

Rescuing Science

*Recovering Science
as Civic Virtue*

J. SCOTT TURNER

NATIONAL
ASSOCIATION
of SCHOLARS



Rescuing Science

Recovering Science as Civic Virtue

A report by the

NATIONAL
ASSOCIATION
of SCHOLARS

13 West 36th Street, 4th Floor
New York, NY 10018

Author

J. Scott Turner

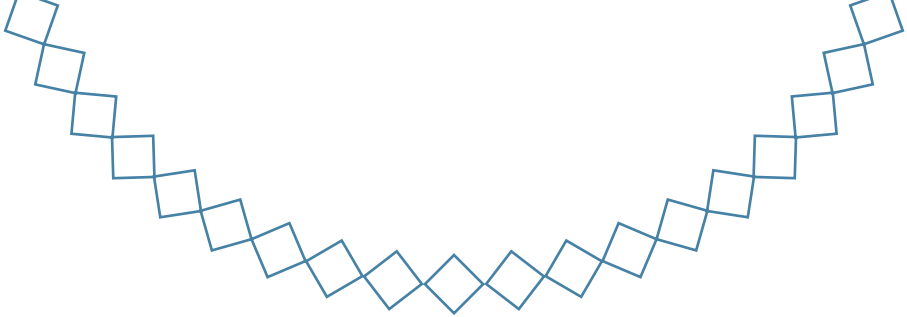
Director of Science Programs
National Association of Scholars

Cover Design by Beck&Stone

Typesetting by Chance Layton

Published February 2026

© 2026 National Association of Scholars



About the National Association of Scholars

Mission

The National Association of Scholars is an independent membership association of academics and others working to sustain the tradition of reasoned scholarship and civil debate in America's colleges and universities. We uphold the standards of a liberal arts education that fosters intellectual freedom, searches for the truth, and promotes virtuous citizenship.

What We Do

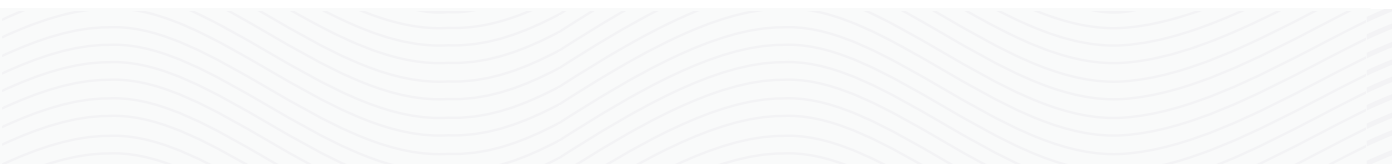
We publish a quarterly journal, *Academic Questions*, which examines the intellectual controversies and the institutional challenges of contemporary higher education.

We publish studies of current higher education policy and practice with the aim of drawing attention to weaknesses and stimulating improvements.

Our website presents educated opinion and commentary on higher education, and archives our research reports for public access.

NAS engages in public advocacy to pass legislation to advance the cause of higher education reform. We file friend-of-the-court briefs in legal cases defending freedom of speech and conscience and the civil rights of educators and students. We give testimony before congressional and legislative committees and engage public support for worthy reforms.

NAS holds national and regional meetings that focus on important issues and public policy debates in higher education today.



Membership

NAS membership is open to all who share a commitment to its core principles of fostering intellectual freedom and academic excellence in American higher education. A large majority of our members are current and former faculty members. We also welcome graduate and undergraduate students, teachers, college administrators, and independent scholars, as well as non-academic citizens who care about the future of higher education.

NAS members receive a subscription to our journal *Academic Questions* and access to a network of people who share a commitment to academic freedom and excellence. We offer opportunities to influence key aspects of contemporary higher education.

Visit our website, www.nas.org, to learn more about NAS and to become a member.

Our Recent Publications

Case Studies of DEI at America's Technical Institutes Series. 2025.

Shifting Sands: False Positives. 2025.

The Archimedes Standards: Model PreK-12 Math Standards. 2025.

Ideological Insistence. 2025.

Waste Land: The Education Department's Profligacy, Mediocrity, and Radicalism. 2025.

Instagram the Intifada. 2024.

Shifting Sands: Zombie Psychology. 2024.

Shadow of Influence: Uncovering Hidden Foreign Funds to American Universities. 2024.

China and Our Children. 2024.

The Franklin Standards: Model K-12 State Science Standards. 2024.

The Illusion of Institutional Neutrality. 2024.

Contents

Introduction	7
Science and Government	11
1. The transformation of science from civic virtue to public good	11
2. The rise of Big Science.....	24
Restore the Small Science Ecosystem.....	37
Policy Reforms.....	39
1. Indirect costs reform.....	39
2. Return grant proposal review solely to scientific merit.....	47
3. Fund research separately from facilities and administration	50
4. Phase out the project model for academic research.....	52
5. Refocus university science on basic science.	59
6. Graduate student education reform	63
Cultural Reforms	66
1. Take back control of the scientific professions	67
2. Is the university the natural home for basic science anymore?	69
3. Rebuild philanthropic and private funding for science.....	72
To Rescue Science	79

Introduction

The scientific endeavor has taken many forms through history. Presently, that form is shaped by a radical experiment launched in the 1950s, that government should be the principal means for support of *basic* research, perhaps more accurately described as *curiosity-driven* research.

Prior to World War II, government involvement in science was aimed largely at practical ends and problem-solving: *applied* research in agriculture, mapping and exploitation of natural resources, and public health. University scientists were left to pursue *basic* questions about the fundamental nature of nature. What is the atom? How do birds migrate? How do brains work? In pursuing such questions, academic science had as its only aims to explore what is unknown, and to advance our understanding of the world.

World War II drew on basic science in a way that proved crucial to Allied victory in the war. That experience motivated a question from President Franklin Roosevelt: what other jewels could be mined from those academic laboratories? In 1944, Roosevelt asked Vannevar Bush, his scientific advisor during the war, for his recommendations on just how the federal government could help uncover those jewels, in the hope that the peace and prosperity of the post-war world could be secured by American leadership in the sciences. Bush assembled a distinguished team of scientists, engineers, technocrats and administrators to study the issue and make recommendations for the way forward. Their 1945 report, *Science: The Endless Frontier* (*STEF* henceforth) became the founding manifesto for the modern era of Big Science.¹

STEF made the case that the federal government should do what it had long declined to do: subsidize the basic sciences with taxpayer dollars. In so doing, it was claimed, the government would fertilize discoveries of what as yet was undiscovered, save for the resources needed to discover them. The federal government would henceforth provide those resources. After five years of Congressional debate

1 Hiltzik, M. (2016). *Big Science: Ernest Lawrence and the Invention that Launched the Military-Industrial Complex*, Simon & Schuster.

and one presidential veto, the radical experiment with Big Science began, with the passage of the National Science Foundation Act of 1950.

We are now seventy-five years into that hopeful experiment. The NSF funding model has spread throughout the federal government, with numerous federal agencies now funding science in the universities. Where the pre-war presence of federal and state governments in academic sciences had been minuscule, it now dominates the funding landscape.

As for any experiment, the question must eventually be asked. Has it “worked,” that is, has it upheld the hypothesis that government funding of the academic sciences would fertilize discovery? If, on the other hand, the experiment has failed, an additional question must be asked: should it continue to be funded by taxpayers?

We can now confidently say that the experiment has failed - decisively. Not only has generous government funding failed to stimulate discovery, it has set in place an array of perverse incentives that have actually smothered the spirit of discovery that the experiment was intended to support. Government support of academic science has now morphed into a massive government spending program, increasingly disconnected from its mission and the results it was supposed to provide. It has become, in short, a very expensive version of Head Start.

In light of the failure, the academic sciences face a new challenge: how to restore the vibrant spirit of discovery that prevailed prior to World War II? Crucial to this question is a clear understanding of how the Big Science experiment has failed science. This report begins with an exploration of how science became entangled with government. It is a long and complicated story, extending back to the founding of the American republic. The report goes on to lay out a series of reforms, both policy-oriented and cultural, to rescue science from the morass in which it is now mired.

While the Big Science experiment has failed, it has not entirely snuffed out the pre-war spirit of discovery that long prevailed in the universities. There is still fine science being done in universities, and by fine scientists. Whatever the plan for rescuing science from its current predicament, its goal should be to preserve and fan what flickering embers of discovery that remain. Extracting science from the predicament that was set in 1950 will involve a careful withdrawal of government funding from the academic sciences, while fanning those remaining embers until the sciences can themselves restore the spirit of discovery. Government cannot rescue science, only scientists can.

As this report was being prepared, the Trump administration has undertaken a radical approach to federal science funding. Many of the administration's actions parallel the recommendations outlined in this report. For instance, we recommend

radical reform of the indirect costs regime on research grants, which has simultaneously enriched universities and degraded the spirit of discovery in the scientific communities employed there. Within a month of taking office, the Trump administration undertook to cut indirect costs rates by two-thirds. For the record, we recommend deeper cuts, as well as a variety of long-term reforms in indirect costs.

Additionally, we argue that generous federal support of academic science has had a net negative effect on scientific discovery and culture, and that science would benefit if federal spending on academic research was dialed back, ultimately to zero. To much controversy, the Trump administration is now undertaking just such cuts. Again, for the record, our recommendation is to phase out altogether federal spending on academic research, to free the academic sciences from political control. The Trump administration wants to redirect federal science funding to its own political goals.

While many of the Trump administration's actions parallel our own recommendations, we nevertheless remain skeptical of the administration's motivations. Among the troubles afflicting university science has been the reduction of academic scientists to being minor players embedded in a vast network of institutions and rent seekers that we describe as the Big Science Cartel. Rescuing science will mean dismantling the entangled interests of the Big Science Cartel, which are propped up by the enormous revenue streams from federal research spending. Science will be rescued only by getting the federal government out of the academic sciences altogether.

That does not seem to be the rationale at work in the Trump administration's actions. Rather than dismantling the Big Science Cartel, the Trump administration's actions will continue it, just now redirected to new political priorities. No matter what the outcome of the current controversy, the Trump administration's strategy will ensure that academic science remains chained to the disparate and contrary interests of the Big Science Cartel. The goal should be to liberate the basic sciences from the ebbs and flows of American politics. The Trump administration's current campaign will ensure that the academic sciences will remain political pawns.

1. Rhodes, R. *The Making of the Atomic Bomb: 25th Anniversary Edition*. (Simon & Schuster, 2012).
2. Numbers, R. L. *Galileo Goes to Jail : and Other Myths about Science and Religion / edited by Ronald L. Numbers*. (Cambridge, Mass. : Harvard University Press, 2009., 2009).

3. Kealey, T. Bacon's shadow. *Prospect* (2005). <https://www.prospectmagazine.co.uk/essays/56979/bacons-shadow>.
4. Kaiser, D. *How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival*. (W. W. Norton, 2011).
5. Bird, K. & Sherwin, M. J. *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer*. (Knopf Doubleday Publishing Group, 2007).
6. Bush, V. Science. The Endless Frontier. A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945 (Washington, D.C., 1945).

Science and Government

1. The Transformation of Science from Civic Virtue to Public Good²

Science and the American culture of civic virtue

Science - the notion that nature is a rational place that can be understood through reason - has flourished in many diverse cultures throughout human history. All the while, science has presumed to offer a transcendent value that bridges human cultures. The motion of the planets and the law of universal gravitation apply for all cultures. Mathematics is a truly multicultural endeavor.

Even so, science is necessarily embedded in culture, which looks at nature through its own colored lenses.³ Sometimes those views are contradictory, as in Galileo's too-close-for-comfort encounter with the Catholic Church.² Sometimes, science is viewed in a utilitarian light, something to be marshalled to serve economic or geopolitical objectives, as when Francis Bacon argued for Crown support of technology and global exploration³, or later when science was mobilized to serve the needs of a nation at war.⁵ Or culture may bring new and unexpected perspectives to long-standing scientific questions, as how dissident physicists in the 1960s and 1970s grappled with some of the spookier aspects of quantum theory.⁴

In the cultural *milieu* of the American experiment, science has traditionally been regarded as a kind of *civic virtue*, something to be cultivated by a free people governing their own affairs.⁴ This sentiment is embodied in Article 1, Section 8 of the US Constitution ("... to promote the progress of science and the useful arts ...") as part of the Constitution's *intellectual property* clause. 'Property' is the key word here:

² I drew on two major sources for this chapter: Dupree, A. H. (1986). *Science in the Federal Government: A History of Policies and Activities*, Johns Hopkins University Press; Turner, J. S. (2020) Science and the decline of the American academy. *Heritage Foundation First Principles*, 27.

³ Strevens book

⁴ Guenther, M. B. (2008). *Enlightened pursuits: Science and civic culture in Anglo-America, 1730–1760*, PhD Dissertation, Northwestern University.

scientific knowledge does not belong to a government, but properly reposes in its natural custodians, the people.

The spirit of science as civic virtue was imported into the American colonies from a similar tradition in England, exemplified by the 1760s Lunar Society of Birmingham (the “Lunar Men”), informal groups of curiosity-driven minds who laid the ground for England’s remarkable industrial and economic transformation, as much a matter of culture and class aspiration as it was of engineering and science.⁵ The Lunar Society included luminaries of the Midlands Enlightenment such as James Watt, Joseph Priestley, Erasmus Darwin and Josiah Wedgwood. Benjamin Franklin (who was well acquainted with members of the Lunar Society) planted the roots of the Midlands Enlightenment in America, embodied in his founding of the American Philosophical Society. Other prominent American luminaries, such as Thomas Jefferson were devotees of Enlightenment virtue, reflected in his 1781 *Notes on the State of Virginia*, and founding the University of Virginia, both motivated by a republican spirit of individuals governing themselves. This spirit was not limited to Franklin and Jefferson. The civic landscape from colonial times through the 19th century included numerous voluntary scientific societies, nearly 350 of them by the mid-19th century, often locally based, and often vehicles for local civic pride.⁶ These local societies were not parochial in their outlook: American ethnology, for example, traces its roots to the pioneering work of Lewis Henry Morgan and the several informal societies he formed dedicated to the language and customs of the tribes of the Iroquois Confederacy. This proliferation of libraries, small museums, and intellectual societies reflected the Tocquevillian character of American science as cultivated civic virtue.⁷

Science as a Public Good

The subsequent history of the American republic is marked by the gradual transmutation of science as a civic virtue into science as a *public good*, in the same class as roads, parks, and public water supplies. By definition, public goods are available to all members of the public and use by one user does not diminish its value to others. This definition could apply equally to the science-as-civic-virtue concept, but the shift has radical consequences. A civic virtue is undertaken voluntarily and supported by contributions of similarly-minded individuals. A public good, on the other hand, is an obligation, to be administered by government, and generally to be met through taxes.

