SCIENCE AND PUBLIC POLICY : THE ROLE OF THE SCIENCE ACADEMIES IN THE POST –TRUTH ERA

Policy for Science and Science for Policy: Role of Science Academies

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27 December 2017

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PUBLIC PERCEPTION OF SCIENCE IS IN A FLUX

- A scientific order, philosophy and public policy that served us for over seventy years now appears broken
- The social contract between practitioners of science, the beneficiaries of science and the economic and political environment that defined scientific enterprise appears no longer relevant
- There is a need to construct a new science and public policy framework and dialog that will defend future science

EVIDENCE BASED SCIENCE IS UNDER ATTACK

April 3, 2017

- Alternative facts
- Fake news and misinformation
- Instant analysis on social media
- Ultra-nationalism
- Polarized and pernicious political landscape
- Mythology masquerading as history

Civil discourse suffers both from the echo and the chamber

PRACTICE OF SCIENCE AND THE SCIENTIFIC ENTERPRISE

Money

University **Government** Laws, Regulation

Industry

(Professor/Student/Research/Thesis)

(Development, Manufacturing, Distribution/Sales)

Justus von Liebig 1803-1873

Students: Employment

Professor : Consultant

Knowledge/People

Products/Solutions

Is this model still relevant in the 21st century ?

THE BENEFICIARIES OF SCIENCE (THE SOCIETY)

- The human race in the early part of 21st century is living in an unprecedented period of peace and prosperity. More people in the world have been lifted out of penury in the last half a century, are healthier, living better and longer. So it is not surprising that an average citizen's interest in science has also waned.
- This does not mean the world has no problems; environment, sustainability, dwindling resources, energy, global warming, climate change, water etc, are issues that are threatening the long term survival of the planet.
- However, an average human mind cannot grasp issues that do not impact him in his own life time. To make a case for science for solutions that are needed in a distant future is no easy task !

THE DISCONNECT BETWEEN SCIENCE AND SOCIETY

- In reality, practical importance of scientific discoveries are often overestimated and hyped by the scientific community, purely for selfish interests.
- Have you wondered how many cures for cancer have been announced in the past few decades or how many methods to capture carbon dioxide?
- Consequently, the credibility of science driven solutions to problems faced by the society has suffered damage.
- Common man is more interested in short term solutions that will make his life better in his life time !

This has led to more and more demand for short term focus

THE POLITICAL AND ECONOMIC ENVIRONMENT

- Shrinking global economy and competing demand for resources for human development is putting severe pressures on Government's discretionary expenditures.
- Public policies in science is therefore demanding quick return on investments implying relevance and importance to national objectives
- While current national objectives may be momentarily worthy, decisions based solely on this premise may ultimately diminish our capacity to produce any kind of science
- What is considered good science and find support today may fall from favor tomorrow

The greatest folly in public support for science is the belief that science can provide solutions to society's problems in the time frame which defines Government longevity and election cycles

UTILITARIAN AND ROMANTIC VIEW OF SCIENCE: BERNAL Vs POLANYI

- Utility is the central objective of the scientific enterprise
- Central role of state in supporting / promoting science
- The rationale for organized science, government funded or directed science

- Individual scientists pursuing truth leads to the most efficient social outcomes

The Social Function of Science, J.D. Bernal, George Rutledge and Sons, 1939.
Roger Pielke, Nature, 27 March 2014, Vol. 507, 427
The Sage of Science, A. Brown, Oxford University Press, 2007

Michael Polanyi The Republic of Science : Its Economic Theory, Minerva, I , 54 (1962)

IN DEFENCE OF BASIC RESEARCH

- Should scientists be restricted by shortsighted timelines and narrowly defined objectives ?
- Curiosity driven research is under pressure to justify itself; It is endangered and has become vulnerable
- Today's prevailing policy is to measure the value of research solely on whether it is useful, whether the research addresses a social problem or whether it is possible to deliver a marketable product in the foreseeable future, preferably within a few years

On the Usefulness of Useless Knowledge
Nature Reviews, Chemistry, 11 January 2017
Doi:10.1038/S41570-016-0001

PUBLIC FUNDING OF SCIENCE

- Most of the arguments on why public Government funding is needed for science have been constructed by the scientific community themselves ; and almost all of them are wrong !
- Public funding of science is looked at as charity; we have lost sight of the economic underpinning of Government investment in science
- Scientists love public / Government funds, because it comes with no obligations other than to their own community; funds from other sources demand far greater accountability

