Australian Government
Chief Scientist

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Future prescriptions for medical research

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Last week it was reported that Jeff Bezos, the founder of Amazon, had become the world's richest man, with a personal net worth of $100 billion.

It's a big number.

It got me thinking what I would do if I had $100 billion.

And it occurred to me, not for any particular reason, that I could take the annual Commonwealth contribution to the national research infrastructure facilities.

I could quadruple it.

I could throw in several hundred postdocs, and a supercomputer.

And I would *still* have more than $99 billion left to spend.

But what would I *actually* do, if I were a Silicon Valley billionaire?

Well, I imagine my thought process would look something like this:

Alan, as a Silicon Valley billionaire, what do you want more than anything else in the world?

To be rich? Done. To be famous? Done. What's next?

Of course! To live forever. To be immortal.

OK then, Alan, what do you need to do to live forever?

Hmmm. *Solve Death*.

Excellent! Solve Death it is.

Alan, *how* are you going to solve death?

I know: set up a research institute with an enormous endowment.

Google has Calico: the California Life Company, with a billion dollars to fight ageing.

Mark Zuckerberg has Chan Zuckerberg Science, with $3 billion to "cure or prevent all disease by 2100".

Jeff Bezos is an investor in Unity Biotech: with the motto "Age Different".

Death: it's overdue for disruption.

So Alan, which camp will you join?

The *New Yorker* magazine tells me that I have two options.

On the one hand, I could try the biological path: hack death by hacking yourself. The New Yorker calls this camp "the Meat Puppets".

I could take blood from the young and infuse it into the old.

Or I could take a pill designed to target the accumulation of the so-called zombie cells in ageing tissues.

Or I could take my epigenetic destiny into my own hands, with the next generation gene editing tools, tweaking the genes that turn adult cells back into youthful cells… or sort of, possibly, at least in mice.

On the other hand, I could give up on the old hardware completely, and try the digital route: join the second camp, the "RoboCops", or "Uploaders".

Here, I would gradually replace all my body parts with bionics to keep myself alive until computer memory and algorithms have advanced to the point that they can hold every nuance of my human brain.

And somehow, a means will be found to upload me. Into an immortal silicon shell.

Now Alan, let's be honest, what's the reality?

The reality is, I'm still going to die.

Yes, sad to say: you can do many things with $100 billion, but you can't buy immortality.

But that's not to say that the people spruiking it are completely detached from reality.

They sense what you sense: that we are on the verge of something extraordinary in medical science.

It feels like a tipping point. It feels like the dawn of an era.

And it feels that way even to Baby Boomers. Perhaps *especially* to Baby Boomers.

After all, we were there for the run-up.

Take me.

I was born in 1953: the year that Crick and Watson demonstrated the molecular structure of DNA.

I was thirty when the first disease gene was mapped.

I was fifty when the human genome was sequenced.

Fifty years: fifty years of painstaking work.

For all that time, people were thinking about what we could do if we went beyond investigation: if we could somehow intervene.

We even had a name for it: *genetic engineering*. It turned up in a science fiction novel, way back in 1951: it pre-dates Crick and Watson.

But that was science fiction: light years away from science fact.

Something else that we were promised in the 1950s: artificial intelligence.

I was three when the term was first used at an academic conference, in 1956.

Once again, science fiction beat science to the punch. Asimov coined his famous Laws of Robotics in 1950.

At the time, we had one computer in Australia. It was considered to be a technological marvel. It weighed two tonnes.

It seemed inconceivable that we would ever really be forced to grapple with the implications of Asimov's vision: if it cost so much, to build a machine that big, that could do so little, how could we possibly build a machine that could think?

And if we couldn't build a machine that could think, how could we possibly conceive of hacking ourselves: recoding, reprogramming, optimising? For longevity, if not for eternity?

That's how it feels to travel along an exponential curve: to the best of your knowledge, it's linear. Until it's not.

From then, the breakthroughs cluster closer and closer together, trickle into tide, tide into tsunami.

And that's what we're seeing now.

Think about the last decade in AI.

IBM's Watson beat the humans at Jeopardy in 2011.

AlphaGo Master beat the best human at the ancient game of Go, in 2017, after three years of development.

Its successor, AlphaGo Zero, took a mere forty days to learn all the principles and strategies that human players have ever conceived, over thousands of years and countless generations. Then it came up with novel tactics we'd never imagined. Forty days. And getting faster.

Every branch of science feeds the progress in computing. Physics. Chemistry. Now biology, with developments like the neuromorphic chip, modelled on the neural networks of the human brain.

And progress in computing feeds back into every branch of science in turn, making possible things that perhaps only Einstein could contemplate… but never thought we could actually achieve.

Like the detection of gravitational waves.

Like the mapping of the human brain.

Like gene therapies.

Thanks in part to computing, the cost of genome sequencing has plummeted. We're closing in on the $1000 threshold. The cost crash isn't matching Moore's Law, it's outpacing Moore's Law.

And then, CRISPR. The capacity to edit swiftly and cheaply, at the level of the individual letter. To accelerate research… and develop tailored therapies to treat disease.

Together, the digital revolution and the genetic revolution make a health revolution: precision medicine. At long last, a chance to deliver on the promise of decades: customised treatments, tailored to the person, delivered to the population.

A decade ago it might have been fanciful to prophesy that humanity will leave this century as a different species than we entered it.

