



Australian Government
Chief Scientist

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Opening Address

Solutions

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It is a great honour to pay tribute to one of Australia's most stable compounds: the Royal Australian Chemical Institute, in its centenary year.

Thousands of chemists, in high concentration, in my home town.

I grew up in the era when junior chemistry kits were the rage and children were encouraged to invent their own fun.

You could say that I was an inventive youth.

And one of the *first* things I discovered was that magnesium ribbons could be burned for entertainment, and zinc dust and sulphur powder could make rocket fuel.

And all of these wonderful chemicals and many more could be purchased by inventive youths like me, over the counter.

Nowadays, buying chemicals is apparently much harder than it used to be. At least you might reach that conclusion if you judged by the number of products currently labelled "chemical-free".

It's a sad era for chemistry when you can buy chemical-free water, in a chemical-free plastic bottle, to wash down your chemical-free pills, from your chemical-free pharmacist.

Fortunately for chemophobes, the journal Nature Chemistry has posted a comprehensive overview of consumer products that are *appropriately* labelled chemical-free – "including but not limited to lotions, herbal supplements, household cleaners, food items and beverages".ⁱ

In the interests of public safety, let me read to you this comprehensive list.

<PAUSE>

There you have it. A blank page.

To be truly chemical-free, you would have to go back nearly 14 billion years to the Big Bang and eliminate anything produced afterwards by any process, either naturally occurring or manmade.

To be free of the science that enables us to understand and harness these processes – chemistry – you would have to go back at least as far as the 1600s.

Last week in Italy my wife and I had dinner with some friends from California and their children. One of them, a professional television reporter, lamented that we live in a toxic world.

The fact that regulations are tight, and getting tighter, was not relevant.

The fact that longevity and disability free years of living are increasing by about two years every decade was not relevant.

But otherwise, she was a well-informed and highly literate observer. She just doesn't like chemicals.

The rest of us can just imagine what would happen if we did take chemistry away. And in honour of this centenary event, let's limit ourselves to the achievements of the last 100 years.

Let's imagine Australia, if we took away everything that chemists have created, using – yes – *chemicals* – in that time.

Friends, chemists and countrymen, it's a nightmare.

- The Sydney Harbour Bridge would rust.
- Vegemite would never have been invented.
- Our brilliant plastic banknotes would be paper.
- There'd be no Aerogard. No Speedos.
- No wine in casks, no white tiles on the Opera House and no zinc cream on Shane Warne's nose.

And even if you could accept the loss of all these things... as well as farms that were far less productive, fuels that were far less efficient, foods that were far less nutritious, and pharmacies without most of their stock...

....friends, the worst news for me personally is that *we would have to do without the chemists in the Haigh's Chocolates factory in South Australia who invented the delicious Haigh's chocolate frog.*

I can't go on.

The lesson here is very simple: chemistry is vital to our prosperity and our chemists should be dear to our hearts.

And anti-chemistry is not just un-Australian. Without chemistry, there's no hope for the world.

No-one understood this better than the chemist and Nobel Laureate Richard Smalley.

Richard Smalley was a pioneer of nanotechnology, most famous for the discovery of the buckyball.

Smalley by name, and nanoscopic by choice.

And yet this man, who probably dreamed in the nanoscale, had a vision almost unfathomably large.

He looked at a world of exploding population and finite resources and saw it straining to cope. Then he projected out the trends to 2050 and saw how the problems would scale.

He distilled it into a list of ten: ten words and ten challenges for a world of ten billion people.

Energy was number one. Water was number two. Food was number three.

All ten were massive imperatives, demanding not just an upgrade of our existing practices but a total reimagining of industries.

Number One – energy – is the textbook example. And it is the example I know best.

You might remember that the lights went out in South Australia last year. In the days that followed, I was commissioned by the Commonwealth and State governments to prepare a blueprint for the future of the National Electricity Market.

I spent the next eight months travelling the country talking to the leading players, meeting experts in Europe and the United States, and bunkering down with modellers back home.

So you can believe me when I confirm that the global reimagining of energy is well underway – from fossil fuels to renewable sources; from a handful of central generators to millions of solar rooftops; from electricity used fresh to electricity we generate and store.

You can also believe me when I say that responding to that change is hard.

The challenge is not just to rise to consumer demands. Nor is it simply to meet our global climate commitments.

It is to do so as reliably and affordably as possible.

The classic trilemma: reliable, affordable, sustainable.

Crack that problem, and you can move to Number Two on Richard Smalley's list: water.

A trilemma of its own. And only eight more to go!

So Smalley would run through this list, sometimes for members of Congress, sometimes for public events.

He would paint a picture of catastrophe ahead in the absence of fundamental change.

Then he'd look into the crowd and pause.

"What are we waiting for?" he'd say.

"BE A SCIENTIST. SAVE THE WORLD."

And what he meant was simple: only with science can we truly shift the parameters – so that competing interests can become complementary goals.

As I frequently tell engineering students, their job is to provide solutions, not products. Solutions that benefit multiple masters.

That is the very essence of the field of green chemistry.

Let me pull out a couple of examples.

The first you may have encountered on your flight over. In order to protect aircraft from the environment, manufacturers apply a topcoat of paint, which must be regularly reapplied. This previously involved sanding down the entire plane to ensure good adhesion.

That takes time, it could damage the plane, and it contributes to particle pollution.

