Driven To Discover:

The importance of basic research

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Basic science - motivated by curiosity

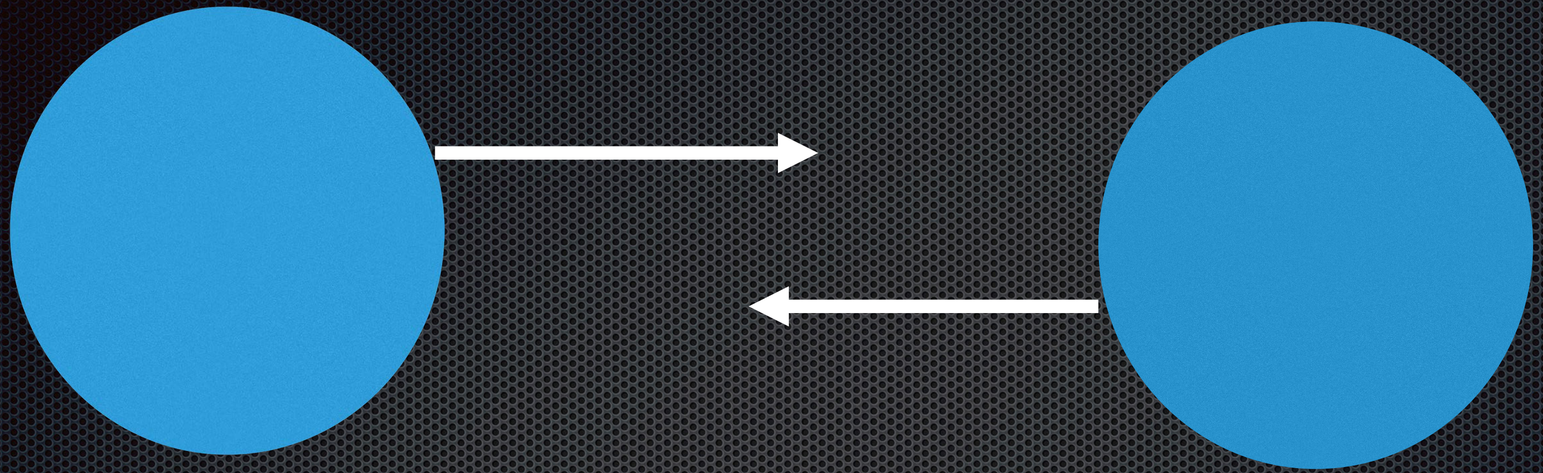
Applied science - designed to answer specific questions

“applied science leads to improvements in old methods, while pure science leads to new methods"

JJ Thompson

To feed applied research by starving basic science is like economizing on the foundations of a building, so that it may be built higher. It's only a matter of time before the whole edifice crumbles.

George Porter



It’s all about the balance between Basic and Applied

When asked by Gladstone what his new-fangled concept of electricity could do for society, Faraday replied

Why sir, there is every possibility that you will soon be able to tax it

The distance between discovery sciences and applications has never been too great.
Yet basic science does not necessarily link quickly to applied outcomes….

……in 1867, nine years after Faraday's death, a meeting of British scientists stated

"*Although we cannot say what remains to be invented, we can say that there seems to be no reason to believe that electricity will be used as a practical mode of power*".

It was not until the second quarter of the twentieth century that electrical power became available to most of the population of the US, Europe, and parts of Asia

And now…..the work of Faraday is worth more than the valuation of the British stock market, and we cannot imagine life without electricity.

Whereas, before we could not imagine that it could even exist.

“If you went to Schrödinger in 1926 and said, "Nice equation, Erwin. What's it good for?" He's not going to say, "Well, if you want to store music in a compact digital format…”

James Kakalios

But without the curiosity-driven understanding of how atoms behave, how they interact with each other, and how they interact with light, the world we live in would be profoundly different.