THE APPROPRIABILITY CONUNDRUM

- How well do the rewards flow back to the investor (in this case the Government) who is investing in science and taking the risk?
- The problem is that the returns from basic research are large, but they are not appropriable !
- The nature of basic research is that the results freely flow to the world. The monetization of basic research in terms of patents, products and economic growth may not necessarily occur in the laboratory where the work is originally done or even in the same country.
- Basic research leading to discoveries is a public good with low appropriability

This shifts the emphasis by Governments to more appropriable R&D, that is more "D" and less "R"

BASIC RESEARCH IN TIMES OF CHANGE IN SOCIAL CONTRACT BETWEEN SCIENCE AND SOCIETY

Do basic research

(and someone will solve societal problems)

OR

Solve societal problems

(and, by the way, if you want to do some fundamental research, that's OK

The emergence of concept of use inspired science. It means using basic science for a purpose and practical problems as stimulus to curiosity driven research (G.W. Whitesides and J, Deutch, Nature 460, 21 (2011)

PRESIDENTIAL ADDRESS

What's So Special About Science (And How Much Should We Spend on It?)

William H. Press

Scientific research probes the deepest mysteries of the universe and of living things, and it creates applications and technologies that benefit humanity and create wealth. This "Beauty and Benefits of Science" is the theme of this 2013 AAAS Annual Meeting.

The subject of my address is a different kind of mystery, although it is also related to this theme. It is the mystery of why society is willing to support an endeavor as abstract and altruistic as basic scientific research and an enterprise as large and practical as the research and development (R&D) enterprise as a whole. Put differently, it is the mystery that a unified scientific enterprise can be simultaneously the seed corn for economic advance and the confectionary corn syrup of pure, curiosity-driven scientific discovery.

The view that science can be supported as a contribution to the intellectual richness of the world has a distinguished list of adherents. In 1969, Robert Wilson explained what Fermilab would do for the country by saying, "It has nothing to do directly with defending our country except to make it worth defending" (*1*). And, almost two centuries earlier, in his first annual address to Congress, George Washington wrote, "[t]here is nothing which can better deserve your patronage, than the promotion of Science and Literature. Knowledge is in every country the surest basis of publick happiness" (*2*).

Indeed, U.S. taxpayers are, to some extent, willing to pay for activities that enrich American social and cultural capital without having a direct economic benefit. Congress, up to now, has appropriated about $150 million a year for the National Endowment for the Arts (NEA) and about $170 million a year for the National Endowment for the Humanities (NEH) (*3*). However, by contrast, Congress appropriates about $40 billion a year for basic research (*4*). If you plot a bar graph with these three numbers, you can barely see that the NEA and NEH numbers are not zero.

It is evident that society is willing to pay much more for curiosity-driven research in science than for the analogous thought- and beauty-driven practice of the arts and humanities. It is easy to guess the reason: the link, sometimes subtle but repeatedly established over time, between investment in basic research and macroeconomic growth. Discovery leads to technology and invention, which lead to new products, jobs, and industries.

Such is the case that we scientists need to reinforce in the austere times that we face. However, mere repetition is not an effective strategy. In today's lean times, we need to articulate our case more powerfully and in a more sophisticated way than in more prosperous times. A skeptical and stressed Congress is entitled to wonder whether scientists are the geese that lay golden eggs or just another group of pigs at the trough.

More Than a Century of Exponential Growth

Figure 1 shows the growth in U.S. gross domestic product (GDP) per capita over the past 130 years. If we ignore a few bumps with time scales of a decade or so, the curve is surprisingly well fit by a pure exponential. Note that the curve is not plotting GDP, which would grow with population and the overall size of the U.S. economy, but GDP per capita, which reflects something like the average income of each individual. Ameri-

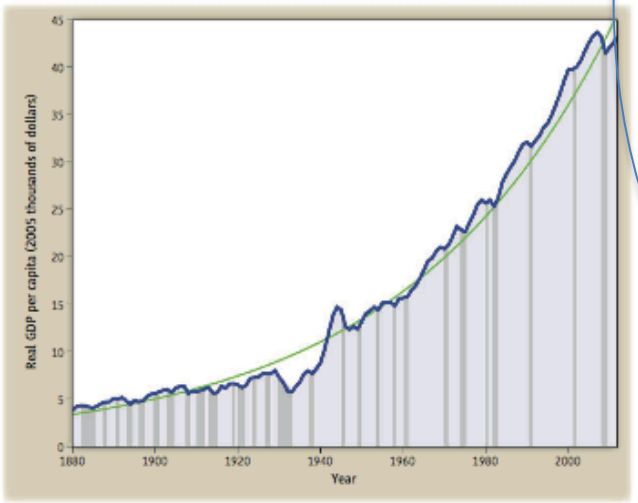

Fig. 1. U.S. GDP per capita, corrected for inflation in 2005 dollars. The smooth green curve is an exponential fit to the data. Shaded date ranges show official periods of recession. On average, an individual's income in the United States has increased by about 2% per year for more than 130 years.