Now, it is commonplace to see talk of Humanity 2.0.

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You look at that maze of possibilities, and Silicon Valley looks at that maze of possibilities.

You both want the same thing: to find the path through the maze to impact.

It's just a question of expectation – and degree.

Hubris means setting out on the path to the utterly inconceivable. Solving death.

Audacity, on the other hand, is setting out on the path of the unconceived.

Something that others haven't grasped, that you know to be achievable, that people of credibility will sign on to.

It means framing the goal. And asking – *demanding* – to be held to account.

Hubris is just asking for mockery. But audacity, for a medical research institute, in the year 2017, is required.

So let's go back to the start of the thought process.

This time, you're not a free and easy billionaire: you're in Australia, spending other people's money, and looking for impact. So the questions are for you.

Question: What do you want to achieve?

Answer: It's already there, in the mission statement of this alliance. Hope, health and prosperity. And it's not about vastly better lives for a few of us, achieved at tremendous and unsustainable cost, but greater health span for all: longer lives, with fewer years of disability.

Question: Are the existing technologies sufficient?

Answer: Well, they're good… but we wouldn't be here if we thought the task was done. There's so much more to do.

Look at brain cancer. A five year survival rate of 25 per cent. It's hardly shifted in thirty years.

Look at Alzheimer's disease. We might be better at managing the symptoms, but we can't stop the progression. Nor can we prevent it.

Look at the enormous cost and trauma associated with chronic conditions. Mental illnesses. Diabetes. Heart disease.

In the twentieth century we reaped enormous benefit from basic public health interventions: workplace safety, tackling smoking, infection controls.

We certainly haven't picked the last of the low-hanging fruit.

Working higher in the tree, through medical science we have improved the survival rates on breast cancer and leukemia, and we have pushed out the age of death due to cardiac disease.

I tip my hat to Professor Ian Frazer: Australia has also led the way in vaccination.

For new solutions we need more Ians – and more research.

And Australians overwhelmingly agree. The support for medical research is strong and sustained. The trust in our medical research institutes is consistently high.

So **Question:** where is the path to impact?

Answer: Everyone in this room should have an answer.

Let me give you the answer I give in the capacity of Chief Scientist. Countries like Australia have to be creative.

It would be easy to replicate what other countries are already doing, on a smaller scale, with less money. But it wouldn't be helpful.

We've got to be better than that: we've got to make our money work hard.

We succeed when we collaborate on the strategy: when we combine our capabilities in novel ways to make a new mission.

"A mission" is not code for an "applied research agenda". On the contrary.

Look at the lessons of CRISPR.

The story of its development is so complicated that even science can't sort it out. That's a job for lawyers.

But it begins with the discovery of a strange microbial repeat sequence, by a microbiologist named Francisco Mojica, working on samples collected in the marshes off the Spanish coast, way back in the early 1990s.

It had to wait for advances in bioinformatics, for the development of massive DNA sequencing databases, for the momentum of the Human Genome Project, and above all, for better computers.

It's the classic dance: new technologies open new doors in science, and science opens new doors in technology.

It's always serendipity waiting to happen.

When we engage in the basic science, in developing the research technologies, and in applying them, we put ourselves in the sweet spot: the serendipity sphere.

We can make new potential.

But we have to be looking with an eye to really seeing – and seizing the chance.

It's not about basic or applied, it's about serendipity with strategy across the spectrum.

Last question: How will you engage with Australians?

Answer: Include them.

As Chief Scientist I read many articles about research grants and new discoveries. But I also try to think about what the average person might know.

Assume for a moment that the members of Parliament represent the general community.

If you search Hansard, which records every word spoken in the House of Representatives and the Senate, these are phrases you won't find:

- CRISPR.
- Gene editing.
- Bioprinting.
- Precision medicine

"Telesurgery" has been mentioned… once.

"Synthetic biology" has been mentioned… once.

It may be that the politicians are aware of these topics, but haven't had reason to talk about them. But they will need to talk about them: to understand them, to explain them, and to enable them.

We hear a great deal about "transformational" and "disruptive" technologies.

Perhaps we forget: they mean change. Change on a scale and at a speed that is difficult to predict but nonetheless, has to be planned for and paid for.

So we need people to notice.

And we have a powerful starting position: the most important commodity of all.

It's not cat videos, or celebrity endorsements.

It's trust.

Australians trust you.

And they trust you not just with navigating the path to the future, but with the decisions they make for themselves.

I've learned from having tried that it's not helpful to refer your questions about medicine to Google.

Instead I go to the Mayo Clinic, or the John Hopkins Institute, for advice that's credible, integrated, and helpful.

I want to have go-to sources in Australia, and I know that many of you are working hard to fill that space.

A media release can spark interest – but we want more than interest, we want insight and sustained engagement.

The best research institutes develop it by their skill in telling human stories and arming us with practical information.

How do I talk to my children about cancer?

What are the implications of taking a genetic test?

How can I support a relative who has dementia?

Providing that information is part of our social responsibility.

But it's also part of the strategy: it's about earning trust, investing it, expanding it, protecting it, and putting it to work!

Let's treat it as core business – because it is.

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So my challenge to this conference is simple: pull the brilliant future down from the billionaires and put it in everyone's grasp.

Show us your path to impact.

Inspire us, as a nation, to achieve it together.

We might not live forever… but let's make it splendid to be alive.

THANK YOU