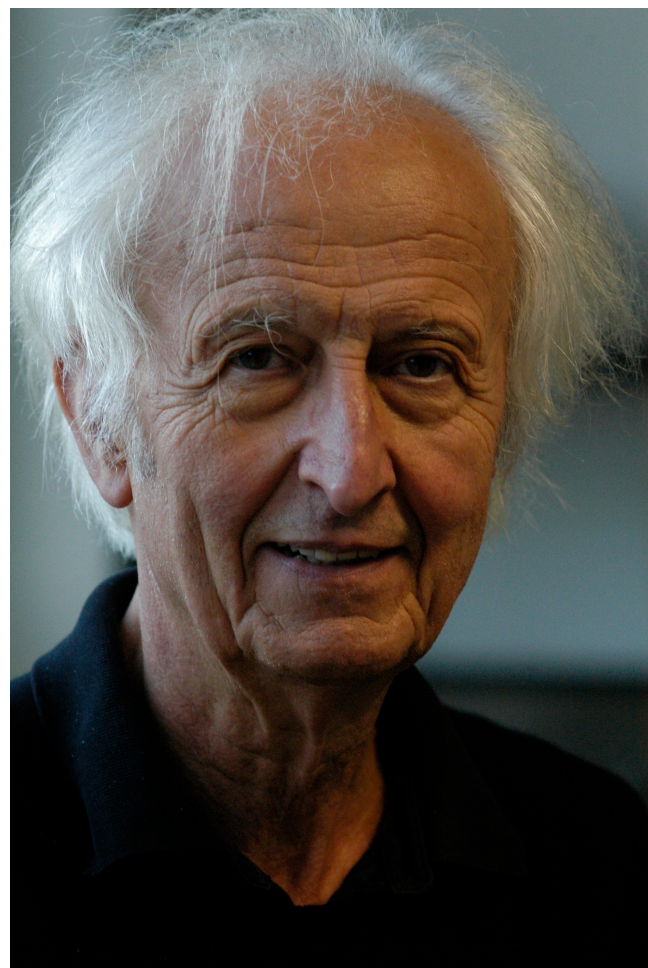




MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND



Professor Dr. Helmut Schwarz

President of the Humboldt Foundation

"The Usefulness of Useless Knowledge"

on the Vital Role of Basic Research in

Preserving Societies' Dreams and Aspirations

2016 SIR NEIL WATERS PUBLIC LECTURE*

WEDNESDAY 10 FEBRUARY 7:00 pm

**VENUE: School of Business, Massey University Auckland
Main Entrance, Gate 1, Dairy Flat Highway, Albany**

Drinks and Canapés from 6:00pm in the Staff Lounge

Professor Dr. Helmut Schwarz is a leading international researcher molecular chemistry and has been Professor for Organic Chemistry at the Technical University of Berlin since 1983. Recognition for his work in basic research included the Bayer Award for Chemistry, the Leibniz Award, the AvH Max Planck Research Award, the J.J. Thomson Medal in Gold, the Lise Meitner-Alexander von Humboldt Award, the Liebig Medal, the ETH Prelog Medal in Gold, the Field and Franklin Award, the Hahn Award for Chemistry and Physics, the Schrödinger Medal, the European Academy of Sciences' Blaise Pascal Medal, the Lichtenberg Medal, Karl Ziegler Prize of the GDCh along with the Officer's Cross of the Order of Merit of the Federal Republic of Germany.

Helmut Schwarz is an excellent public speaker and well versed in science policy, he was Vice President of the German Research Foundation from 2001-2007.

** This public lecture is part of the celebration of Dist. Prof. Peter Schwerdtfeger's 60th Birthday Celebrations at Massey University.*

Neil Waters Lecture
by the President of the Alexander von Humboldt Foundation,
Professor Dr Helmut Schwarz,

"The Usefulness of Useless Knowledge" – on the Vital Role of Basic Research in Realising Societies'
Dreams and Aspirations

10 February 2016, Auckland, New Zealand

Abstract:

Most breakthroughs in research are not planned, could not and cannot be planned. Genuinely new knowledge is generated when researchers are driven by the desire to understand, by the thirst for insight. The usability of results – both the scientific utility and the potential economic relevance – cannot usually be predicted at an early stage. To recognise when and whether one is perhaps hot on the trail of something quite new – that is the real, the creative achievement. And it needs the intellectual freedom that allows it the scope to unfold, that liberates it from concrete applications and does not force it to conform to tightly-set targets.