5 Uglow, J. (2002). The Lunar Men: Five Friends Whose Curiosity Changed the World, Farrar, Straus, and Giroux.

6 Goldstein, D. (2008). Outposts of Science: The Knowledge Trade and the Expansion of Scientific Community in Post-Civil War America. *Isis* 99(3): 519-546.

7 Hoffmann, S-L (2003). Democracy and Associations in the Long Nineteenth Century: Toward a Transnational Perspective. *The Journal of Modern History* 75(2): 269-299.

Science in the United States today is treated largely as a public good, underwritten by an annual public expenditure of more than \$200 billion (Table 1). More than half of this will go to defense-related research and development. The rest goes to supporting research in universities, other federal agencies, private companies, and research facilities, such as national laboratories.

Table 1. FY2024 and FY2025 federal budgets for scientific research, and House and Senate proposals for the 10 December 2024 continuing resolution. Figures in billions of dollars. Source: American Association for the Advancement of Science.

	FY 2024 Estimated	FY 2025 Requested	FY 2025 House	FY 2025 Senate
Basic research	\$44.42	\$47.68	\$46.68	\$46.62
Applied research	\$52.85	\$52.95	\$54.49	\$52.29
Development	\$98.69	\$96.83	\$96.18	\$96.54
R&D facilities	\$4.29	\$6.21	\$5.38	\$5.50
Total R&D	\$200.25	\$203.68	\$202.72	\$200.96
Defense R&D	\$109.22	\$101.13	\$104.75	\$103.68
Non-defense R&D	\$91.03	\$102.55	\$98.15	\$97.28

The transformation of science from civic virtue into public good reflects a long-standing dilemma for science. Public support of scientific research carries with it an expectation that some public benefit will accrue, in the forms of better health, new products, new processes that did not exist before. Delivering on these public expectations rests on an assumption that spending on research reliably produces discovery of new knowledge about nature. The dilemma is this: discovery of new knowledge must proceed *without* expectations: it cannot operate as a public good, only as an expression of civic virtue. New knowledge is itself the goal of discovery, which emerges on its own unpredictable timetable and path.

The conversion of American science from civic virtue into public good took place over three major phases spanning roughly two centuries:

1. Prior to the Revolution and up to the Civil War, science as civic virtue was the prevailing attitude. Government took a deliberate hands-off approach to scientific endeavors, except for those areas where public benefit could be clearly articulated, such as promoting navigation or military necessity.
2. From the Civil War up to the mid-20th century, science became increasingly institutionalized and professionalized, culminating in what we will call the *Small Science Ecosystem*. Science as civic virtue - that is to say, *basic* science - came increasingly to be harbored in the universities and

colleges, under the guardianship of a rising class of professional scientists. *Applied* science—delivering on public expectations—came to rest in industrial research and development labs (paid for by private capital), and mission-oriented government agencies (paid for by taxpayers). Newly created educational entities—notably the land-grant colleges—were established to cultivate *applied* science. The land-grant system was a state, not a federal, enterprise.

3. Following World War II, the distinctions between science as private or public good and science as civic virtue have been nearly erased. As government has become the dominant funder of academic science, and increasingly shapes industrial research around public (political) ends, *all* science, including basic science, has become a public good. This has transformed the Small Science Ecosystem into what we may call “Big Science,” leading to the emergence of a “Big Science Cartel.”

Phase 1: Pre-Civil War

In the early years of the Republic, the federal government took a generally hands off approach to education and science. This was not due to any aversion to education or science *per se*, but to a general attitude that such things were not federal responsibilities. Thus, various proposals to establish a national university or a national academy were rebuffed by successive Congresses, on the grounds that both, being expressions of civic virtue, were best left in the hands of the natural custodians of those virtues—the people.

The early federal government did not distance itself entirely from support of science. Where it did so, it was under the umbrella of a clear constitutional authority. So, for example, national defense was a constitutional responsibility assigned explicitly to the federal government. This justified federal funding of research programs in the service academies, mostly in engineering. Similarly, the National Observatory and the Coast and Geodetic Survey carried out research in astronomy and geomagnetism, again in support of a clear federal responsibility to the needs of interstate and international commerce.

Where a clear constitutional authority could not be discerned, Congress fastidiously rebuffed attempts to involve the federal government in scientific research. This hands-off attitude is famously illustrated by how Congress dealt with the 1829 bequest of British chemist James Smithson “to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase and diffusion of knowledge among men to the United States.” It

took the efforts of at least five successive Congresses to work out how to handle Smithson's bequest. At one time, the Congress even considered returning the money to Smithson's estate, because of doubts over Congress's authority even to accept the bequest.⁸ In the end, the Smithson bequest was only accepted when a strong fiscal firewall could be erected between it and the federal government.

Even when such Congressional fastidiousness prevailed, federal support for scientific research could sometimes be pulled off, albeit through political sleight-of-hand. For example, Congress was persuaded to fund the Lewis and Clark expedition under the guise of mapping the navigable waters and natural resources of the Louisiana Purchase. Even so, Jefferson snuck basic science into the expedition, returning a treasure trove of new knowledge of the plants, animals, geology, indigenous cultures, and natural history of a vast, and largely unknown, part of the continent.

Cloaking support of scientific research behind political aims was, in fact, widespread in the early American republic. Following the Lewis and Clark expedition, several other expeditions to explore the west were cast as *de jure* military expeditions, undertaken to build networks of forts and trails to defend the westward migration of settlers. All of these expeditions had botanists, zoologists, and geologists on their rosters, however, making them also *de facto* federally sponsored scientific expeditions. In this, the federal government followed the model established by Alexander the Great and Napoleon Bonaparte in their military expeditions (which did not operate under the Constitutional constraints the Americans did).

Phase 2: The Lincoln Watershed

The Lincoln administration brought a major shift in the relationship between scientific research and the federal government, enabled by three acts of Congress, all signed into law in 1862 by President Lincoln.

1. The Morrill Act established the system of the state-based land-grant colleges. The land grant colleges were dedicated to scientific research in the agricultural and mechanical sciences: the *practical* sciences, in short.
2. The Department of Agriculture Organic Act, which established a new federal cabinet department, the US Department of Agriculture.
3. The Homestead Act, which granted parcels of land to settlers migrating into the expanding westward reach of the republic.

8 Dupree, A. H. (1986). *Science in the Federal Government: A History of Policies and Activities*, Johns Hopkins University Press.

Together, the three acts worked to give the federal government a stronger foothold in the academic sciences. The land-grant colleges were ostensibly set up as state institutions independent from federal authority. Federal authority nevertheless intruded, through the USDA and the networks of Agricultural Research Stations and Agricultural Extension offices the USDA established. This opened a conduit for funneling federal monies into supporting applied research in the land-grant colleges. Meanwhile, the rising populations of homesteaders in the western states ramped up demands for government support, which the USDA and land-grant colleges strived to provide through agricultural and mechanical research.

The extent of the government's reach into the agricultural sciences is indicated by the USDA's funding trajectory over the twenty-five year period bracketing the turn of the 20th century (Figure 1). During this time, USDA appropriations increased exponentially, doubling roughly every five years. As we shall see, this pattern of exponential growth of expenditures is repeated whenever the government intrudes into scientific research. This pattern reflects a widespread and ongoing fallacy that more spending on science produces more science and more of the derived benefits that more science is supposed to bring. In the case of the USDA, much of the exponential spending growth fueled growth of the USDA bureaucracy. Staff positions in the Agricultural Research Stations, meanwhile, came to be used increasingly as instruments of political patronage, squeezing out *bona fide* agricultural scientists.

The rise of progressive ideology through the late 19th and early 20th centuries coincided with increasing entanglement of government and science, indicated by the proliferation of new science-oriented federal agencies. Nature conservation and natural resources management were initially strong motivators: the the Fish and Wildlife Service (FWS) was founded in 1871, the United States Geological Survey (USGS) and the National Park Service (NPS) were founded in 1872, and the US Forest Service (USFS) in 1876.⁹ Ethnology of American Indian tribes became the beneficiary of federal support in 1879 with the establishment of the Bureau of Ethnology in the Interior Department.¹⁰ The Food and Drug Administration (FDA) and the Public Health Service (PHS, from which grew the National Institutes of Health, NIH) were also established at this time.

These developments reflected the shifting perspective from science as civic virtue toward science as public good, something to be marshalled and controlled for solving public issues, like epidemic disease, unsafe or ineffective pharmaceuticals, tainted foods, and social inequality, all to be undertaken at public expense.

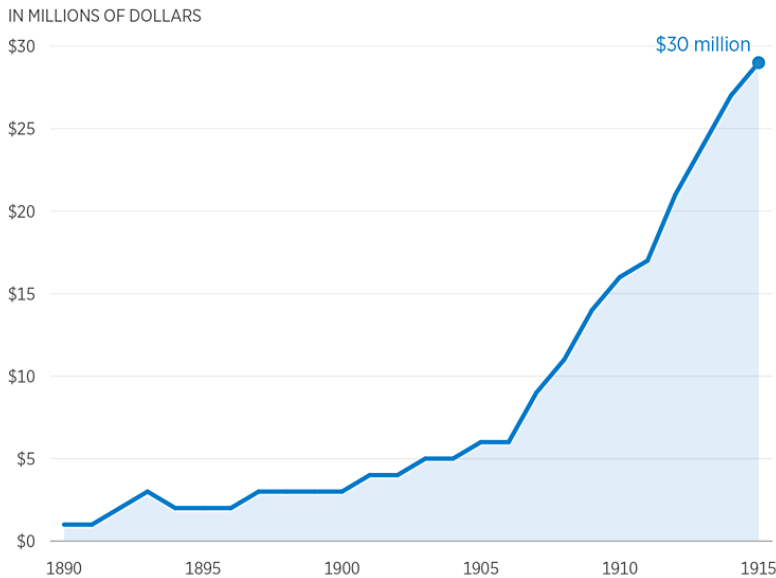
⁹ Each of these agencies began under different names

¹⁰ The Bureau of Ethnology was eventually transferred to the Smithsonian Institution, where it became the Bureau of American Ethnology.

Figure 1. US Department of Agriculture funding from 1890-1915.
Source; Dupree, A (1986), adapted from Turner (2020).

CHART 2

Total Appropriations of the U.S. Department of Agriculture, 1890-1915



SOURCE: A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities* (Baltimore: Johns Hopkins University Press, 1986), p. 182.

FP81  heritage.org

The emergence of this attitude was not driven so much by advances in scientific knowledge *per se*, but by the rise of the Christian social gospel movement, which melded Christian theology and practice to political activism. The rise of the social gospel coincided with the post-Darwinian rising tide of scientism, the notion that “science” broadly defined, is a superior guide to a just society. While progressivism’s roots had been planted in the Christian social gospel movement, “science” came gradually to replace God as the standard against which society and its problems were to be measured. Both social gospel and scientific ideologies developed along their own complicated trajectories, but were united in a common desire to broaden government action to desired social ends.

Where governments prior to the civil war had sought to sneak science in under a cloak of politics, as in Jefferson’s legerdemain with the Lewis and Clark expedition, the situation was reversed as post Civil War political aims now came to be advanced under a cloak of “science.” This is illustrated by the career of the second Director of the USGS, the charismatic John Wesley Powell, Civil War hero (whose arm had been shot off at the Battle of Shiloh), explorer (the first American to navigate the

Colorado River through the Grand Canyon) and naturalist (sometime professor at Illinois Wesleyan University).

During Powell's tenure as USGS Director, settlement of the semi-arid Southwest was underway, and scarcity of water was an obvious concern. White and Indian settlement and agriculture in the Southwest had long managed to accommodate to prevailing conditions by settling along riparian corridors, with small scale and local management of water, and an economy built around low-density semi-nomadic livestock grazing. The completion of the trans-continental railroad, the discovery of rich deposits of copper ore and other minerals, and the opening of the Santa Fe trail brought greater immigration to the Southwest, and settling them became a federal political priority. Powell was tasked with making this happen, in particular to resolve the inevitable conflict between scarce water resources and increasing demand of increased numbers of settlers. Powell's solution was to impose top-down regulatory regimes of "scientific" water management, basically using science to usurp long-settled practices of local water management and agriculture, all in the name of advancing a federal political priority. Even though Congress thwarted some of his ambitions, Powell's example of advancing political aims behind a scientific cloak set the example for future generations of activists to employ science as a cloak for various political ends, and to use science to justify top-down regulatory regimes over local interests. We are living with Powell's legacy still.

The Rise of the Professional Scientist

The latter half of the 19th century also saw the rise of a professional class of scientists, which came to displace the largely amateur class of scientists that had prevailed prior to the Civil War. Increasingly, scientists could now find professional careers *as scientists*, rather than as itinerant amateurs. The expanding industrial economy of late 19th century America generated significant demands for engineers and scientists trained in the practical sciences, which increasingly were met by the expanding land-grant colleges.¹¹ The basic sciences, in contrast, had resided mostly in the diverse array of sectarian colleges that then comprised the bulk of American higher education. While science commonly found a place in such institutions, the institutions themselves often had priorities other than science, such as training for the clergy, perpetuating social class or standing, or commerce.