It’s estimated that 30% of the worlds’ GDP relies on Quantum Mechanics

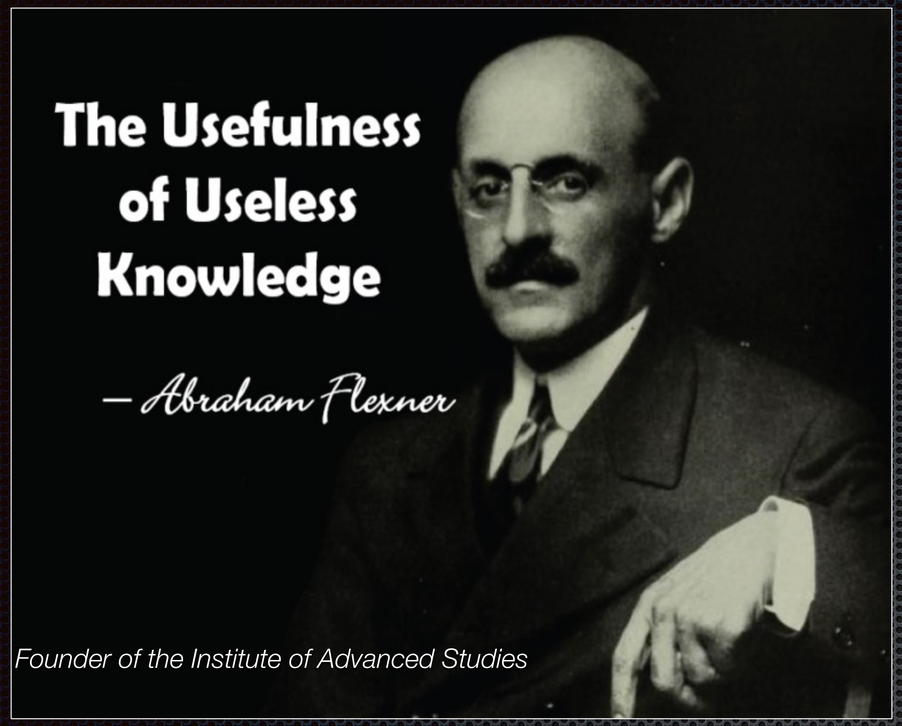
……..one might speculate ….whether transistors might have been discovered by people who had not been trained in wave mechanics or the quantum theory of solids. It so happened that the inventors of transistors were versed in and contributed to the quantum theory of solids…. Casimir

Basic research is driven by curiosity and imagination.

It’s outputs are unpredictable…….

..and life changing.

It is not easily directed

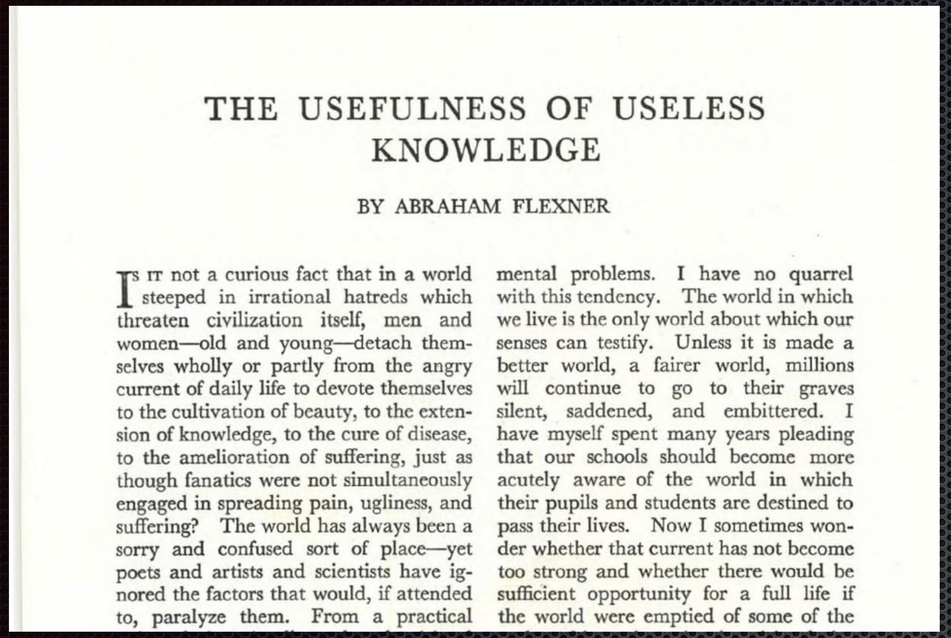


Founder of the Institute of Advanced Studies

THE USEFULNESS OF USELESS KNOWLEDGE

BY ABRAHAM FLEXNER

Is it not a curious fact that in a world steeped in irrational hatreds which threaten civilization itself, men and women—old and young—detach themselves wholly or partly from the angry current of daily life to devote themselves to the cultivation of beauty, to the extension of knowledge, to the cure of disease, to the amelioration of suffering, just as though fanatics were not simultaneously engaged in spreading pain, ugliness, and suffering? The world has always been a sorry and confused sort of place—yet poets and artists and scientists have ignored the factors that would, if attended to, paralyze them. From a practical mental problems. I have no quarrel with this tendency. The world in which we live is the only world about which our senses can testify. Unless it is made a better world, a fairer world, millions will continue to go to their graves silent, saddened, and embittered. I have myself spent many years pleading that our schools should become more acutely aware of the world in which their pupils and students are destined to pass their lives. Now I sometimes wonder whether that current has not become too strong and whether there would be sufficient opportunity for a full life if the world were emptied of some of the