The experience of the Alexander von Humboldt Foundation shows that generously sponsored, sustainable support for individuals based on strict criteria of scientific excellence is a viable and highly profitable investment. Support and optimum conditions for basic research create the foundations for breakthroughs and innovations that contribute to realising societies' dreams and aspirations.

Redetext:

Dear Dr. Schwerdtfeger, or as I would like to say in German, “lieber Peter”,
Humboldtians, ladies and gentlemen, distinguished audience:

When the flattering invitation to deliver the Sir Neil Waters Lecture in connection with the symposium to honour Professor Schwerdtfeger on the occasion of his 60th birthday celebration reached me last year, I was delighted to accept, and I will do my best not to disappoint your expectations! Alexander von Humboldt, the namesake of the Foundation which I am serving as President, never travelled to New Zealand – and yet, in a certain sense, it is his spirit that has brought us together today – the spirit of academic exchange, international networking, and a common interest in science and research.

Peter: This is your special day – your impressive achievements as a scientist and your dedicated engagement for science in New Zealand, the country you have chosen to make your home for many years, are currently being honoured in many different ways. Your contributions to chemistry and physics and your extensive international collaborations have brought about changes in the geography of knowledge, certainly in this scientific community, and – believe me – after the long journey from Berlin, I can still feel it in every bone of my body!

The Sir Neil Waters public lecture is – at least in my view - not intended to be a scientific presentation, but a talk of a more general nature. So in the light of Dr. Schwerdtfeger's on-going interest in the role of basic research – and the fact that so many of you are present indicates that he is not alone in this – the decision to choose as a title "The Usefulness of Useless Knowledge" was not especially difficult.

It was Abraham Flexner, the founding Secretary General of the legendary Institute for Advanced Studies in Princeton, who coined this phrase back in November 1939 for the title of his highly-readable essay in Harper's Magazine. In this article he describes how apparently random “experimentation” eventually leads to the most important discoveries. He argues vehemently against the hegemony and use of the term “utility” in research promotion and the allocation of funding; instead, he delivers a rousing plea for “the freeing of the human spirit”.

It is almost impossible to describe how much our world has changed since Flexner's essay appeared more than 75 years ago. And yet, it is still one of the most compelling documents on the crucial role of fundamental research also for the benefit of society at large.

The debate on this issue – that is, the usefulness of basic research – has a long history stretching back well before Flexner, but it is still extremely topical. When discussing this theme, it is quite irrelevant, in my opinion, whether you conduct applied research or pure research, whether you are a science manager or

simply someone who is interested in science and research – because what we are dealing with is not, or at least not only, some kind of contest for allocating funding, but a fundamental attitude to basic research, indeed, to the freedom of research, and to the role that, in my opinion, scientific and scholarly activities are first and foremost *cultural* activities.

The distinguished Cambridge-based number theorist G. F. Hardy is not only known for his outstanding contribution to mathematics, but also for his superb essay, published in 1940, on the aesthetics of mathematics entitled "A Mathematician's Apology". There he touches upon the question of "useless knowledge" by stating: "I have never done anything 'useful'. No discovery of mine has made, or is likely to make, directly or indirectly, for good or ill, the least difference to the amenity of the world (...) Judged by all practical standards, the value of my mathematical life is nil; and outside mathematics it is trivial anyhow. I have just one chance of escaping a verdict of complete triviality, that I may be judged to have created something worth creating. And that I have created is undeniable: the question is about its value."

To pose the question about the value of research – Hardy even talks about the value of his life – as a highly respected, most distinguished scientist may strike one as cynical or even arrogant, but that is precisely the point: is it really meaningful to relate everything to value or to usefulness, however that may be defined? Indeed, is it even possible? What is the real motivation behind such outstanding achievements and what value is it based on?

Humboldt: motivation

Allow me at this point to return for a brief while to Alexander von Humboldt, the man after whom the Humboldt Foundation is named and a demanding role model for our day-to-day work.