The roots of a rising professional class of academic scientists had been planted in Prussia earlier in the 19th century. Following Prussia's 1806 defeat by Napoleon, and the revolutions that swept Europe in 1848, the Prussian state embarked on a radical change of policy toward science and education. At the time, science in the German universities followed the Enlightenment ideal of knowledge for knowledge's

11 Adams, S. (2021). The Late-19th-Century Economy. *The Oxford Research Encyclopedia of American History*, Oxford University Press.

sake: the romantic roots of basic science, in short. This idealistic model followed Germany's most famous naturalist, Alexander von Humboldt, who was firmly embedded in the culture of science as Enlightenment virtue, and the Enlightenment ideals of thought over practice.

Von Humboldt's older brother, Wilhelm, was a luminary and functionary in the Prussian educational ministry who sought to establish those ideals in the Prussian educational system, while at the same time reconciling them with the emerging demands for science to serve the interests of the Prussian state. Von Humboldt's reforms gave birth to the German research university. Most of the elements of our modern conceptions of university-based basic science—academic freedom, freedom of thought and inquiry, the close integration of teaching, research, the humanities and science—were planted by von Humboldt. Among these was the modern conception of the university as the natural venue for support of curiosity-driven research insulated from political and commercial interests.¹²

The emergence of the German research university was marked by a tension between two aims: should the universities be the “bearers of culture” (the romantic Humboldtian ideal), or should the universities be preparatory schools for the labor market (what we might call the practical Bismarckian ideal)? The tension was resolved in various ways throughout the developing landscape of German science and industry. Various research institutes independent of the universities were established, for example, which allowed scientists to conduct research on a topic, say microbiology, free of the teaching that was a core responsibility for a “bearer of culture.” Industrial concerns, for their part, built their own internal research programs, tasked with meeting their industries' needs for scientific expertise. Overall, there was an abiding faith that economic growth and political power depended crucially on new scientific discoveries about nature: basic science, in short. *Science: The Endless Frontier*, which launched the modern era of Big Science, strongly reflected this article of faith.

In 1876, the German research university model was imported into the American science ecosystem with the founding of the Johns Hopkins University, which incorporated many of its features: dedicated departments of science, permanent science faculty protected by tenure, and graduate education in the sciences. So successful was the Johns Hopkins model that it inspired other philanthropists to found their own new universities, including Stanford University (Leland Stanford) and Syracuse University (Andrew Carnegie). Established colleges like Harvard University began to transform themselves from secular colleges into research universities. State-run universities like the University of California also adopted the

12 Lenoir, T. (1998). Revolution from above: The Role of the State in Creating the German Research System, 1810-1910. *The American Economic Review* 88(2): 22-27.

research university model. Philanthropists established independent research institutes, as in the Carnegie Foundation's support of the Station for Experimental Evolution at Cold Spring Harbor, on Long Island. Industrialists set up their own internal research institutes such as the Bell Labs, which carried out pioneering work on communications and semiconductor technology.¹³

The emerging system of research universities supported the rise of the new American class of professional scientists that came to dominate the academic sciences. Where the pre-Civil War science ecosystem had been dominated by a Tocquevillian network of amateurs, the late 19th century saw an increasing presence of semi-amateur scientists employed by colleges and universities. The institutional attachments of these semi-amateurs often were flexible. John Wesley Powell's professional affiliation with Illinois Wesleyan University, for example, was only five years, and he bounced between various lecturing positions at Wheaton College and Oberlin College. Edward Drinker Cope, the paleontologist who opened up American paleontology and was America's pre-eminent scientist of the late 19th century, had an on-again-off-again affiliation with Haverford College in Pennsylvania. Similar informality marked the careers of several scientists of this era. The botanist Asa Gray, for example, bounced between various teaching, exploration, and curating jobs until finally settling at Harvard University, where he spent thirty years as Professor of Botany.

The "Small Science Ecosystem"

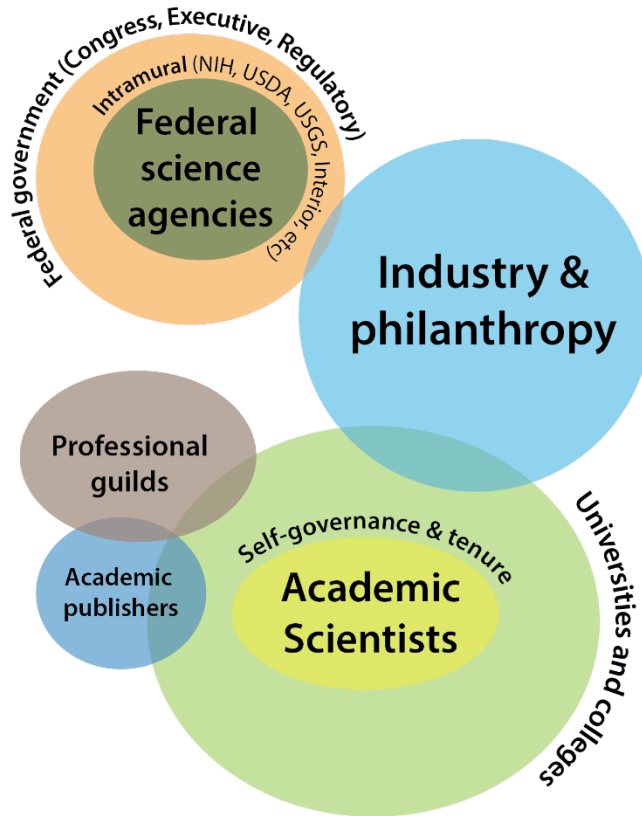
By the mid-20th century, the various practices and motivations of scientists had resolved themselves into an informal "Small Science Ecosystem" consisting of three complementary, but largely separate, realms (Figure 2).

1. *Government science-based agencies.* Agencies such as the USDA, PHS, USGS, USFS, FWS, the FDA and others employed scientists as civil servants who were expected to engage in "mission-oriented research." Research was tied explicitly to political ends, and was funded through government appropriations.
2. *Industrial and privately-funded research laboratories.* Scientists were employees of private research and development laboratories (e.g. General Electric) whose work was geared to the development of products or processes for profit.
3. *University-based departments of science.* Scientists employed by universities were generally motivated by the Humboldtian ideal of curiosity-driven research melded with teaching. These were largely supported

13 Gertner, J. (2013). *The Idea Factory: Bell Labs and the Great Age of American Innovation*, Penguin Press.

by institutional and philanthropic funds, including funds derived from tuition. Research was organized largely around *ad hoc* projects guided by curiosity, intellectual opportunism, and without reference to a particular end or product.

Figure 2. Elements of the small science ecosystem that prevailed in early 20th century American science.



Universities in the Small Science Ecosystem had evolved into safe havens for scientists pursuing the Humboldtian ideal of basic science. By 1915, the basic outlines of protection of tenure and academic self-governance had been planted, which provided academic scientists some measure of intellectual independence and job security. Academic scientists also attended to their interests through autonomous professional guilds, such as the American Geological Society, or the American Society of Zoologists. These were supported by qualified dues-paying members, often published their own scientific journals, awarded prizes and honors to their members deemed worthy by the members of the guilds, and often were consolidated from the existing Toquevillian network of local museums, libraries, and scientific organizations. As a result, academic scientists effectively retained control of their professions, and all aspects of their professional practice: science curricula, networks

of prestige and rewards, dissemination and evaluation of their findings, and most significantly, the tradition of science as civic virtue.

More succinctly, academic science in the Small Science Ecosystem operated under what Stephen Turner and Darryl Chubin have termed an *ethic of discovery*,¹⁴ shaped around the so-called “Mertonian norms” of science, expressed as an acronym, CUDOS:¹⁵

- **Communalism**
- **Universalism**
- **Dispassionate and/or Disinterested**
- **Organized Skepticism.**

Adherence to the Mertonian norms formed the framework of incentives and disincentives that shaped scientists’ careers in the Small Science Ecosystem.

The distribution of funding of scientific research in the Small Science Ecosystem was dominated by industrial research and development (Figure 3), powered by the robust economic growth of the late 19th and early 20th centuries (which averaged around 7% per annum). Much of this growth centered around new technical developments in electrification, power generation and transmission, transportation, and telecommunications. All these areas required a well-trained scientific work force, which the research universities and land grant colleges were largely able to provide.

At their peaks, total expenditures for scientific and technological research amounted to less than a half percent of GDP, with industrial research accounting for about 60% of the total. Colleges’ and universities’ expenditures on scientific research were comparatively modest, accounting for about 10% of total expenditures.

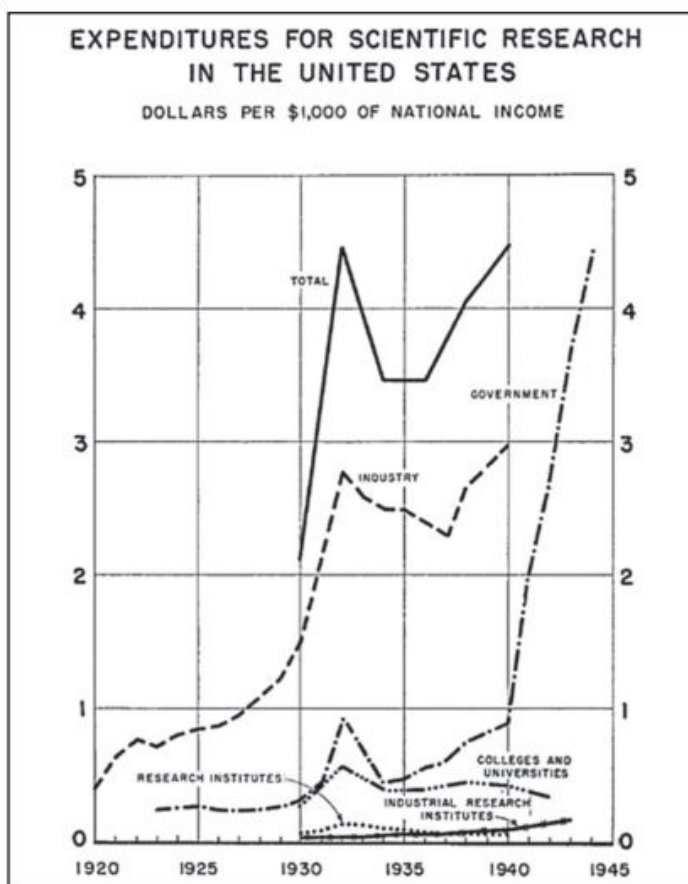
The Small Science Ecosystem was fertile ground for vigorous and innovative scientific progress. In colleges and universities, research needs were met as they arose, and were supported largely out of institutional funds, such as university endowments and gifts. Private individuals and philanthropic foundations also filled the bill. Government expenditures for research were commonly *ad hoc*, disorganized, and minuscule. In the interval between World Wars I and II, for example, the federal government empaneled a Council of National Defense (CND), eventually to be superseded by a National Defense Research Committee (NDRC). These served largely in advisory roles, and with very limited authority to grant funds.

This landscape of funding was well suited to the nature of basic science, and the Small Science Ecosystem supported a flourishing scientific culture. Particle physics was a robust field of inquiry. The first cyclotrons were built around surplus

14 Turner, S. P. and D. E. Chubin (2020). The Changing Temptations of Science. *Issues in Science and Technology* 36(3): 40-46.

15 Merton, R. K. and N. W. Storer (1973). *The Sociology of Science: Theoretical and Empirical Investigations*, University of Chicago Press.

Figure 3. Expenditures for scientific research in the United States from 1920 to 1945. The measure of dollars per \$1,000 national income (roughly equivalent to Gross National Product) is convertible to percent GNP by dividing the number by 10. Source:



magnet cores that were donated by private companies, for example.¹⁶ Thomas Hunt Morgan carried out pioneering work on genetics in his cramped “fly room” filled with milk bottles and banana mash, and supported by the Rockefeller Foundation.¹⁷ Robert Goddard’s pioneering research in rocketry was supported with modest funding from the Smithsonian Institution, and a network of patrons, including the Guggenheim Foundation.¹⁸ Significant discoveries in semiconductors were being made in the remarkable Bell Labs.¹⁹ Prior to 1928 at least, the country was enjoying significant economic growth, fueled by new technologies of electrification, power generation, communications and automation.

16 Hiltzik, M. (2016). *Big Science: Ernest Lawrence and the Invention that Launched the Military-Industrial Complex*, Simon & Schuster.

17 Goodstein, J. R. (1991). The Thomas Hunt Morgan Era in Biology. *Caltech Engineering and Science* Summer 1991: 12-23.

18 Hunley, J. D. (1995). The Enigma of Robert H. Goddard. *Technology and Culture* 36(2): 327-350.

19 Lojek, B. (2021). *William Shockley: The Will to Think*, Springer International Publishing; Shurkin, J. N. (2006). *Broken Genius: The Rise and Fall of William Shockley, Creator of the Electronic Age*, Palgrave Macmillan.

2. The Rise of Big Science

The Roosevelt Watershed

The science ecosystem began to shift with the looming mid 20th century crises that would launch World War II. The aforementioned National Defense Research Council (NDRC) was formed to mobilize science in preparation for war. Government research expenditures began to ramp up modestly after 1934. In 1940, out of concern that the NDRC's work was too narrowly focused, the Roosevelt administration established the Office of Scientific Research and Development (OSRD). Roosevelt's pick to head the OSRD was Vannevar Bush, who had had a distinguished career as engineer, scientist, academic, and philanthropist. Under Bush's leadership, the OSRD began to fund numerous ambitious projects, most prominently the Manhattan Project, as well as similarly-motivated projects in communications, weapons control and automation, and improved manufacturing and logistics. The OSRD's activities account for the rapid rise in government research expenditures beginning in 1940 (Figure 3).

As American victory in the war was approaching, the OSRD's spectacular success opened up a new question for Roosevelt. If mobilizing basic research had played such a significant role in helping secure victory in war, could basic research similarly be mobilized to secure the peace? In his 1944 charge to Vannevar Bush, President Roosevelt characterized his vision in this way:

“New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful life.”