CREDIT: DATA SOURCE: MEASURINGWORTH.COM, WIKIPEDIA

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SPACE Battle of the planets could see a new moon p.392

WORLDVIEW Energy scientists must show their workings p.393

OPTICS Semiconductor camera has eagle-eyed vision p.395

Beyond the science bubble

Research leaders in the United States and elsewhere should address the needs and employment prospects of taxpayers who have seen little benefit from scientific advances.

One question dominated discussions at the annual meeting of the American Association for the Advancement of Science (AAAS) at the weekend. Researchers, journalists and science lobbyists squeezed into conference rooms, perched on recycling bins and sat on the floor between rows of filled chairs as they strained to listen to those who tried to offer a response. The question was phrased in various ways, but the variations all boiled down to: how should science and scientists respond to the administration of President Donald Trump?

The answers were numerous too — from political activism to better communication — and were met with cheers, applause and the odd standing ovation. Many scientists will have left the Boston conference with renewed hope, or at least a sense of combined purpose. They had an answer of sorts to their question.

But it's the wrong question. It is not Trump that scientists must respond to. The real question is what science can do for the people who voted for him. Exactly who did support him, and why, is still being debated by political scientists, but it's clear that many of those who voted Trump are those he canvassed in his campaign and credited in his inauguration speech. It is people who feel left behind by supposed progress and who have suffered a real or perceived collapse in their quality of life.

PERSUADING THE UNCONVINCED

One speaker at the AAAS meeting appropriately sharpened the challenge. There are two types of taxpayer: those who pay up voluntarily because they believe in the public good that the money generates, and those who pay only because they will be put in jail if they don't. How many scientists, he suggested, could confidently say their project was so important to people that those people should be thrown into prison for not supporting it?

Just telling the same old stories won't cut it. The most seductive of these stories — and certainly the one that scientists like to tell themselves and each other — is the simple narrative that investment in research feeds innovation and promotes economic growth. 'It's the economy, stupid', so the saying goes, and as nations become a little less stupid by pushing against the frontiers of knowledge, so the benefits of all this new insight spread from the laboratory to the wider population, as improvements in the standard of living and quality of life.

This comfortable story has all the hallmarks of a bubble waiting to pop. For a start, it always has a happy ending. The hero of various quests, science slays the dragon of childhood disease and retrieves the elixir, if not of everlasting life, then at least of increased lifespan. And ,like all good stories, this one comes with a pleasing twist: for when it sets off on its quest, science does not know exactly which good deeds it is planning to perform. Pure of heart and research, it is merely enough to send our science hero out into the world, with its consumables, overheads and a postgraduate squire paid for by donations from a grateful and trusting public.

This narrative is truthful enough to have sustained itself for many decades. From the famous discovery of the apparently useless laser that launched uncountable applications to how Einstein's theories of relativity underpin the Global Positioning System — these stories indeed make a case to Trump and his supporters that continued investment in science will help to create companies and jobs.

But as this journal and others have pointed out, it is also clear that the needs of millions of people in the United States (and billions of people around the world) are not well enough served by the agendas and interests that drive much of modern science. There are plenty of reports that show, for example, how public investment in the Human Genome Project has paid off many times over and created firms and jobs, but rather than trickling down through society, these benefits of discovery science arguably deepen the pools of wealth and privilege already in place — creating expensive new drugs that most people cannot afford.

"The needs of millions of people in the United States are not well enough served by the agendas and interests that drive much of modern science."

It is right that more scientists should tell stories of the good their research can do. But it is more important and urgent than ever that researchers shou
stories really end — a
of the people they clai
get to live happily ev
should focus more effo
cation and scientific research can help the man
to be displaced by the very inventions that scie

As they ponder their next move in respo
Trump, science organizations — universities, fu
the rest — should look harder at social proble
and seek ways for science to help.

For example, some universities are incre
climate-change adaptation. There will be employment opportunities in creating companies that help cities and other regional communities to protect themselves from climate change (whatever the sceptics may be saying), stimulated by the readily applicable and intellectually stimulating insights and improved decision-making that research will deliver.