His life convincingly demonstrates what scientists are capable of achieving and discovering when they are able to give their curiosity free rein. In his masterpiece, *Kosmos*, Humboldt, perhaps the most charismatic and inspiring man of his time, highly admired by fellow colleagues like Charles Darwin, describes what drove him as a researcher: "My main motivation was to prepare myself to comprehend the phenomena of corporeal things in their general connection; to embrace Nature as a whole, actuated, animated by internal forces." What Humboldt is describing here is nothing less than genuine, curiosity-driven research at the frontiers of knowledge. Even today, researchers from all disciplines will probably agree with him: we have made a profession of science because we are curious and, in the venerable spirit of the German poet-philosopher, Friedrich von Schiller, do not live *off* science, but above all *for* science. Fundamental research itself thrives on the scientist's desire to explore new territory – *terra incognita* –, to discover and investigate the truly unknown in order, finally, to be able to explain it – and this is usually a protracted process, fraught with setbacks.

Role of individuals in scientific insights

Most breakthroughs in research are not planned, could not and cannot be planned. Initially, their value and usefulness are usually unknown or difficult to estimate. Breakthroughs usually come out of the blue, popping up like Puck in a Shakespeare play in entirely unexpected places. Scientific progress is generated, first and foremost, by the work of individuals. Of course, we know that science is like a mosaic, composed of the contributions of many, but the crucial breakthroughs – or to put it another way, the innovations – are nearly always based on the achievements and passion of individual people and on a random and individual combination of creativity, intelligence, curiosity, persistence, and serendipity. These individuals need space, freedom and trust to be able to develop to the full. Then they will have the courage to take the risks that make discoveries possible; take risks, because the usability of results – both the scientific utility and the potential economic relevance – cannot usually be predicted at an early stage. To recognise when and whether one is perhaps hot on the trail of something quite new – that is the real, the creative achievement.

Fundamental research

New knowledge is generated when we are driven by the desire to understand, by the thirst for insight. And it needs the intellectual freedom that allows it the scope to unfold, that liberates it from concrete applications and does not force it to conform to tightly-set targets. “Knowledge must precede application,” stated Max Planck in 1919, amidst the most depressive atmosphere that prevailed in Germany after World War I, and his dictum has remained the precept upon which the Max Planck Gesellschaft operates to this very day. The Max Planck Society is Germany's most successful research organisation. It focusses on conducting basic research in the natural sciences, life sciences, social sciences, and the humanities for the benefit of the general public. Since it was re-established in 1948, no fewer than 18 Nobel laureates have emerged from the ranks of its scientific members, putting it on a par with the best and most prestigious research institutions in the world.

Thirst for insight is the engine behind daring, curiosity-driven fundamental research and the engine that generates true innovations. But at the outset, fundamental research means travelling a long and winding road, swimming against the current, beset by obstacles, with no shortcuts in sight. And what this means is that basic research needs time, which costs money, and that, to begin with, its primary goal is to acquire a better understanding of the object of research itself. To explain this to non-scientists, to the general public or the decision makers in parliaments or ministries, is often quite difficult, and, thus, basic research regularly comes under pressure to justify itself: it has become vulnerable. Because the tendency to measure the value of research solely on whether it is “useful”, whether the object of research addresses a social problem or whether it is likely to deliver a recognisable and marketable product in the foreseeable future, preferably within a period of few years, all this is very dangerous: basic research, applied research, business and society are all elements of a network in which the path from one point to another may be anything but straight and involve frequent back-coupling. If you cut out the nodes of basic research you

endanger the network as a whole. Fundamental research is still necessary and not just that, it is also cost-effective!

Examples of fundamental research

After all, ladies and gentlemen, how infinitely less secure and comfortable our lives would be without the things that we take for granted and which originated in basic research: no GPS without Einstein's esoteric, and for practical purposes, totally irrelevant theory of general relativity! Apparently random "trials" led to the discovery of x-rays or the elucidation of the double helix structure of DNA by Watson and Crick, a curiosity-driven study that has revolutionized the whole life sciences, or a moldy bacterial culture engendered penicillin and, when it was discovered, the laser was described as "a solution in search of a problem." As some of you are well aware, the list is endless, and one of my favourite examples goes back to 1927 when the young Cambridge-based mathematician Paul Dirac predicted the existence of anti-matter, specifically the positron. It took four years before this elusive particle was observed experimentally by Carl Anderson. For many decades, the positron was regarded as a novelty, a curiosity with little, if any practical purpose. Now, almost every major hospital uses PET, positron-emission tomography, in the early diagnosis of tumours. The list is, indeed, endless.