To help answer his question, Roosevelt tasked Bush with assembling a group of prominent scientists, engineers, physicians, and university administrators to study the matter, and if warranted, to make the case for expanded federal funding of basic research in universities and colleges. The product of this group's labors was the 1945 report to the president, *Science: The Endless Frontier*.²⁰

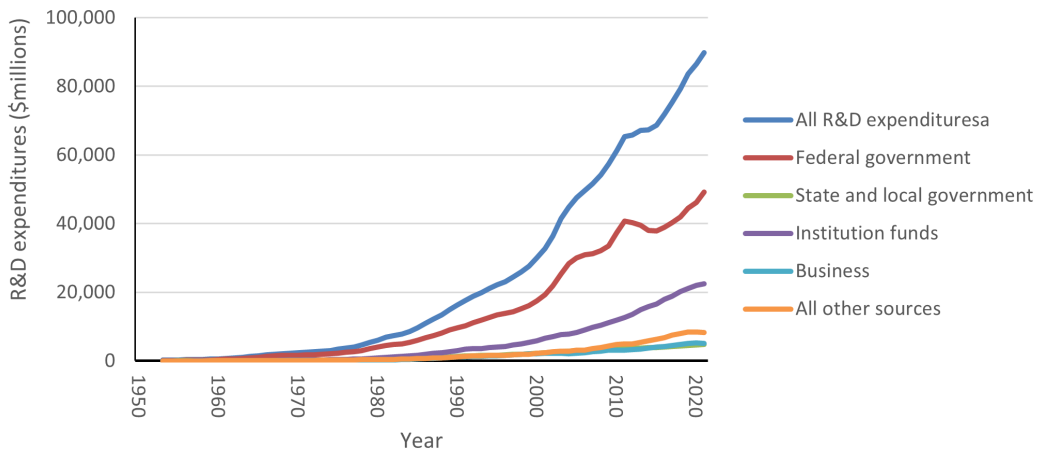
Roosevelt died before the end of the war, so implementing STEF's visionary plan fell to the Truman administration. Truman's plan of action was for the Congress to establish a federal program to support basic research in universities and colleges. It took five years of legislative wrangling to sort out a number of issues related to administrative structure, public accountability, and intellectual property. In 1948, Congress passed the National Science Foundation Act of 1948, which presumed to resolve those issues. Truman vetoed that legislation, on the grounds that it was not

20 Bush, V. (1945). *Science: The Endless Frontier*. A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945 Washington, D.C.

sufficiently responsive to public and government oversight: to the accountability expected of a public good, in short. Correcting these issues culminated in the 1950 passage of the National Science Foundation Act (Public Law 81-507), which established the National Science Foundation (NSF), and which Truman signed into law.

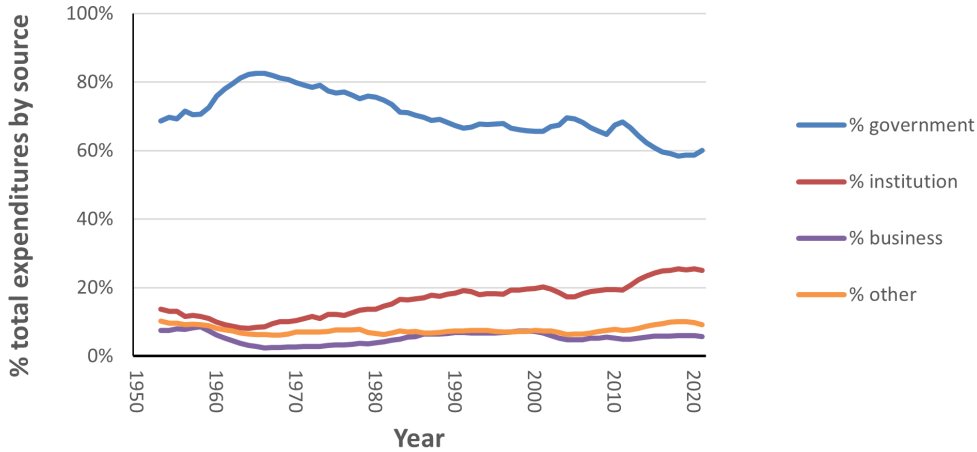
Where the Lincoln watershed had circumscribed federal support for research around ostensibly practical ends, the establishment of the NSF was the initiating event of what we may call the Roosevelt watershed. In 1953, the NSF issued its first research grants, disbursing \$138 million in its first year. Since 1953, government expenditures for research have doubled roughly every seven years (Figure 4), rising to their present levels of about \$100 billion (Table 1). Where government support for academic science prior to the war had been minuscule, government now became science's dominant post-war funder, contributing between sixty and eighty percent of total university research expenditures (Figure 5).

Figure 4. Expenditures for scientific research in American universities and colleges. Source: Higher Education Research and Development (HERD) Survey. National Science Foundation.



The founding of the NSF opened the door to an extensive expansion of existing agencies into support of academic research, through so-called extramural research programs. A few years prior to the NSF being established, the National Institutes of Health (NIH) began to fund extramural research contracts, mostly in medical schools, to supplement the work of the NIH's "intramural" research scientists, that is, NIH scientific staff.²¹ Following the establishment of the NSF, the number of federal agencies issuing extramural research grants has grown to twenty-six, with the NIH being the biggest funder of extramural research. The NIH's extramural

21 <https://hekint.org/2022/10/18/the-origins-of-nih-medical-research-grants/>

Figure 5. Proportion of expenditures on research in institutions of higher education.

research grants, which began as a small supplement to the NIH's research profile, now constitute 86% of the NIH's research expenditures.²²

The Hopeful Experiment of Science: The Endless Frontier

Science: The Endless Frontier was strongly motivated by the Humboldtian ideals of academic science that had prevailed in the Small Science Ecosystem: freedom of inquiry, curiosity-driven research, protection of tenure, an ethic shaped by the Mertonian norms, and training of new generations of scientists to perpetuate those norms.

STEF's hopeful vision was predicated on the assumption that government funding would promote discoveries that, for want of funding, would otherwise remain undiscovered. According to *STEF*'s authors, the traditional avenues that had funded academic research pre-war—institutional funds, donations, and philanthropic foundations—could no longer be expected to rise to the task, because their financial resources had supposedly been tapped out by depression and the war. To reap the benefits that basic research was expected to provide, the federal government therefore had to step in to bridge the gap.

Within that blithe assumption, however, danger lurked. Throughout, the drafters of *STEF* were keenly aware of the susceptibility of basic science to being co-opted by funders' contrary expectations. At several points throughout *STEF*, the need to protect the Humboldtian ideal was emphasized, and the concern was repeatedly expressed that the expectations that would accompany federal funding would crowd out the academic culture that basic science needed to thrive: public good crowding out civic virtue, in short. In any program to fund academic research with federal funding, the authors of *STEF* argued, pains therefore had to be taken to

²² <https://grants.gov/learn-grants/grant-making-agencies/>

insulate the unique culture of basic research from the demands of mission-oriented and commercial research interests.

The drafters of *STEF* thought that two bulwarks would sufficiently protect the intellectual autonomy of academic scientists. One would be the strong traditions of academic self-governance that had come to prevail in the Small Science Ecosystem. The other would be a kind of firewall that would be constructed between government and academy through *STEF*'s proposed funding body, the originally envisioned National Research Foundation (NRF). The NRF would be funded through Congressional appropriation. In turn, the NRF would distribute block grants to universities which could use the funds as they had used institutional funds: distributing money to researchers as ideas and needs arose, through institutional research committees, direct appeal to deans, provosts, and presidents, and where necessary, outreach to philanthropic funds. Thus, the science would be governed by scientists and universities, while the means would be provided by the Congress.

The recommended National Research Foundation was organized into five divisions, reflecting the scientific priorities of the drafters (Figure 6). A division for the natural sciences would be purely curiosity-driven research. A division of medical sciences similarly would facilitate basic research but with a conduit to the ultimate applied science, medical practice. A national defense division would play a similar role, but for defense applications. Training of new scientists was also to be included to build the nation's scientific workforce, delegated to a division of scientific personnel and education. A fifth division sought to promote publication and collaboration, which American university scientists allegedly regarded with indifference: said by the authors of *STEF* to be an "embarrassment" at international conferences (*STEF*, p82).

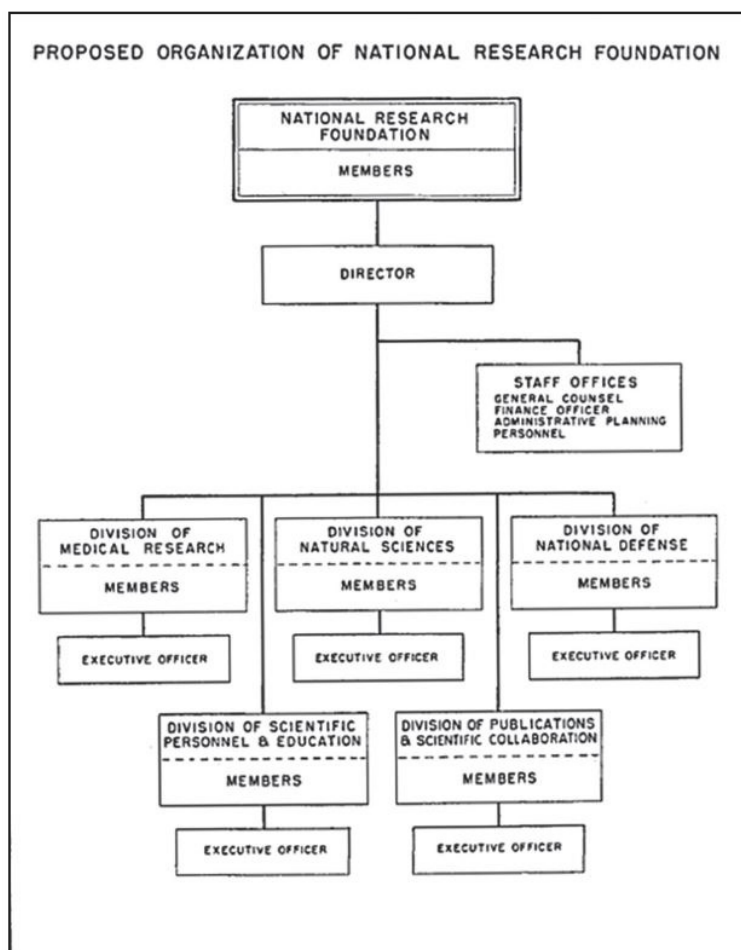
The NSF Act of 1948 adopted many of *STEF*'s recommendations, but it was the lack of accountability of public funds that was the grounds for President Truman's veto. Accordingly, the NSF Act of 1950 resolved those concerns. Rather than the five divisions recommended by *STEF*, the NSF Act established four: Medical Research, Mathematical, Physical and Engineering Sciences, Biological Sciences, and Scientific Personnel and Education. Much of the Medical Research division was soon folded into the extramural research programs of the National Institutes of Health. Military research was similarly relegated to the Department of Defense, with each service having its own research division (*e.g.* the Office of Naval Research). The NSF also was barred by statute from conducting research in nuclear energy, which was assigned to the Atomic Energy Commission (AEC).

The Research Grant Schrödinger's Cat

The 1950 NSF Act did not specify how the new NSF was to distribute grant monies. The proposal of unrestricted long-term block grants to universities had been deemed unacceptable by President Truman. Instead, the NSF adapted the ready-at-hand model of *research contracts* which the NIH had adopted a few years earlier.

The research contract had long served as the mechanism for government to fund research by outside bodies, such as private research labs. The research contract model admirably serves *applied* research projects, such as characterizing the material properties of metal alloys. As in any contract, a research contract laid out specific deliverables, timelines, and plans of work. The NIH's initial extramural grants were structured as research contracts, with specific deliverables and short-term timelines.

Figure 6. Proposed organization of the National Research Foundation.
Source: Bush, V. 1945. *Science. The Endless Frontier*.



The NSF opted to follow the NIH research contracts model, with a few modifications intended to protect university scientists' intellectual autonomy. As in research contracts, research grants would be project-oriented and would operate on a short-term (three-year) funding cycle. Unlike research contracts, which were initiated by government agencies wanting a specific deliverable, research grants would be *investigator initiated*, that is, by a scientist with an idea he wanted to explore (Table 2). If awarded, grant funds would be administered by a scientist's employer, usually a university.

Table 2. Distinctions between contracts and grants

Contracts	Grants
• Government is contractor • Short term • Specified work plan & budget • Specified timeline • Specified deliverables	• Scientist-initiated • Open ended • Fluid work plan & budget • Unknown timeline • Unknown deliverables

The grant regime established by the NSF (and since adopted by the numerous federal agencies that fund extramural research) has made research grants a kind of Schrödinger's cat, simultaneously contract / not contract, depending upon who is looking inside the box. To the scientist, the research grant is the means to scientific discovery conducted in a regime of intellectual freedom and autonomy. The investigator is motivated to apply for funds, based upon an idea the scientist wants to explore, free of outside expectations to deliver anything but new knowledge, and that on an essentially unpredictable timeline, and with no guarantee of a deliverable outcome. To the university, the research grant is a contract with specific terms to be fulfilled (Table 2).

Many unresolved conflicts are embedded within this dual nature, precisely because scientists and institutions bring very different values to the relationship. To the scientist, the funds are the means to an end, to supporting the open-ended, unfettered, and unpredictable exploration of nature. To the institution and the bodies that fund them, the funds *are* the end.

Setting up research grants in this way has proven to be the fatal mistake in the federalization of academic science. It set the seeds for the eventual emergence of the Big Science Cartel from the new regime of Big Science. It also led to the very thing the drafters of *STEF* wanted to avoid: science being made to serve powerful political and commercial demands, to the degradation of curiosity-driven research.

The Changing Temptations of Science

Stephen Turner and Darryl Chubin have reflected on this problem in their provocative essay, *The changing temptations of science*.²³ They argue that the post-War era of Big Science has seen not only a dramatic change in how science is funded, but also a fundamental shift in the ethical norms of the scientific profession.