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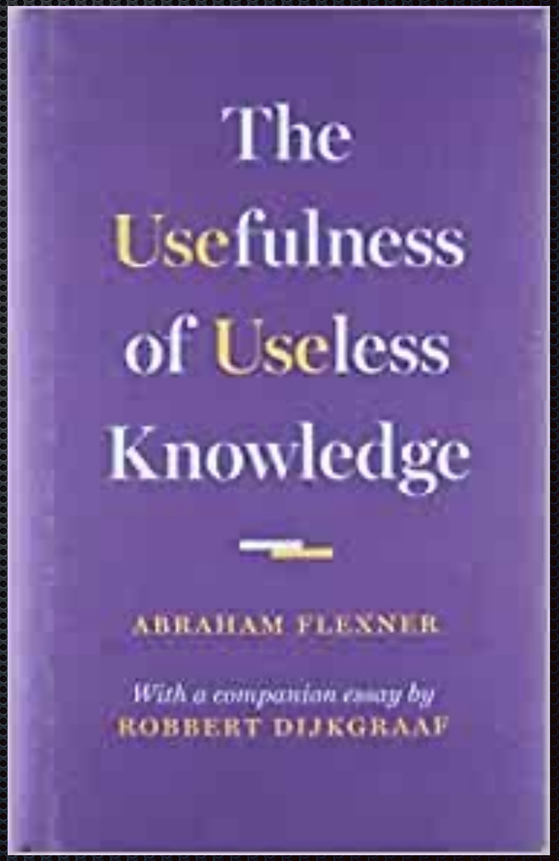
76 years later…..

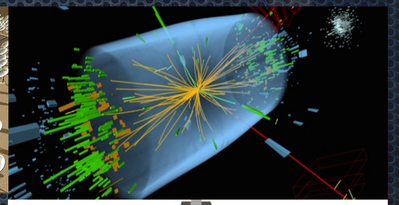


Robbert Dijkgraaf: The Usefulness of Useless Knowledge and the Importance of Basic Research https://www.youtube.com/watch?v=lO0XcYgEHag

Hay Festival: the Usefulness of Useless Science……

https://play.acast.com/s/bbcinsidescience/the-importance-of-basic-research

GLOBAL/NATIONAL collaborations do provide
large sums of sustainable money for basic research…mainly physics
..also….. Human Genome Program…..


CERN
SKA
DIAMOND (UK)
ARGONNE National LABs (USA)
National Synchrotrons

- **In general**

- 1. Applications of new knowledge can be highly profitable;
- 2. They are unforeseen when the underlying discoveries were made;
- 3. There is a long time-lag between the fundamental discoveries and their exploitation;
- 4. The discoverers in general do not get rich.

A recent US National Science Foundation study found that 73% of the papers cited in industrial patents were published "public science", overwhelmingly basic research papers produced by university and government laboratories.

Why are we still having the discussion on the importance of basic research for the economy?

Short termism of government in Australia does not help.