Or another, my last, example goes even further back to Michael Faraday's ground-breaking work on the riddle of electricity. Without his scientific interest in electricity, which was seen as an amusing but largely useless gimmick in the first half of the 19th century, we should literally all still be sitting here in the dark! When asked by the British Prime Minister of the day, Lord Gladstone, whether his publicly funded research on electricity would ever be of any use, Faraday coolly replied, "Well Sir, one day you will tax it." Although Gladstone himself, one of the major British statesmen of the 19th century, did not live long enough to see the rise of the electrical industry or benefit from the concomitant tax income, this story illustrates a seminal point: the rate of returns on investments in research are long-term and can be massive¹; estimates suggest between 20 and 60 per cent per year. An example from chemistry provides a good illustration: approximately 20 per cent of the entire world economy is related in some way or another to chemical catalysis, that is, the initially purely academic question of how bonds in molecules are formed and split. So let us be in no doubt: basic research that, sooner or later, generates further discoveries or inventions and then produces applications that benefit the common weal is a public good!² As far as funding is concerned, it must therefore remain an essentially public matter; it must not be subjected to economic rules of speedy profit maximisation or politically opportune considerations.

As the American author James Freeman Clarke noted "A politician thinks of the next election; a statesman thinks of the next generation." And I should like to add: scientists, on the other hand, often think in timespans that cross generations.

¹ William H. Press, "What's So Special About Science?" Nov. 2013, Science: estimate of rates of return on investments 20-60% per year

² Ibid. "Basic research leading to scientific discovery is thus a public good."

The meaning of the individual

Returning to Flexner's essay on "The Usefulness of Useless Knowledge" once more, the most important message is certainly the freeing of the human spirit. Dreams and aspirations, ladies and gentlemen, need free spirits who bravely stake their entire claim on realising their dreams – even in the face of opposition.

The German saying "Innovation im Konsens ist Nonsense" ("consensus innovation is nonsense"), coined by the innovation researcher Erich Staudt³, is not just a play on words. Rather, Staudt gets to the very heart of the matter: innovation is generated by daring thinkers leaving the tried and established paths and trying out new ways. Staudt recognised the fact that strategies based exclusively on technology are less likely to be successful; he placed the focus firmly on people and their expertise, saying, "It is always individuals or minorities who dare to drive new developments, take risks and strive for change. Many of them fail and some succeed. Only then are they followed by the majority." In the experience of the Alexander von Humboldt Foundation, generously sponsored, sustainable support for individuals based on strict criteria of excellence is the best method of providing scope for risks and changes, and opening up new paths for the majority to subsequently follow.

The Foundation's sponsorship philosophy

The Humboldt Foundation has its own, rather special profile: its sponsorship principles have not changed since the Foundation was established more than 60 years ago. These principles have stood the test of time and they state, quite simply, that we are committed to excellence and to promoting people. Academic excellence and the highest quality are the most important, not to say the only, criteria we use to select our fellows and award winners from a large international pool of outstanding candidates. We do not believe in quotas – not for countries, not for disciplines, not for gender, not for age – and we certainly do not get involved in those forms of short-term project funding that are dictated by the fashion of the day. We promote people, individuals, and we have very good evidence to back our claim that this is indeed the best form of support.

Sponsorship programmes and Humboldt Network

Every year, our fellowships and research awards bring hundreds of excellent academics to Germany from all continents to work together with colleagues on research topics they have chosen themselves; be they natural scientists, scholars from the humanities or social sciences, or engineering scientists – all are free to pursue their particular research direction. The Foundation provides funding tailored to every career

³ Prof. Dr Dr Erich Staudt (d. 2002), founder of the Institute for Applied Innovation Research at Ruhruniversität Bochum – studied Physics, doctorate/*habilitation* in Business Studies, Chair of Labour Economics in Bochum

stage – from young postdoctoral researchers at the beginning of their careers to experienced researchers and world leaders in their fields.