Specifically, they argue that the pre-war academic sciences were dominated by a long-standing *ethic of discovery*, as described above, encapsulated in the Mertonian norms and its descriptive acronym, CUDOS. It was the ethic of discovery that the drafters of *STEF* wanted to preserve and support. As the federalization of academic science grew in the post-war years, the academic sciences have come to be dominated by an *ethic of production*, in which the measure of success has become how “productive” a scientist is, quantified through metrics such as numbers of papers published, students mentored, grants obtained, citations, and publication in “high-impact” journals.

The ethic of production can be summarized in a new acronym: PLACE.²⁴

- **Proprietary**
- **Local**
- **Authoritarian**
- **Commissioned**
- **Expert**

Science is in crisis, argue Turner and Chubin, because the ethic of production has put in place a number of perverse career incentives, among them intense competition between scientists for funding resources.²⁵ It is important to realize that the shift in ethical norms has not been *imposed* on scientists by administrations and governments. Rather, it has grown organically as scientists themselves have adopted the ethic of production and enforced it upon themselves and their colleagues. To paraphrase Walt Kelly’s Pogo, “the enemy is us.”

The perversity arises from a conflict in the disparate interests of universities and funding agencies *versus* the scientists they employ and support. The interests of universities and funding agencies are in revenues and accountability: to gather revenue streams and to account for the success of the spending programs they administer. The metrics of production cited above provide handy proxies for measuring and meeting the prevailing interest of accountability.

The metrics of scientific productivity bear only a tenuous relationship to discovery, however, which is inherently unquantifiable and unpredictable. Pursuit of

23 Turner, S. P. and D. E. Chubin (2020). The Changing Temptations of Science. *Issues in Science and Technology* 36(3): 40-46.

24 Attributed to the New Zealand physicist, John Ziman.

25 Fang, F. C. and A. Casadevall (2015). Competitive Science: Is Competition Ruining Science? *Infection and Immunity* 83(4): 1229-1233.

these metrics is justified by the healthy spirit of competition they are supposed to encourage. Instead, the ethic of production has reshaped the entire landscape of scientists' professional incentives and disincentives.²⁶ Grants become ends in themselves, rather than the means to the proper end of scientific discovery.

Scientists now find themselves tethered to a “grants treadmill,” with their major effort being devoted to writing lengthy and detailed grant proposals rather than discovering new knowledge.²⁷ Intellectual independence, risk-taking, and novelty, the gold standard for success in an ethic of discovery, are discouraged and replaced by intellectual conformity and crowd-following, because risk takers and renegades do not win grants. Deference to the biases of funders (now predominantly government) comes to prevail over independence of thought. Creativity and curiosity, the twin essences of discovery, are crushed.²⁸

Universities incentivize their scientists to adopt an ethic of production through systems of rewards and disincentives. By tying tenure and promotion to metrics of production rather than the slippery, ethereal and unpredictable metrics of discovery (Sidebar 1), academic scientists' careers depend upon adopting an ethic of production and imposing it on their peers. As successive generations of scientists have grown into their careers, the ethic of production has become more deeply entrenched.

Organizing science around the ethic of production has fostered a number of illusions, among them that science is remarkably productive and robust. This illusion is strong throughout the modern science ecosystem. To take one such metric—scientific papers published—the roughly trillion dollars of federal spending on research since 1950 appears on the surface to have yielded great dividends. From 1996 to 2022, for example, American scientists have published nearly 15 million scientific papers and filed hundreds of thousands of patents.²⁹ Publication in “high-impact journals” (as measured by another metric, the *h*-index, which measures numbers and breadth of a paper's citations) is sought as a highly valued prize for promotion and tenure.

Discovery—the whole point of federalizing academic research—seems to be taking a back seat to production, however. An alarmingly high proportion of scientific papers are either never read, never cited, or are not replicable.³⁰ The proportion of

26 Besancenot, D. and R. Vranceanu (2024). Reluctance to pursue breakthrough research: A signaling explanation. *Research Policy* 53(4): 104974.

27 Lowe, D. (2009). “The grant application treadmill.” *Science. In the Pipeline*, <https://www.science.org/content/blog-post/grant-application-treadmill> 2009; Lawrence, P. A. (2009). Real Lives and White Lies in the Funding of Scientific Research. *PLOS Biology* 7(9): e1000197.

28 Amabile, T. M. (1998). How to kill creativity. *Harvard Business Review* 76(5): 76–87.

29 On both papers published and patents filed, China has now overtaken the United States.

30 Baker, S. (2018). Uncited research. *Inside Higher Ed*. Washington, DC, Inside Higher Ed; Jago, A. G. (2018). Can it really be true that half of academic papers are never read? *The Chronicle of Higher Education*. Washington, D C, The Chronicle of Higher Education; Hamilton, D. P. (1991). Research papers: who's uncited now? *Science* 251(4989): 25–25; Ioannidis, J. P. A. (2005). Why Most Published Research Findings Are False. *PLoS medicine* 2(8): e124.

“breakthrough papers” that disrupt conventional thinking (which is a marker of discovery) have declined since 1950 as funding has increased. Scientific discovery is happening, but seems to have ticked along at a steady pace since 1950, seemingly indifferent to the exponentially-rising floods of money to support academic research.³¹ The twin irreproducibility and retraction crises have unmasked the essential unreliability of scientific publications as a reliable indicator of scientific progress.³² This has led to growing and widespread doubts about the integrity of the entire scientific literature, and of the vast scientific personnel that produce it.³³

What the trillion dollars seems to have funded, rather, is a tide of mediocre or useless “science,” validating the concern expressed by James B Conant, President of Harvard and one of the authors of *STEF*: that, rather than funding the neglected 90% of Einsteins that supposedly populate the academic sciences, government will instead fund the 90% “who could never be Einsteins.”³⁴

Sidebar 1: Tenure: License to discovery, or reward for production?

Tenure, once the bulwark of intellectual freedom and inquiry, is eroding badly. Where it is not being eliminated entirely, tenure policies are under fire for protecting faculty deemed recalcitrant from discipline or dismissal, never mind that such protection is tenure’s entire point.

That said, much of the tide turning against tenure reflects its perverse use. Long criticized as protection of “deadwood” faculty who contribute nothing to the mission of the university, tenure is increasingly becoming a tool for enforcing the ethic of production, and the perverse incentives that come with it.

The dilemma was illustrated starkly for me when I had the opportunity to observe closely the deliberations over tenure reform at two different universities, one where I was an active faculty member, and another where I was part of that university’s faculty senate. To quote from an article of mine:

The character of the debates could not have been more different. The faculty of the private university discussed **tenure as a license to take intellectual risks**. The state college’s faculty, in contrast, centered its discussion around developing a matrix of **performance**: papers published, grants obtained, students trained, and so forth. So what did the two institutions think tenure was intended to protect? Risk-taking, or a reward for past performance? One aimed to build a community of intellectuals, the other to build a community of Teamsters.³⁵

To sustain an ethic of production, the “tenure matrix” will do just fine. To restore the ethic of discovery, tenure needs to be recast as a license to take intellectual risks, and evaluated accordingly.

31 Park, M., E. Leahey, et al. (2023). Papers and patents are becoming less disruptive over time. *Nature* 613(7942): 138-144.

32 David Randall and Christopher Wesler, *The Irreproducibility Crisis of Modern Science* (National Association of Scholars 2018), <https://www.nas.org/reports/the-irreproducibility-crisis-of-modern-science>.

33 J. Scott Turner, “Science ‘Integrity’ and Its Discontents,” *Minding the Campus*, <https://www.mindingthecampus.org/2024/10/16/science-integrity-and-its-discontents/>.

34 Turner, S. P. and D. E. Chubin (2020). The Changing Temptations of Science. *Issues in Science and Technology* 36(3): 40-46.

35 J. Scott Turner, “On Tenure,” *National Association of Scholars*, <https://www.nas.org/blogs/article/on-tenure>

The Emerging Big Science Cartel

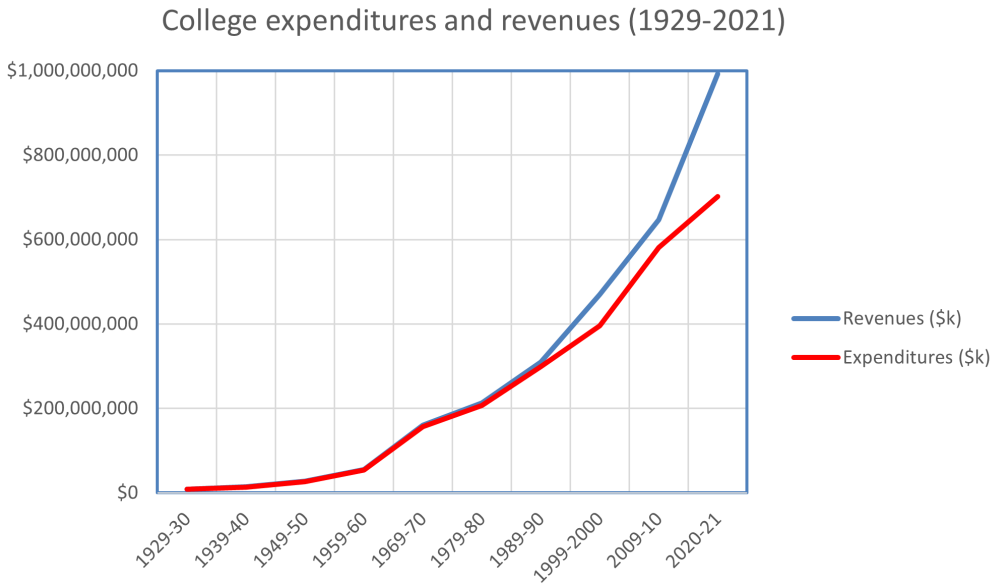
Since the Roosevelt watershed, government expenditures on science have risen exponentially (Figure 4). This pattern mirrors the rising expenditures on agricultural research that followed the Lincoln watershed (Figure 1). The parallels are not accidental. Then, the rising expenditures reflected the growth of a growing network of rent-seekers and political patronage. A similar dynamic has shaped the development of Big Science since 1950. What began in 1950 as a hopeful experiment to promote basic science and discovery has evolved instead into a tangled network of mutual back-scratching and rent-seeking, all fed by the exponentially increasing stream of taxpayer monies (Figure 4).

Science has not been served well by this, because none of these other interests are motivated by discovery. Rather, they are motivated by capturing the revenue stream that federal research money provides. Universities benefit from their scientists bringing in large revenue streams through research grants. Funding agencies for scientific research glean credit for escalating spending, demonstrating to lawmakers how thinly their budgets are supposedly stretched and demands that never can be met. Politicians derive benefit from delivering taxpayer money into the welcoming hands of constituents, mostly through universities that are often the largest employers in their districts. Academic publishing, once the province of professional societies who put out small, affordable, and independent journals supported by members' dues, has grown into a multi-billion dollar industry dominated by a few major publishing houses, their growth fertilized by inflated page charges paid by grant dollars (to publish an open access paper in *Nature* carries a price tag of \$11,000).

In this way, Big Science has gradually been transformed into an effective Big Science Cartel, motivated by one overarching interest: self-aggrandizement and enrichment through skimming ever-growing research revenue streams. This is most evident in the rise of the administrative university, which has paralleled the increasing expenditures for science, and which has driven up costs for higher education, largely through the expansion of the expensive cadre of administrators that permeate the American higher education system. In this system, revenues consistently outstrip expenditures (Figure 7), with the surplus being directed to growth of universities' administrator class, and with the bulk of the surplus provided by research funding. Scientists, once the whole point of this enterprise, are now reduced to being turnkeys for the spigots of federal money that fuel the growth of the administrative university and the Big Science Cartel.

Effective cartels act through subordinating the interests of individuals to the self-serving interests of the cartel. A cartel stands or falls on its ability to enforce

Figure 7. Exponential growth of college expenditures and revenues in thousands of 2021 dollars. Source: National Center for Education Statistics.

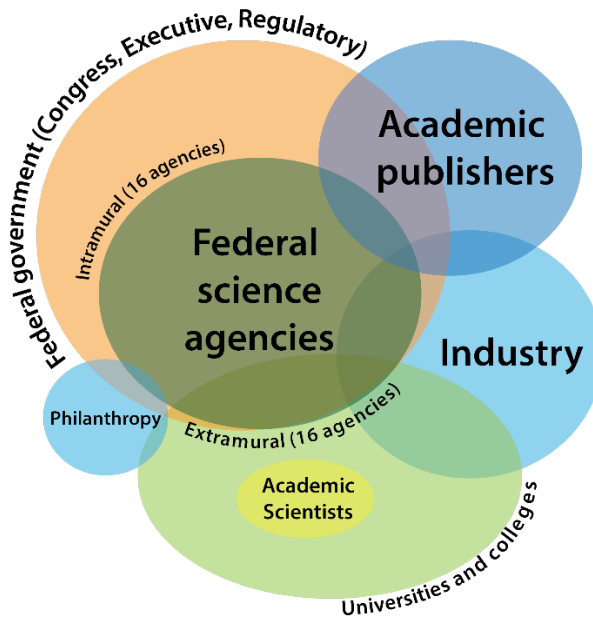


the cartel's interests over competing interests of their components. Drug cartels enforce their interests through the threat of violence to wayward dealers and producers. Energy cartels enforce their interests through threats to bankrupt renegade producers. Agricultural cartels work by withholding technology or patented seed varieties reserved for obedient members. In all instances, the temptation to "go rogue" is suppressed by the benefits of staying put.

The Big Science Cartel works by punishing scientists who try to put the unprofitable ethic of discovery above the revenue-generating ethic of production. There is a profound imbalance of power at work here. Scientists have little power to enforce their interests over those of the other components of the cartel, who are ultimately in control of the money and the power that comes with it.