Australia's CSIRO developed a new spray-on system to chemically reactivate the old topcoat surface, so the new paint can be applied without sanding – saving labour, materials, and money. Brilliant.

A second example, from the pharmaceuticals sector. Manufacturing vital medicines is an energy intensive process. So global giant Pfizer has used the principles of green chemistry to change the way its drugs are made. The new process for just one drug, the antidepressant Zoloft, doubled product yield, eliminated some 800,000 kg of hazardous waste products each year, and cut the bill for energy and water.

A third example: those chemical-free bottles of chemical-free water. It turns out the bottles are made of plastic – who knew? A million plastic bottles are purchased every minute around the world.

In response, polymer chemists are improving their materials so that manufacturers can cut the inputs and achieve the same end. Biochemists are isolating enzymes that allow certain worms and other organisms to chomp through plastic. Organic chemists are turning bottles into fuels.

All of these examples of improved processes are solutions to the problems of growth.

Actively creating these solutions is surely far better than waiting for alternatives that might never arrive – or allowing chemophobia to blind us to the need for action at all.

Yes, it seems too obvious to say it – but when the current practices are unsustainable, doing nothing is not acceptable!

It is locking in the escalating costs of an unsatisfactory status quo.

The challenge for communities is to weigh those costs and make truly informed decisions.

The challenge for chemists is to be effective participants – knowing that the answers are rarely simple... and never complete.

So what advice can I offer to you, as our custodians of chemistry, on the frontline of chemophobia, in 2017?

The first point I would make is that chemistry contains a great deal of transferable wisdom.

Richard Smalley is a case in point.

Or we could take a leaf from the principles of green chemistry – and I believe we have the authors of the 12 Principles of Green Chemistryⁱⁱ in the audience today, Paul Anastas and John Warner. Welcome.

Principle 1: “It is better to prevent waste than to treat or clean up waste after it is formed.”

Principle 12: “Substances should be chosen to minimise the potential for accidents including explosions and fires.”

That’s not just good chemistry – that’s a mantra for life.

But we need more people literate in chemistry bringing what they know into the public debate. And I recognise that making that step – and then standing your ground – is hard.

So I’ve distilled my experience as a scientist in public life into a formula for impact: and you’ll be pleased to know it’s a triphosphate, with three P’s. So it ought to be a high-energy compound.

My three P’s are PERMISSION, PURPOSE and PERSPECTIVE. We need to act with all three in mind.

PERMISSION means seeking and earning a social licence to operate.

And we need it for the most pragmatic of reasons. It’s a democracy out there, and chemophobes vote.

Pragmatism aside, we have a choice.

We can settle for regulations as pointless encumbrances – or we can embrace them as a powerful tool.

Effective regulations give us the opportunity to reflect critically on what we do and consult with the people affected by our products and actions.

They make our day-to-day practices more efficient by establishing the shared expectations.

And for those who play by the rules, they provide a competitive edge: a stable policy environment for investors and a quality reputation for Australian products.

In all these ways, regulations can assist us to live up to the promise of green chemistry.

So I say effective regulations ought to be our best friend.

How do we make the case for effective regulation, as opposed to less regulation – or a blanket ban?

That brings me to the second P – PURPOSE.

Purpose means seeing beyond a product or process to its applications.

It seems to me that conversations about new technologies often go awry when the focus narrows to the tool, rather than its use.

The classic example is nuclear medicine. Nuclear technology plays a vital role in the diagnosis and treatment of many conditions, including cancer.

Every week, the Australian Nuclear Science and Technology Organisation (ANSTO) at Lucas Heights creates 10,000 patient doses, distributed to more than 250 hospitals across Australia.

Any interruption in the supply would be catastrophic.

And anyone who calls for the reactor to be shut down should be aware of the cost in human lives, and be required to defend their belief that this cost is fair to impose.

Then the community can decide if they agree that the manageable risks associated with nuclear waste are more compelling than the massive costs of untreated cancer.

The same is true in chemistry.

We do need to demonstrate that chemical X is safe – but we also need to explain the reason we use chemical X in the first place. And the costs that would result if we took chemical X away.

To have that conversation we need our own line of sight to the way that our ideas can be used or abused. We need to speak in terms of problems and solutions for communities; not just products and processes for chemists.

And so to my final P – PERSPECTIVE.

And I want to emphasise that it is “perspective” – not perfection.

If perfection is your goal, you are doomed to disappointment.

I think of it like an engineer.

We can't be perfect – it's too expensive.

We can't compromise – it's too dangerous.

So we have to optimise – and to optimise we need to be able to *learn*.

And chemists know this: you are constantly balancing the cost of the inputs, against the speed of the process, against the environmental impacts of the by-products, *ad infinitum*.

And you consult. If there is a better tool in the scientist's toolkit, I've never found it.

Never underestimate the value of getting out and listening.

I promise, you will find unexpected opportunities and allies every time.

You will also be far more likely to win government and community support if you can demonstrate your understanding of their concerns.

The best project proposals have the affected people onside to start with.

So there's my triphosphate. Now it's over to you for solutions.

So once more: Be a Scientist – Save the World!

THANK YOU

ⁱ See <http://blogs.nature.com/thescepticalchymist/2014/06/a-chemical-free-paper.html>.

ⁱⁱ For further information on the field of Green Chemistry, see <https://www.epa.gov/greenchemistry/basics-green-chemistry>.