Humboldt Network in New Zealand

The first fellow from New Zealand came to Germany in 1955. Since then, the Humboldt Foundation's selection committees have granted 128 fellowships to researchers from New Zealand whilst six scientists and scholars have received prestigious research awards for outstanding achievements in their fields. Peter Schwerdtfeger is one of them. Three of these awards were granted in the last three years, which can certainly be seen as evidence that New Zealand has become a particularly potent, internationally-connected and attractive research location in recent years. My compliments! By the way, this claim is also substantiated by the fact that Feodor Lynen Fellows from Germany regularly choose host institutions in New Zealand for their research fellowships.

The community of Humboldt fellows is particularly active on this side of the globe and it promotes strong ties between our countries. The New Zealand–Germany Science Circle, set-up in 2009, has evolved into a well-established and very interesting format. To my delight, the founding of the Science Circle and the events it holds promote what is a common goal of both countries: to support and strengthen research cooperation and to bring outstanding academics and science managers together to exchange ideas and expertise. From a German perspective, New Zealand certainly feels “remote” at times. And yet, scientific cooperation between our countries is flourishing. We are told that Germany ranks fourth amongst New Zealand's most important research and technology partners worldwide, after Australia, the United States, and the United Kingdom.

In this context, I should also like to draw your attention to the Julius von Haast Fellowship which has been granted to internationally recognised researchers from Germany by the New Zealand government since 2004. The Julius von Haast Fellowships complement Humboldt sponsorship, allowing German researchers to spend time collaborating with their colleagues in New Zealand and establishing or enhancing collaborative research of benefit to both countries.

Out of conviction, but also based on experience, the Humboldt Foundation supports activities which drive international cooperation. A common element of all the Foundation's programmes is that contact continues and is fostered after the initial sponsorship period has come to an end – indeed, for the recipient's entire academic lifetime. We subscribe to the modified Oxbridge motto: "Once a Humboldtian, always a Humboldtian". Sixty years of practising this principle have created the Humboldt Family Network that now embraces some 27,000 individuals in over 140 countries. Many of them have pursued stellar careers, including 52 Nobel Laureates of whom 38 were “discovered” by the Humboldt Foundation often long before they were awarded the Nobel Prize. We at the Foundation seem to have a

nose for spotting talents at an early stage in their careers! And we believe that our Humboldtians' success stories prove the point. Let me give you a specific example.

Humboldtians: Schwerdtfeger

Peter Schwerdtfeger applied for one of the Humboldt Foundation's Feodor Lynen Research Fellowships in 1986. The programme had only been launched a few years earlier with the aim of enabling German scientists and scholars to collaborate on research with a Humboldtian, a researcher who had already been sponsored by the Humboldt Foundation. For this purpose, a generous fellowship was granted, which allowed the recipient to spend time working at a research institute abroad. In 1987, Peter came to Auckland – and this is where he stayed. It was here that he pursued his truly stellar career in theoretical chemistry – and beyond! In fact, nowadays his research activities cover basically all areas of electronic structure theory in chemistry and physics.

The crowning glory of his career came with the conferral of the internationally-distinguished Humboldt Research Award in 2010. This award is granted to eminent researchers from abroad – or in this case, whose main, long-term focus of life and research has been abroad – for their life's work; it is a special honour for the world's research elite. In their various disciplines the award winners have made extraordinary contributions to extending our knowledge and understanding of the most diverse phenomena.

An award of this kind is not without its consequences – and not just for those who receive it – because outstanding academics are a magnet for other excellent talents, be they junior researchers who arrive as post-docs and doctoral candidates or collaborative partners. They are like a condensation nucleus for excellence. And the list of participants attending the Schwerdtfeger Symposium just now speaks for itself: it is certainly no coincidence that three other Humboldt Research Award Winners are in our midst, yet further success stories from the Humboldt cosmos.