The growth of the administrative university combines with a troubling demographic trend. For roughly the first two decades of the era of Big Science, working scientists had been steeped in the ethic of discovery, which shaped their activities around the Mertonian norms. These cohorts of discovery-oriented scientists have since died or retired, giving way to successors who are increasingly motivated by the ethic of production. It is no longer administrations, funders, publishers and the other actors who enforce the interests of the Big Science Cartel: it has now become academic scientists themselves who have shaped their careers around the ethic of production, and who see no reason, nor can conceive of any reason, to return to an ethic of discovery, and who have diminishing patience for colleagues who insist on following the ethic of discovery.

Figure 8. The shape of the Big Science Cartel



In his 1961 farewell address, outgoing president Dwight Eisenhower had prophetic words about the experiment in federalization of science that had begun a decade previously. It is worth quoting Eisenhower at length (emphasis mine):

In this revolution, research has become central; it also becomes more formalized, complex, and costly. *A steadily increasing share is conducted for, by, or at the direction of, the Federal government.*

Today, the solitary inventor, tinkering in his shop, has been over shadowed by task forces of scientists in laboratories and testing fields. In the same fashion, the free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research. Partly because of the huge costs involved, *a government contract becomes virtually a substitute for intellectual curiosity.* For every old blackboard there are now hundreds of new electronic computers.

The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present and is gravely to be regarded.

Yet, in holding scientific research and discovery in respect, as we should, *we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.*

We are presently at the stage Eisenhower cautioned against. Lavish funding of Big Science has not produced more or better science, but has instead fueled the growth of a powerful and unaccountable Big Science Cartel.

The next stage is clear: to rescue science means disentangling scientists from the grips of the Big Science Cartel, and dismantling the network of perverse incentives that are crushing the ethic of discovery (Figure 6).

Restore the Small Science Ecosystem

The vision outlined in *Science: The Endless Frontier* - that public support of academic science would stimulate scientific discovery - has failed. It has not fertilized scientific discovery, as *STEF*'s authors hoped. Rather, it has transformed a flourishing pre-war culture of scientific discovery³⁶ into a colossal public spending scheme that supports a vast and expensive set of hangers-on and rent-seekers, rendering scientific discovery superfluous. To draw an analogy, Big Science has become a zombie spending program, like Head Start, only much more expensive. Like Head Start, which has had no measurable impact on preparing underperforming preschoolers for success, Big Science has not achieved the goals it set out to accomplish. Both persist primarily to spend money for self-perpetuation.

The foremost question before all who care about science therefore should be: how can we extricate the academic sciences from their present entanglement with the Big Science Cartel, while restoring the intellectual autonomy and independence basic science needs to thrive? The answer is both clear, and unpleasant, in its implications. It is government spending on science that has driven the growth of the Big Science Cartel, and drawn the academic sciences into its present entanglement. Disentanglement will mean recognizing the failure of the post-war federalization of the academic sciences. It will also mean coming to grips with an illusion that has shaped science for seventy-five years: that science cannot be done without public funding. The near-forgotten memory of the flourishing Small Science Ecosystem where government funding was minuscule is testimony to the power of that illusion.

Disentanglement may be the logical answer to science's present dilemma, but implementing it will be enormously difficult. Government funding of academic science is akin to an addiction, in this instance addiction to its present \$100 billion annual subsidy. The only logical cure for science's present troubles will be to phase out federal support for academic science altogether. Close down the National Science

36 Mills, M. A. and M. P. Mills (2020). The science before the war. How the technological feats of World War II grew out of curiosity-driven research. *The New Atlantis* Winter 2020(Winter 2020).

Foundation. Shutter the extramural research programs of the nearly two dozen federal agencies that sponsor them. Restore the Small Science Ecosystem, which effectively fostered a flourishing culture of basic research.

The second Trump administration is presently engaged in its own experiment to reform the toxic relationship of federal funding to academic science. Many of its actions parallel some of the policy recommendations we outline below. For example, the administration proposes to roll back excessive overheads charged by universities, which have mostly transformed scientists into revenue spigots. The administration is also proposing deep cuts in overall funding for the academic sciences to reflect new administrative priorities. We propose the same, although we go would go farther than the Trump administration.

We differ from the Trump agenda in some significant ways, however. Where the Trump administration is taking a “cold turkey” approach to federal funding of science, our recommendations are for a glide path that will eventually wean the academic sciences off federal funding altogether. We think the problem afflicting the academic sciences are the conditions imposed by federal funding, and that the goal should be to disentangle the academic sciences from those conditions. The Trump administration, in contrast, is using federal funding as a tool to impose its own policy preferences and priorities. That is certainly its right to pursue, but it only perpetuates the entanglement with government that is the heart of the problem.

Weaning the academic sciences from federal funding will be a multigenerational project, rife with possibilities for backsliding and relapse. At all times, the aim should be to fan whatever flickering embers of the ethic of discovery that remain until the sciences can be built back to what they were prior to the emergence of the Big Science Cartel. The Big Science Cartel was built up over decades, and successfully dismantling it will have to proceed along a similar timeline.

We lay out below a series of reforms for how the academic sciences can be put on a trajectory to a restored Small Science Ecosystem. We envision a ten to twenty year time span for restoration. Some reforms can be implemented over a short term of 1-5 years. Some will come into play over intermediate time spans of 5-10 years, and others over a longer-term of 10-20 years. Some of our proposed reforms will involve top-down policy initiatives related to grants programs and other aspects of the academic research infrastructure. Other reforms will be bottom-up: scientists rethinking the culture of their professions and how to restore their lost intellectual independence and autonomy.

The focus of our proposals throughout is to restore, preserve, and cultivate the intellectual autonomy and freedom that academic scientists need to thrive as scientists.

Policy Reforms

The emergence of the Big Science Cartel and the crushing of the ethic of discovery was driven in large part by policy initiatives, starting with the establishment of the National Science Foundation and the subsequent expansion of the NSF model into the nearly two dozen federal agencies that presently fund extramural research. This has been followed by ever more policy issues piled on top of that, including structuring of merit review to reflect politically desirable ends, rules for scientific integrity that impose burdensome constraints on researchers with little to show, structuring research proposals as if they were research contracts, and a host of other policy mistakes.

Disentangling science from the Big Science Cartel can be done (at least in part), through policy initiatives that recognize these failures, and which work to remove the perverse incentives that sustain them.

We propose six broad areas of policy reform:

- Reform of indirect costs determination and accounting.
- Restructuring grant proposal review to emphasize intellectual merit.
- Separating research funding proposals from funding facilities and administration costs.
- Phasing out the current project-oriented grant proposal to put funding decisions more strongly in the hands of scientists.
- Refocusing academic science more strongly on discovery.
- Reforming science graduate student support and training.

1. Indirect Costs Reform

Background. A major source of entanglement for scientists lies in the Schrödinger's cat structure of research proposal budgets, which are modeled after research contracts.

A research proposal budget consists of two parts.³⁷ *Direct costs* tabulate the funds needed to carry out the research, which include salaries and benefits for people employed on the project, graduate student stipends (which often include tuition

³⁷ The requirements for preparing the budget are specified in the NSF's *Proposal Preparation Instructions* here: <https://new.nsf.gov/policies/pappg/24-1/ch-2-proposal-preparation#ch2D2f>

waivers), costs of materials and supplies, costs of equipment, expenses for page charges, and other miscellaneous items. *Indirect costs* are overhead surcharges imposed by university administrations for the *incremental cost* of supporting the research, also known as F&A (Facilities and Administration) costs. Indirect costs include maintaining and operating the buildings and facilities where the work is to be done, costs of accountants and auditors needed to ensure legal compliance, salaries of administrators, and so forth.

Indirect costs are presently imposed as a percentage of a proposal's direct costs. A proposal's total cost is the sum of the direct and indirect costs. Presently, average indirect costs are assessed at 53% of direct costs. For a proposal's total budget of \$100,000, for example, roughly \$35,000 of that goes to indirect costs, leaving \$65,000 to support the research. Alternatively, if the direct costs are \$100,000, the total budget will be the sum of the direct costs and indirect costs: for a 53% IDC rate, the total budget will be \$153,000.

Constructing the proposal budget this way represents the research *contract* side of the research grant Schrödinger's cat. The NSF adopted this model from the NIH research contract model, which itself was modeled after the long-standing practice of government contracting to outside vendors for research services. The research contract model has since spread throughout federal extramural research spending.³⁸ The entanglement comes through manipulation of indirect costs by universities and funding agencies. Scientists never see the revenues from indirect costs, which go directly to administrations. Nevertheless, scientists are the principal generators of indirect costs revenues, which have fueled the growth of the administrative university, and hence the subordination of science faculty to administrative power (Figure 7).

Since World War II, indirect costs rates have been on an upward trajectory (Table 2). Prior to the war, the Department of the Navy set the federal standard for research contracts at 8% of direct costs. The NIH used the 8% rule when it first began to issue extramural research contracts, and this rate was initially adopted by the NSF for its research grants. For a time, Congress worked to set indirect costs rates, which grew, then hovered for a time at 15% to 25%. In 1966, Congress opted for rates to be set through negotiated agreements between universities and funding agencies, to be renegotiated every three years. Despite various attempts since then to set uniform rules for indirect costs rates, the absence of a statutory cap set indirect costs rates on its trajectory to their present high rates, which are two to four times higher than indirect costs rates for other countries with national programs for scientific research.

38 The National Cancer Institute of the National Institutes of Health began funding academic research in 1937. In 1946, the NIH discontinued indirect costs payments altogether, but under pressure from universities, adopted the 8% rule shortly thereafter.

Table 3. Timeline of indirect costs rates since 1950. Source: Sundro, L. (1991). Federally Sponsored Research: How Indirect Costs Are Charged by Educational and Other Research Agencies, Office of Inspector General. National Science Foundation: 31.

Year	Action
Prior to 1955	NIH and NSF capped IDC at 8% DC
1955	NIH and NSF boosts IDC to 15% DC
1960	NSF boosts IDC to 20% DC
1963	NSF boosts IDC to 25% DC
1964	NIH boosts IDC to 20% DC
1964	Congress caps IDC on federal research grants at 20% DC
1966	Congress abolishes statutory limitations on IDC rates by colleges and universities
Post-1966	IDC rates begin to rise to present level (50-90% DC)

The governing principles for the triennial indirect costs negotiations are laid out in the Office of Management and Budget (OMB) guidance *Circular A-21: Cost Principles for Education Institutions*.³⁹ Circular A-21 was intended to bring clarity to what may, and what may not, be claimed as indirect costs. So, for example, depreciation of facilities and equipment constitute legitimate indirect costs, as well as operations and maintenance of buildings and grounds that are used for a university's research mission. Alcoholic beverages, flowers and furniture for the president's office, yachts, costs of lobbying legislators, and exotic dancers do not qualify.⁴⁰

The rules laid out in Circular A-21 appear to be very strict. In its sixty-seven printed pages, 129 examples of "unallowable" charges are listed. The strictness is deceptive, though. During their triennial negotiations, universities and funding agencies will inevitably disagree over various points, such as a depreciation schedule. The standard the OMB sets for resolving these disagreements is the "prudent person" standard. Where some difficult or arcane point of disagreement crops up, such as how to set up a depreciation schedule, "reasonableness" is to prevail.

"Reasonableness" is prevalent throughout Circular A-21. Some variation on the word "reasonable" appears fifty-nine times in the document, indicating the broad range of issues for universities and the cognizant agencies to be "reasonable" about. While reasonableness can be a useful lubricant for negotiations, which way the compromise slides obviously depends upon which party pushes the hardest. The climb of indirect costs rates since 1966 indicates that the strongest shoulder in the negotiations has been the universities'. The best that can be said in defense of the Circular A-21 regime is that indirect costs rates are not as high as universities would

³⁹ Circular A-21 has been revised at least six times since 1966, the most recent being in 2004.

⁴⁰ All are actual instances of indirect costs abuse.

like them to be. To be fair, Circular A-21 seeks to guide an impossible task: resolving the unresolvable dilemma of the research grant Schrödinger's cat (Table 2).

Circular A-21 might lay out reasonable policy for managing research *contracts*. It is comparatively simple to account for the overheads on a research contract to produce, for example, a table of metallurgical properties of an alloy. Time and effort along with administration and maintenance of equipment and infrastructure is straightforward when there is a specified plan of work to produce the specified deliverable. All these constitute the so-called incremental costs for the contractor to fulfill the contract, that is the additional cost accruing to a project above what it would be if the contract had not been accepted.

While calculating incremental costs for a research *contract* might be straightforward, the very concept of incremental cost is problematic for a research *grant*. The core mission of the university seamlessly integrates research with teaching and service. This makes it impossible to disentangle the incremental costs for one project from another, or from other aspects of a university's core mission. How, for example, does one parse out the incremental research cost of a university library that is used for both the teaching and research missions of the university? Arguably it cannot be, nor should it be: the virtue of the university is its seamless integration of teaching and research. Nevertheless, the rationale for applying the Circular A-21 regime is predicated on the ability to do precisely that.

The result is a rococo edifice of revenue pools, imaginary time and effort accounting, complicated financial models, and other decorations and fligrees that constitute Roger Noll's and William Rogerson's characterization of indirect costs rates as based on Precisely Calculated But Arbitrary (PCBA) estimates of universities' overhead costs.⁴¹ There's a great deal of slipperiness in those PCBA estimates. This is the principal reason why indirect costs rates are so high in the American research ecosystem.

There is also a deeper question. What expectations should we have for universities to support their core missions? Is it the responsibility of the institution itself, as it was prior to World War II? If that is the case, both education and science are aspects of civic virtue. Or is it taxpayers who should be expected to cover the bill? If that is the case, then both education and science become public goods. Since the end of World War II, nearly all American universities have adopted the latter option, both for their research and teaching missions, and in so doing have made both education and scientific research fundamentally political activities.⁴²

41 Noll, R. G. and W. P. Rogerson (2010). The economics of university indirect cost reimbursement in Federal research grants. *Challenges to Research Universities*. R. Noll and L. R. Cohen. Washington, D C, Brookings Institution Press.