More universities, for example, could follow the example of Michigan State University in East Lansing, in building stronger links with their local communities, and seeking to work with them to tackle research problems that affect their quality of life. These include monitoring soil and water quality, for example, and addressing the challenges of regional demographics, such as the large numbers of elderly people who live alone in some regions and how to deliver health care to them.

There is also a need to tell these stories compellingly — stories that are harder to tell and of less global impact than the hunt for fundamental particles or new materials. And the most important audiences may not be inclined to listen. But those audiences matter. ■

Do the needs of the people served by the agenda and interests of modern science ?

Stories of impact of science on society is becoming harder to tell; and our stakeholders are increasingly less inclined to listen

Nature, 23 February 2017, p.391

THE FUTURE OF SCIENCE

- Science increasingly is interdisciplinary and cross functional
- New paradigms in research funding; public funding increasingly tied to demonstrating measurable benefits to society
- Turbulence on global economy and politics beset with income inequality, low growth, anti-intellectualism and oscillations between globalization and isolationism
- An impatient citizenry, looking for quick solutions and increasingly aspiring for an “ideal” world, which may be beyond our reach

Science, technology and public policy is yet to come to terms with this new reality; we seem to be seeking solutions to future problems using old processes and methods

SCIENCE IN THE 21st CENTURY

- Scientific, technological and social trends are rapidly transforming the way we live and work
- Technology is ubiquitous in the world we inhabit today; yet an average citizen has far little understanding of science and technology today than in the past
- Public policy discourse has also tended to become biased, opinionated with selective dissemination of information
- We all realize that science and technology have to provide answers to many critical problems that we face today; yet we do not have a coherent and shared vision of how we will accomplish this goal

SCIENCE ACADEMIES ROLE IN SCIENCE POLICY

- ***Policy for Science***

- Focus inwards : reform in the way science is taught and practiced in our institutions; unchallenged assumptions about how science works threaten its support and diminish its ability to contribute to society; defending blindly unfettered curiosity-driven research puts the research enterprise in jeopardy
- Define policies that will create fulfilling career opportunities to the vast majority of students pursuing science education and research; we cannot be merely focused on the creamy layer of top 20 %
- With increasing shift in higher education and research to private universities, define methods to bring them into the main stream of national scientific enterprise
- Define structures and models that will turn science into social outcomes; how do we encourage academic investment in "socially valuable knowledge" ?
- How can academies become more "Inclusive" and less "elitist" so that we hear the voice of all stake holders

SCIENCE ACADEMIES ROLE IN SCIENCE POLICY

- ***Science for Policy***

- Provide proactively inputs for science policy and planning, now that Government has vacated this space
- Voice of the Academy should be heard on some of the compelling issues of our time, viz, urban mobility, energy and fuels, biodiversity loss, water, sustainability, neglected diseases, public health, agriculture etc
- Commission, oversee, peer review data-driven and evidence-based reports that will stand scientific scrutiny; use professional resources to publish ; co-opt experts from outside of the fellowship
- Can Academies create social media interface through which scientists can communicate to the public (e.g recent initiative of the Indian Academy of Science, Bangalore)

THE CHALLENGE

- It takes much more than science to make an impact on society. The complex nature of modern science and technology requires a assembling a jigsaw puzzle of complementary and essential capabilities; finding, understanding visualizing and assembling these capabilities is expensive and difficult
- This requires reforms within the scientific enterprise and outside
- Can academies catalyze this transformation?

Scientists will have to wage a new war; for this we will have to regain some of the authority of science. We need to present science as science in action. This is risky because we make the uncertainties and controversies inherent in science explicit; but there is little choice

Bruno Latour, Science, 13 October 2017, p.6360

THANK YOU

for your patient listening

THE RELATIONSHIP BETWEEN SCIENCE AND ECONOMIC DEVELOPMENT

- The integration of Vannevar Bush's tenet with the economic theories of Joseph Schumpeter and Robert Solow in the early fifties led to the identification of technology as a factor of production along with land, labour and capital
- This led to greater justification for Government investment in S&T as all factors of production were under the purview of the Government
- The connection between basic research and macroeconomic growth was based on a linear model that believed that scientific discoveries lead to invention and technology, which in turn leads to new products, industrial growth and job creation

This linear model is no longer relevant

TRANSLATIONAL SCIENCE IN ACADEMIA

- What is translational science ?
- What systemic changes in academia are needed to enable translational science ?
- What are the risks or opportunities ?
- What is the ecosystem needed for translational science?
- Is there a case for a new model for educating and training the future scientists?

Simply put, the “D” in R&D means translation !