Immediate returns are what is wanted by the government – public funds

We are poor at lobbying government for basic research

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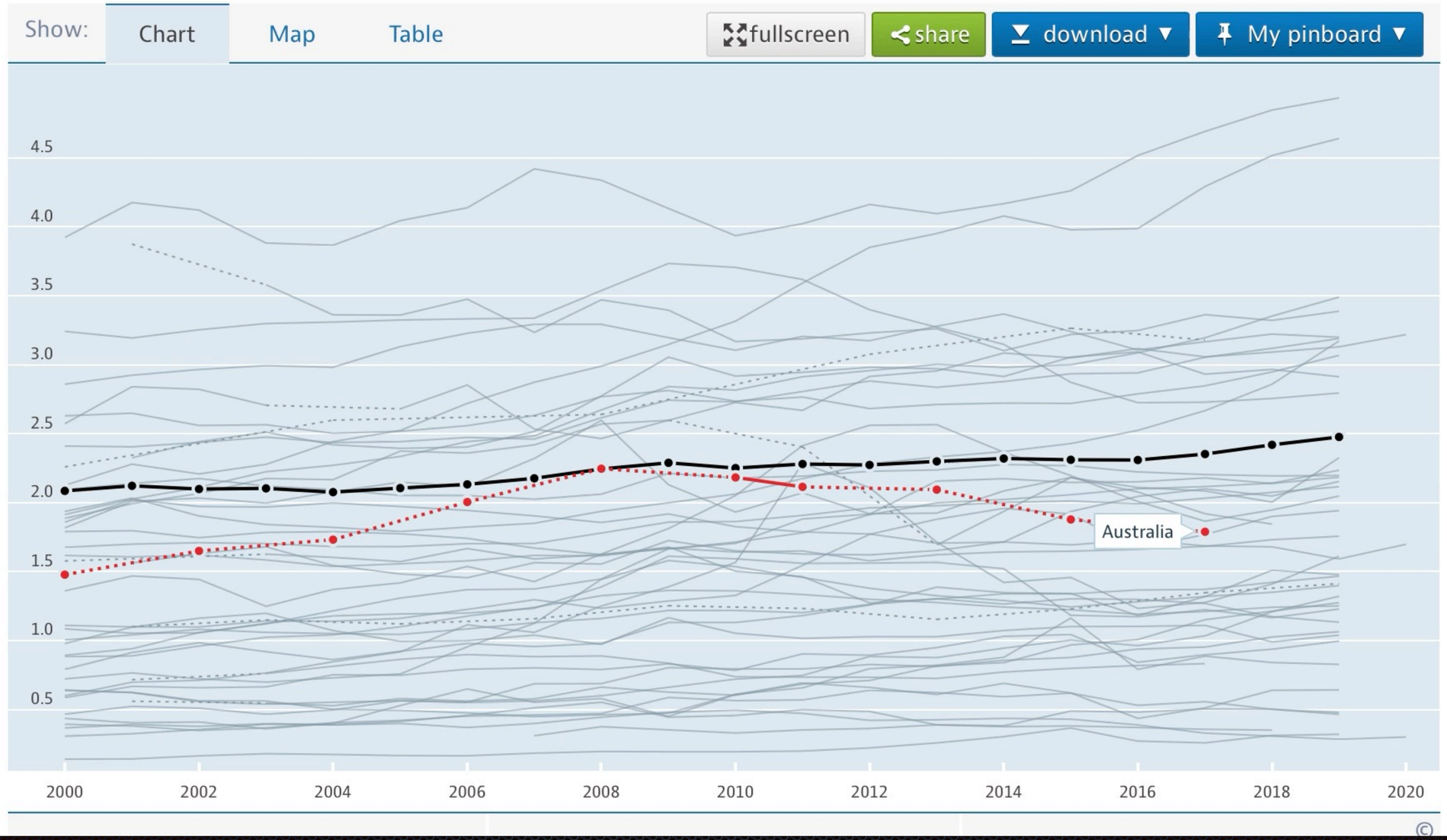
Search for OECD data