42 Pell grants cost taxpayers roughly \$27 billion in 2022-2023. Student loans will cost taxpayers about \$400 billion over the next decade. Indirect costs revenues from government amount to about \$33 billion annually.

What is wrong: The current regime of indirect costs is built upon several illusions and fallacies.

- That incremental costs for academic research grants can be assessed in the same way that incremental costs for research contracts are.
- That indirect costs for academic research grants can be calculated accurately.
- That any reduction of indirect costs recovery or tampering with the models used to calculate them will be disastrous for academic research.

Recommended actions: In the immediate term (1-3 years), the President can take action to liberate science funding from the grip of those illusions.

- The President should immediately issue an executive order nullifying Circular A-21 as the governing principle for federal support of academic research.
- The President should issue an executive order instructing all federal agencies that fund academic and extramural research grants to cap indirect costs at 10% of direct costs.⁴³ The terms of existing research grants should be allowed to stand to the end of their terms (three to five years), after which renewals will have to be governed by the 10% rule.

Sidebar 2: The indirect costs bone of contention

Indirect costs rates have been a perpetual sore point since academic research was federalized in 1950. The bone of contention is, in all cases, whether indirect costs are too high (as researchers commonly assert), or as universities commonly allege, are too low. Universities commonly win the argument here, as illustrated by the hyperbolic response from college administrators to periodic attempts to reduce indirect costs rates. In 2017, for example, the Trump administration proposed that the National Institutes of Health (NIH) cap indirect costs rates at 10%.⁴⁴ This would have allowed an overall reduction in the NIH budget, while still increasing the available monies for direct costs.

Furious doom-mongering followed. The President of Johns Hopkins University (indirect costs rate of 62%) declared the change would deal a “staggering blow to the nation’s vital interest.” The president of the Association of American Universities (AAU), which is a lobbying group for university administrators, jumped in to assert that the proposal would “literally turn out the lights in labs.” Just how those dire consequences would come about was left unclear: it was sufficient for these powerful lobbying interests simply to make the claim. The Trump proposal failed, the Congress increased the NIH budget by roughly 9%, the NIH indirect cost rates remained high, and indirect cost revenues streaming to universities from the NIH were boosted by about \$550 million.⁴⁵

The second Trump administration is again working to rein in indirects costs. The doom mongering is right back. The Trump administration’s current proposal to cap indirect costs rates at 15% is presently in litigation.

43 The Trump administration has settled on a 15% cap.

44 Kaiser, J. *NIH plan to reduce overhead payments draws fire*. *Science*. June 2, 2017. Washington, D.C. <https://www.sciencemag.org/news/2017/06/nih-plan-reduce-overhead-payments-draws-fire>

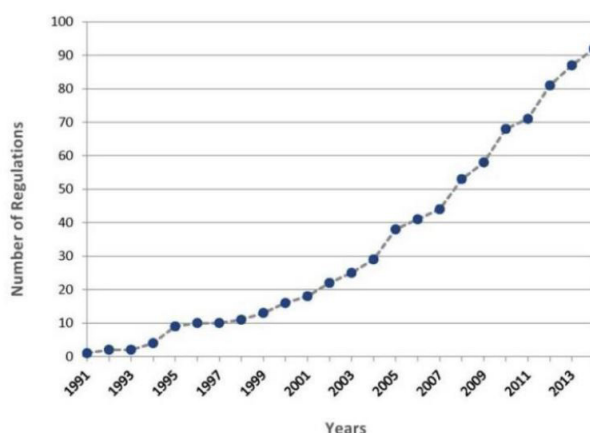
45 Staff. *Daniels: Proposed cap on indirect costs could have devastating effect on university research* *The Hub*. January 23, 2018. Baltimore, Maryland. <https://hub.jhu.edu/2018/01/23/daniels-research-funding-commentary-issues/>. Sargent, J. F., Jr. *Federal Research and Development (R&D) Funding: FY2019*. 75 (Congressional Research Service, 2018); Daniels, R. J. *Knee-capping excellence*. *Issues in Science and Technology* 34 (2018).

Sidebar 3. Are indirect costs really too high?

Defenders of the current indirect costs regime will say, for example, that universities actually lose money on supporting their research missions, and that lower indirect costs rates would lead to “a slow undoing of the academic-government research partnership model,” with dire consequences to follow.⁴⁶

When defenders are not asserting that critics simply do not understand the issue, universities have brought various arguments to the table to defend high indirect costs rates. One common justification has been the increased administrative burden imposed by an increasing number of federal regulations that govern research (Figure 7). If a university is to have a research mission, it simply costs more to administer these regulations, which requires higher reimbursement for these higher overhead costs.

Figure 7. Growth of new regulations governing administration of federally-funded academic research. Source: (2017). Written Testimony of Dr. Kelvin K. Droegemeier. Appropriations Sub-Committee on Labor, Health and Human Services, Education and Related Agencies. United States House of Representatives. Washington, DC, United States Congress: 31.



This argument is undermined by a report from the Goldwater Institute, which traced patterns of growth of the student, faculty, and administrative sectors at 196 universities.⁴⁷ If increasing regulatory burden was driving the growth of university administrations, all campuses should have seen similar patterns of growth. In keeping with the regulatory burden hypothesis, the prevailing pattern among the 196 universities was a disproportionate growth of the administrative sector compared to faculty hiring and student admissions. However, the growth was not uniform, which undermines the regulatory burden hypothesis. A few universities actually shrunk their administrative sector and increased faculty hiring and student enrollments.

The role of indirect costs revenues in administrative bloat is obscured because universities' annual financial statements typically do not itemize indirect costs revenues, folding them instead into general revenues. One exception is Binghamton University (BU), which itemizes indirect costs revenues. In the Goldwater Institute survey, BU ranked 140 out of 196 (196 representing the highest bias to administrative expansion). From 1993 to 2007, BU enrollment (and tuition revenues) increased by about 20%. Over the same time period, per capita (per 100 students) hiring for instruction, research and student support increased by about 1%. Per capita administrative hiring increased by nearly 70%.

From 2011 to 2019, BU's indirect costs revenues ranged between \$6 million to \$8 million annually. Over the eight academic years considered, cumulative indirect costs income was \$57.5 million. Over the same time period, expenditures increased by about \$45 million for BU's largest administrative unit, the Office of Academic Affairs. Administrative costs and indirect costs therefore increased roughly in parallel. Funds being fungible, the inference is strong that increasing indirect costs revenues paid for the growth of BU's Office of Academic Affairs.

⁴⁶ (2017). Written Testimony of Dr. Kelvin K. Droegemeier. *Appropriations Sub-Committee on Labor, Health and Human Services, Education and Related Agencies. United States House of Representatives*. Washington, DC, United States Congress: 31; Daniels, R. J. (2018). Knee-capping excellence. *Issues in Science and Technology* 34(2).

⁴⁷ Greene, J. P., B. Kisida, et al. (2010). Administrative Bloat at American Universities: The Real Reason for High Costs in Higher Education, Goldwater Institute. 239: 20.

Another common argument in defense of high indirect costs rates is that universities actually lose money when they accept federal research grant dollars.⁴⁸ Impressive arrays of tables and charts are often brought to bear in support of that argument. These should be judged⁴⁹ in light of the indirect costs models that provide an illusory gloss of quantitative rigor that Roger Noll and William Rogerson assert have described as PCBA—Precisely Calculated But Arbitrary. The problem, according to Noll and Rogerson, is the inevitable outcome of the Schrödinger's cat research grant, of the insistence of both universities and federal agencies to treat research projects as contracts. In contracts, overhead costs can be rationally assessed as *incremental* costs, the increased cost that accrues to administering a research contract. This is nearly impossible for research grants, which has force funders and universities into a fantasy world of *faux* accountability and objectivity, which sustains an unjustifiable *status quo*.

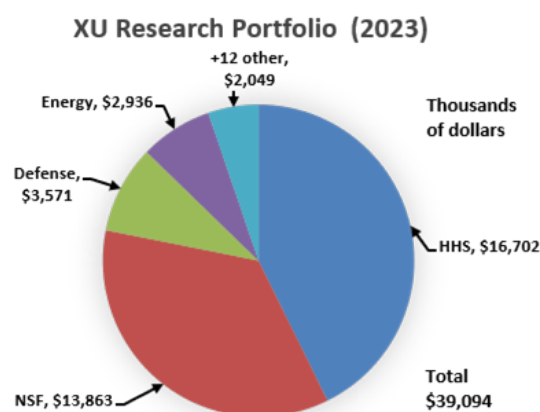
Sidebar 4. Can universities tolerate proposed cuts in indirect costs?

The first Trump administration floated a proposal to cap indirect costs rates on NIH extramural grants to 10% of direct costs. That set off a firestorm, with universities claiming the cuts would devastate scientific research. That proposal was defeated. In February 2025, the second Trump administration proposed a cap on indirect costs to 15% of direct costs, which elicited a similarly fierce reaction. Presently, Trump's proposal is trapped in litigation.

Left largely unanswered is a basic question. What would be the impact on a university's finances were a 15% cap in indirect costs to be implemented? To answer that question, we did a case study focusing on the finances of a typical mid-level R1 research university that has a robust research program. I will not identify the university here, which I have named X University, or XU.

Like any organization, universities compile regular financial reports and audits, usually through private accounting firms. The XU case study is derived from XU's 2023 financial report.

Figure 1. Research portfolio of XU for 2023. Source: XU financial report for FY2023. (Thousands of dollars)



XU's research portfolio is supported by about \$39 million of annual revenues in grants and contracts from sixteen public and private sources (Figure 1). Roughly 95% of that is drawn from four federal agencies. Two (Health and Human Services, which hosts the NIH, and the National Science Foundation) account for roughly 78% of XU's total research portfolio. Two other federal agencies (Departments of Defense and Energy) account for the additional 17%. The remaining 5% comes from twelve other sources, both government and private.

XU assesses indirect costs at a comparatively modest rate of 49% of direct costs (national average is 53%). This yields annual indirect costs revenues of about \$13 million. A reduction of indirect costs rates to 15% would reduce XU's indirect costs revenues to \$5 million, a shortfall of about \$8 million. Assuming true overheads of \$13 million, XU would have to make up the shortfall from some other source. Could it do so?

48 2017 Written Testimony of Dr. Kelvin K. Droegemeier to the Appropriations Sub-Committee on Labor, Health and Human Services, Education and Related Agencies. United States House of Representatives. Washington, DC, United States Congress: 31.

49 Noll, R. G. and W. P. Rogerson (2010). The economics of university indirect cost reimbursement in Federal research grants. *Challenges to Research Universities*. R. Noll and L. R. Cohen. Washington, D C, Brookings Institution Press.

Table 4. XU total assets and liabilities for FY2022 and FY2023.
Source: XU financial report for FY2023. (Thousands of dollars)

	FY2022	FY2023	Change
Assets	\$4,031,067	\$4,263,542	\$232,475
Liabilities	\$1,228,979	\$1,227,282	-\$1,697
Net assets	\$2,802,088	\$3,036,260	\$234,172

In 2022, XU listed its net assets (assets minus liabilities) as \$2.8 billion (Table 3). In 2023, those grew to \$3.0 billion, an increase of about \$234 million. The predicted shortfall of \$8 million in indirect costs revenue amounts to 3% of this increase.

Table 5. XU operating revenues and expenses for FY2024 to FY 2025.
Source: XU financial report for FY2023. (Thousands of dollars)

	FY2022	FY2023	Change
Operating revenues	\$1,157,869	\$1,287,098	\$129,223
Operating expenses	\$1,089,983	\$1,171,328	\$81,345
Net	\$67,886	\$115,770	\$47,884

In both 2022 and 2023, XU's operating revenues exceeded operating expenses (Table 4). From FY2022 to FY2023, XU's operating surplus increased by about \$48 million. The \$8 million shortfall in indirect costs revenue amounts to about 17% of the increased surplus.

Whether the indirect costs shortfall could be absorbed in operating expenses depends upon XU's administrative priorities. Salaries are usually the largest item in any organization's budget, and university administrations are usually the largest consumer of salaries, which have become bloated in recent years.⁵⁰ Perhaps the \$8 million shortfall in indirect costs could be covered by trimming administrative positions or salaries?

According to XU's IRS Form 990 for 2023, the compensation for XU's top paid administrators totals to \$17 million. Form 990 also lists more than 1,100 employees with compensation greater than \$100,000 (Form 990 does not distinguish between administrative and faculty employees). XU also lists more than 70 administrative lines, which carry salaries of \$50,000-\$100,000. Perhaps \$8 million could be found through cuts in administrative staff?

Other administrative choices are open for XU to cover the expected \$8 million shortfall. From 2022 to 2023, for example, XU increased its holdings in buildings and equipment by about \$115 million. XU also sits on an endowment of roughly \$5 billion. Could \$8 million be squeezed out of that? Probably.

Thus, there does seem to be sufficient capacity in XU's finances to absorb the indirect costs shortfall, through adjustments in salaries, numbers of administrators, slowing real property acquisition and capital projects. It is difficult to square this with the apocalyptic language swirling around reductions of indirect costs.

50 Ginsberg, B. (2011). *The Fall of the Faculty: The Rise of the All-Administrative University and Why It Matters*, Oxford University Press, USA.