Promoting junior researchers - scope

I am not telling you all this, ladies and gentlemen, just in order to congratulate Peter on his birthday or praise Humboldtians in general – my intention is rather different: successes like these have been possible because young people were given the chance and the scope to realise their dreams. At the time, it was unclear what, if anything, would come of it. In the last resort, a society's dreams and aspirations are dependent on how their young people develop; what space and creative opportunities these young people are offered. Are they able to develop freely, implement their ideas and thus live out their potential? In the context of science this means: how are younger researchers faring? Young scientists and scholars need space to pursue their quest for knowledge and to test themselves and their ideas: too much control and too many restrictions are fatal. After all, young people, in particular, are full of enthusiasm which can blossom into a genuine love of research, of basic research where their potential can fully unfold. These

young talents need to be nurtured and cared for because they are open-minded and courageous, and the future is theirs.

The experienced colleagues amongst us know only too well that our own success was initially based on talent and hard work, but also depended, and still depends, on support from various quarters. Perhaps you yourself have also experienced disappointment and frustration when you did not receive the support you expected or needed, when you had to battle with unfavourable general conditions.

Example of Humboldt – Liebig

Support from an experienced academic for a young talent can have far-reaching consequences both for the individual's research career and for the entire research field. I should like to illustrate this point with an historical example. In the 19th century, there was a chemist in Germany, Justus von Liebig, who achieved major breakthroughs in chemistry and who effectively raised chemistry to the level of an exact science. The highly-gifted young Liebig attracted the attention of Alexander von Humboldt with his somewhat esoteric work on mercury fulminate – at the time, this work was certainly considered “useless knowledge”. But on Humboldt's recommendation, Liebig was appointed to a professorship at the tender age of 21, despite fierce opposition from the heads of the university. Later, Liebig's research achievements transformed chemistry from an art into a science that could be taught and studied. And Liebig himself was only too aware how valuable the support he had received from Alexander von Humboldt had been. Full of gratitude, he noted in retrospect,

“How many I know who, like I, have the protection and benevolence of Alexander von Humboldt to thank for achieving their scientific goals! The chemist, botanist, physicist, orientalist, the traveller to Persia and India, the artist – all enjoyed the same rights, the same protection. In his (Humboldt's) eyes there was no difference between nations, between countries.”

Liebig's claim is by no means exaggerated. In the words of Humboldt's biographer, Douglas Botting, by the middle of the 19th century, there was hardly an important scientist in Europe who had not benefitted from Humboldt's assistance at the beginning of their careers. Humboldt wrote letters of recommendation, arranged contacts within his own huge international network, drew people's attention to interesting research fields and even provided generous financial support from his private fortune for the one or other aspiring scientist. And Humboldt's support was selfless – he was in no doubt whatsoever that a causal correlation existed between sustainably promoting young researchers and the prospering of science.

Guiding and supporting, creating space, respecting and strengthening personalities, sharing with them one's own networks – these are all essential, interconnected elements of a serious approach to promoting young researchers. Finally, I should like to emphasise that this kind of support is not a luxury one would perhaps like to indulge but feels unable to provide in the course of the demanding university routine. An attitude like this – if prevailing – would be truly fatal because it would endanger the future of science as

well as the future of universities as places in which we can and must consider issues that may only prove their relevance decades from now. Fundamental research gives young people the opportunity to head for new shores. In order to master the future together, the enthusiasm of young people is the most secure currency we have.

Allow me to summarise: excellence in research flourishes best when researchers are given the space to pursue their quest for knowledge. And this is particularly true for young researchers. Basic research – like writing an opera – is first of all a cultural achievement, not a luxury, and certainly essential. Moreover, in research promotion, patience and perseverance are required. The principle of trusting people rather than trusting a monitoring system based on distrust has proved its worth, and the principle of promoting people rather than projects has stood the test of time. All these ideas have been summarized in a most convincing way by Vannevar Bush, the scientific advisor of President F. D. Roosevelt and which led to the creation of the US National Science Foundation: "Scientific progress on a broad front results from the free interplay of intellectuals working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown".

Well, Ladies and Gentlemen, my thoughts are the product of 40 years' experience as a university teacher and my work in science policy, but I should probably have arrived at exactly the same conclusions, if I had used Peter Schwerdtfeger's distinguished biography as input.

You are harvesting the fruits of a rich, fulfilled life and, according to the Talmud, such a life should last 120 years. I wish you and your family all the very best.

Thank you for your attention. I am looking forward to sharing thoughts with you all!