Gross domestic spending on R&D

Total, % of GDP, 2000 – 2020

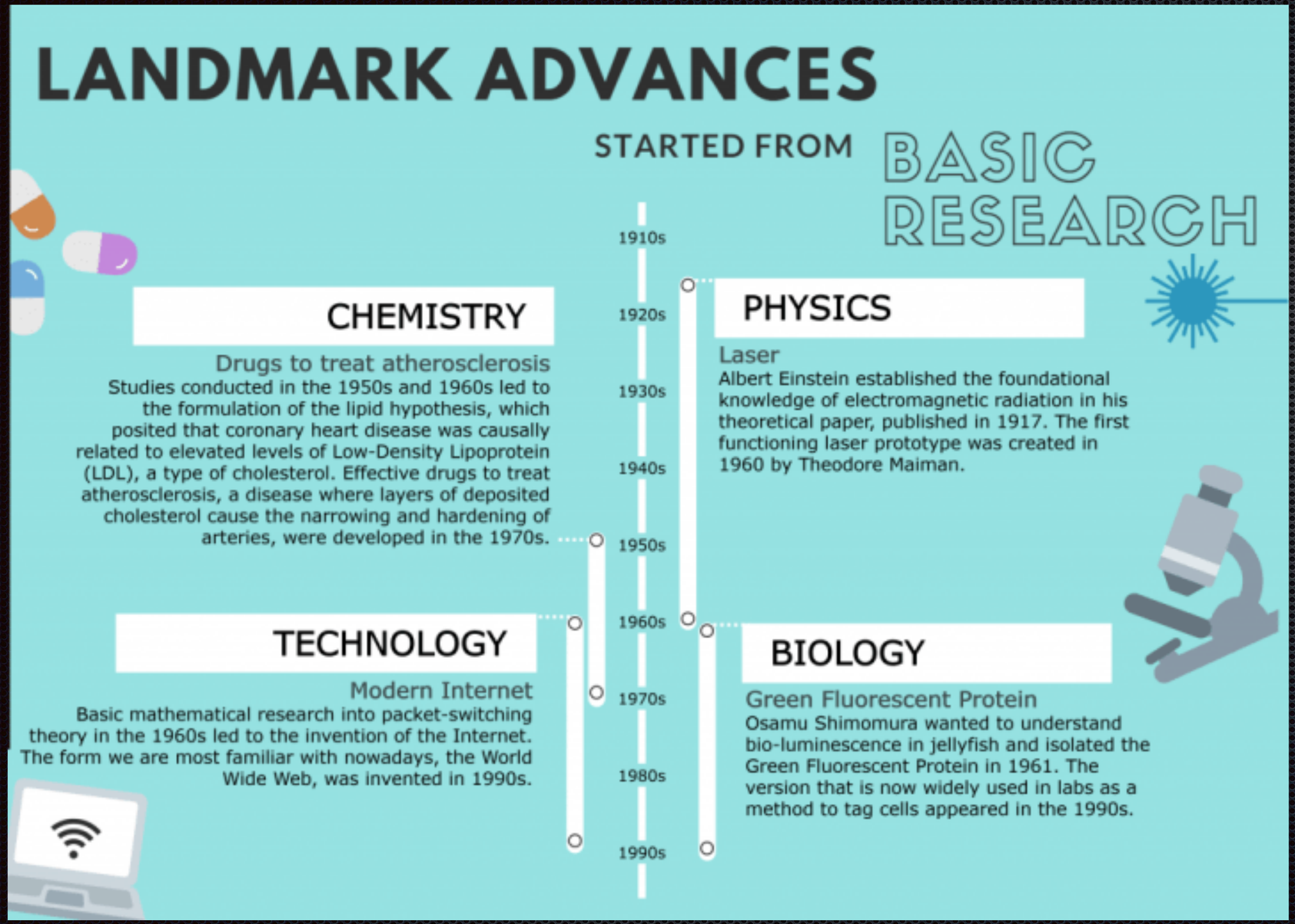
Source: Main Science and Technology Indicators



In Australia we spend c.1.7% GDP on R&D.
Over half of that spend is by non-gov sources.

Compare to Switzerland: 3% of GDP and 2/3rds of that from private sector.

https://theconversation.com/infographic-how-much-does-australia-spend-on-science-and-research-61094



We can make long lists of how basic science links directly to application and wealth creation

https://sitn.hms.harvard.edu/flash/2019/not-so-basic-research-the-unrecognized-importance-of-fundamental-scientific-discoveries/

But that is not the problem……..

We are good at looking in the past and making strong connections between basic and applied outcomes, However, consistently we fail to persuade stakeholders of the usefulness of basic science to the future….and today in Australia we see a move away form funding basic research towards more research directed to wealth creation…..

ARC is the source of much of our gov funded research. RDCs and CRCs account for a large portion as well, but not surprisingly linked to outcomes. They are industry focused, so no surprise there. ARC is science focused. But arguably moving towards a more outcome agenda.

We all know how the ARC DPs are accessed:

Investigators 35%
Project Quality and innovation 40%
Feasibility 10%
Benefit 15%

Who you are and where you are is deemed more important than The project quality and innovation.

My preference would be

Project Quality and innovation 80%
Investigators and feasibility 20%

I asked 15 researchers what they thought and a reasonable assessment from their views was:

Investigators 30%
Quality 70%

Few suggested that feasibility or benefits should be included.

The older they were the more they thought ‘Investigators’ should have a greater weighting!

We are not lacking in ideas

We have clear evidence that basic science pays economic dividends

But we lack the organization and the will to ensure sustained lobbying to government to encourage and fund basic science

We need to get organized and get our story telling right about basic science

Acknowledgments

What's the Use of Basic Science? by C.H. Llewellyn Smithhttps://www-zeuthen.desy.de/~jknapp/JK/Reading_files/basic_science.html

https://www.nature.com/articles/s41929-017-0020-2