2. Return Grant Proposal Review Solely to Scientific Merit

Background: Federal research grants are coming increasingly to tie the likelihood of funding to conformity to an ideology, DEI, which is utterly corrosive to basic science. For certain grant programs, this is quite explicit. For applications to the NSF's program for multi-university research centers, the agency's diversity officer is given an effective veto over which proposals receive consideration for funding.⁵¹ Similarly, the Department of Energy requires applicants for grants for small business innovation research and technology transfer to submit a PIER plan (Promoting Inclusive & Equitable Research) before proposals will be considered for funding.⁵²

These are not exceptions. Ideological conformity is baked into the entire process of grant submission and evaluation, through two Merit Review Criteria. These are intended ostensibly to provide guidance for the external reviewers of grant proposals. All grant proposals submitted for federal funding require an applicant to submit statements to address the Merit Review Criteria. These have changed considerably since 1950. Initially, the sole Merit Review Criterion was Intellectual Merit (IM, sometimes called Scientific Merit). The number of Merit Review Criteria has fluctuated since then, at one point numbering five. By 1997, the number of Merit Review Criteria had settled at two: Intellectual Merit, and Broader Impacts (BI). According to NSF guidance, Broader Impacts should "describe the potential of the proposed activity to benefit society and contribute to the achievement of specific, desired societal outcomes."⁵³

The Broader Impacts statement has been a perpetual source of trouble and confusion.⁵⁴ Scientists applying for grants have no idea what it means (although the NSF provides useful hints).⁵⁵ Reviewers are equally in the dark.⁵⁶ There is little evidence that Broader Impacts statements align federally-funded research more closely with improving society.⁵⁷ Rather, they are kept because they help advance government-approved ideology, lately conformity to DEI ideology. This is usually masked by benign labels such as "increased participation" of "under-represented" or "marginal" "communities."⁵⁸

51 J S Turner. 2021. The brainworms come for Big Science. *The American Mind*. January 25, 2021.

52 <https://pamsexternalhelp.science.energy.gov/pages/viewpage.action?pageld=105513098>

53 From the NSF Proposal & Award Policies & Procedures Guide (NSF 24-1): <https://new.nsf.gov/policies/pappg/24-1/ch-2-proposal-preparation#d-proposal-contents-171>

54 J S Turner. Seven pillars of folly. *Minding the Sciences*. April 9, 2004. <https://www.mindingthecampus.org/2024/04/09/minding-the-sciences-sciences-goose-is-cooked-seven-pillars-of-folly/>

55 NSF 101: Five tips for your Broader Impact statement. <https://new.nsf.gov/science-matters/nsf-101-five-tips-your-broader-impacts-statement>

56 Rothenberg, M. (2010). Making Judgments About Grant Proposals: A Brief History of the Merit Review Criteria at the National Science Foundation *Technology and Innovation* 12: 189-195.

57 Roberts, M. R. (2009). Realizing societal benefit from academic research: Analysis of the National Science Foundation's broader impacts criterion. *Social Epistemology* 23(3-4): 199-219.

58 Pitts, E. A. (2022). *NSF Merit Review Criteria as Points of Entry for Advancing Social Justice*. 2022 IEEE International Professional Communication Conference (ProComm), IEEE.

Even if a grant's reviewers don't support the political agenda, their reviews are only recommendations. Ultimate funding decisions rest with the NSF bureaucracy, which also considers Broader Impacts statements in its funding decisions. This is reshaping the demographics of the holders of NSF grants. The Biden administration made it a national priority to increase the number of women in STEM fields, for example, justified as a means to counter supposed inequities in the advancement of women into STEM fields. The disparities are largest in mathematics, physics and chemistry. In the life sciences, women are actually over-represented. Broader Impacts statements are now expected to address how a project intends to bring the scientific workforce into line with demographics, a bizarre application of disparate impacts theory.

Irrespective of what outside reviewers might say, the NSF clearly uses the Broader Impacts statement to impose disparate impacts theory on funding decisions. If a Broader Impacts statement is judged insufficient at addressing disparate impacts, the grant application will be returned unreviewed. Among proposals that clear that bar, men submit nearly three times the number of proposals compared to women. Meanwhile, proposals from women scientists are funded at a consistently higher rate than proposals from men (Figure 9). Similar creeping biases are seen for racial category, and increasingly, sexual proclivity. One of the perverse incentives of the ethic of production is thereby revealed. Numbers of grants awarded are one of the key metrics that determine hiring, promotion, salary, and tenure, giving a leg up to favored demographic groups.

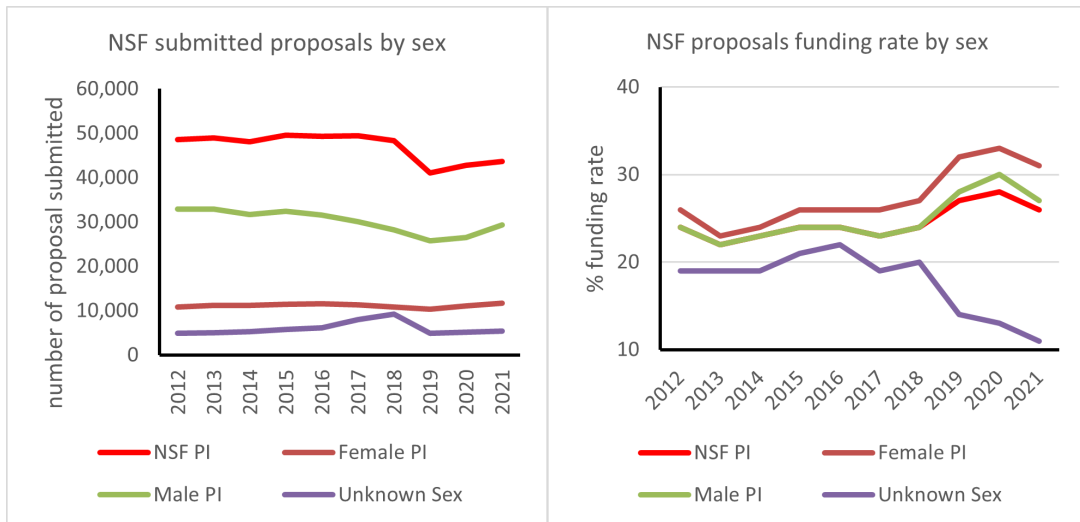
Ongoing skepticism by scientists and peer reviewers over the value of Broader Impacts statements has led the National Science Board to recommend taking Broader Impacts review altogether out of the hands of external reviewers, which would allow NSF staff to make funding recommendations separately from the Intellectual Merit criterion.⁵⁹ This will give the NSF bureaucracy effective power to veto proposals deemed insufficiently attentive to the NSF's political priorities, as is currently the case for large-scale funding programs for research centers.⁶⁰

What is wrong: The original intent of federal funding of research was to foster basic research while insulating academic scientists from political or commercial pressure. Broader Impacts statements have allowed political pressure and ideologically-cloaked agendas to intrude to tie funding decisions increasingly to conformity to political agendas.

59 J S Turner. Seven pillars of folly. *Minding the Sciences*. April 9, 2004. <https://www.mindingthecampus.org/2024/04/09/minding-the-sciences-sciences-goose-is-cooked-seven-pillars-of-folly/>

60 J S Turner. 2021. The brainworms come for Big Science. *The American Mind*. January 25, 2021.

Figure 9. Patterns of grant submission and funding success sorted by sex. Left: Total number of proposals submitted by year. Right: Proportion of submitted proposals approved for funding. Source: Merit Review Process. Fiscal Year 2021 Digest (NSB-2023-14), https://nsf-gov-resources.nsf.gov/nsb/publications/2022/merit_review/nsb202314.pdf



Solutions: The Trump administration has been taking aggressive action against ideological biases in federally-funded research, canceling thousands of grants that advance DEI ideology, and holding decisions on thousands more. Presently, cancellation decisions are being made through audits of language in Broader Impacts statements. This is a welcome initiative, but it does not relieve the politicization of federally-funded research. We propose reforms that would reverse the politicization of academic research by future administrations.

- The president should sign an Executive Order instructing the National Science Board, the NSF and all federal agencies with extramural research programs to eliminate Broader Impacts as a Merit Review criterion, and make Intellectual Merit the sole Merit Review criterion for funding decisions.
- The president should sign an executive order instructing all federal agencies that support extramural research to close their DEI offices and strip them of veto authority over grant funding decisions.

3. Fund Research Separately from Facilities and Administration

Background: Currently, bundling indirect costs with a proposal's direct costs pits the competing interests of scientists and administrations against one another. Scientists pursue research funding for discovery, while institutions pursue research funding for revenue (Figure 10). When the two are bundled, scientists and institutions must compete for the same supply of money.⁶¹ In the end, it will always be the interests of administrations that prevail, because they are the only party with the effective power to enforce its interests.⁶² Scientists are thereby reduced to generators of revenue, fostering the growth of the ethic of production over the ethic of discovery, and facilitating the growth of the Big Science Cartel.

Decoupling overhead costs from direct costs would help re-align the interests of both scientists and universities toward an ethic of discovery (Figure 11). In an ethic of discovery, both scientists and universities pursue prestige rewards, even though the nature of the prestige rewards differs for each. Among scientists, prestige rewards accrue from discovery and esteem among peers. Among universities prestige rewards accrue when they aid scientists in pursuing their own prestige rewards. They do so by providing scientists the infrastructure they need to pursue discovery-motivated research.

Pursuit of prestige rewards was once a significant driver for universities prior to World War II. An example was the competition between MIT, Harvard, Yale, and UC Berkeley to establish themselves as world-class centers for physics research, and to take that mantle from European universities. Berkeley, for a time a physics backwater, strove to lure leading American physicists like Robert Oppenheimer and Ernest Lawrence to their campuses, and to keep them there as the east coast universities dangled lucrative job offers before them.⁶³

What is wrong: Academic scientists and institutions operate under divergent sets of interests, with institutional interests always prevailing over scientists'. By coupling overhead costs to direct costs, our present system of funding academic science has been counter-productive, as scientists are incentivized to pursue rewards based on *faux metrics* of scientific productivity, subordinating the different sets of rewards that shape the ethic of discovery. Decoupling direct costs from F&A costs would provide both scientists and universities the opportunity to realign their

61 Turner, J Scott (2025). \$15 billion saved from Indirect Costs Boosts Research. *Minding the Campus*, April 9, 2025. <https://mindingthecampus.org/2025/04/09/15-billion-saved-from-indirect-costs-boosts-research/>.

62 Ginsberg, B. (2011). *The Fall of the Faculty: The Rise of the All-Administrative University and Why It Matters*, Oxford University Press, USA.

63 Hiltzik, M. (2016). *Big Science: Ernest Lawrence and the Invention that Launched the Military-Industrial Complex*, Simon & Schuster.

Figure 10. Bundling indirect costs with costs of basic research puts the interest of institutions (pursuit of revenue) into conflict with the interests of scientists (pursuit of discovery).

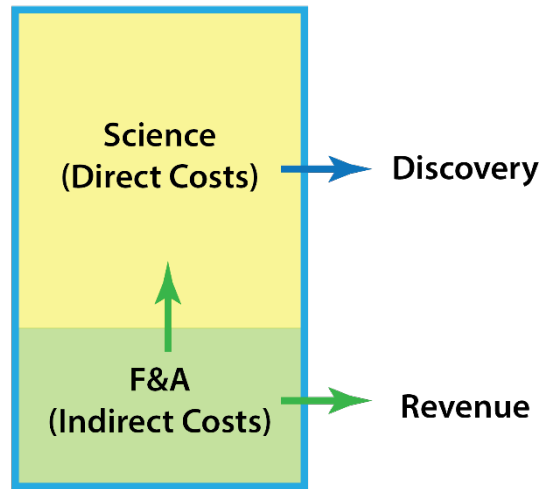
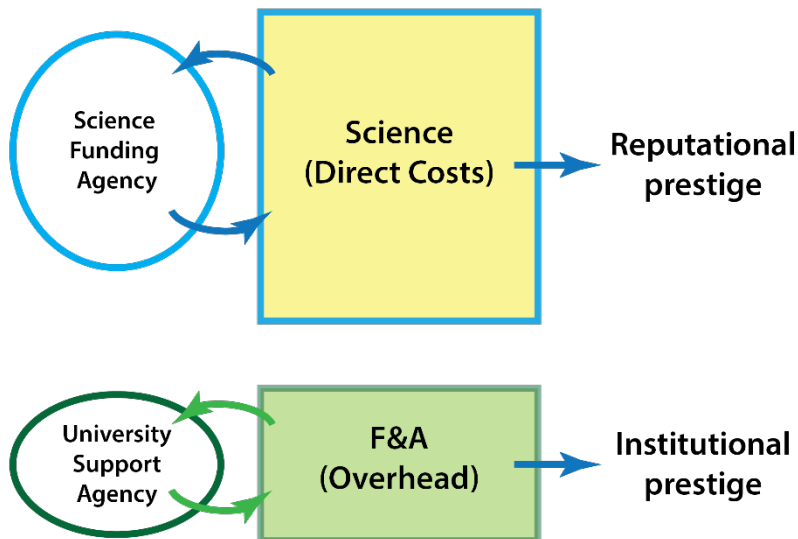


Figure 11. Separating funding for research from support for institutional overhead would align scientists' and institutions' interests toward pursuit of prestige.



interests to pursue parallel and complementary prestige rewards, an alignment that sustained the ethic of discovery prior to World War II.

Recommended actions: The regime of government funding of academic science should be restructured so that scientists can apply for funds to do scientific research independently of the F&A costs of universities to support its research program. A new funding program should be set up to allow universities to apply separately for support to build and maintain infrastructure that is conducive to basic

research. This can include laboratory infrastructure, equipment, and services such as network services and library services. This will allow more straightforward and transparent auditing and accounting for determining actual overhead costs than the current regime allows. It will also help wean universities off the illusion that overhead costs reimbursements are an entitlement to be borne fully by government funds.

- The President should issue an executive order to all federal agencies that fund research grants to universities develop new protocols so that grant applications budget for direct costs only.
- The President should issue an executive order terminating the Circular A-21 regime for negotiating overhead costs, and to develop new interim accounting and auditing protocols for evaluating legitimate overhead costs.
- The President should instruct the NSF and all federal agencies that operate extramural research programs to cap indirect cost at a flat rate of 10%-15% of a university's aggregate direct costs portfolio, and to issue "Dear Colleague" guidance letters informing universities that they are expected to take more responsibility for funding the infrastructure of their core research missions.

4. Phase Out the Project Model for Academic Research

Background: Presently, grant applications are built around short-term (usually three year) research projects, modeled after the research contract. The NSF processes between 45,000 and 50,000 grant applications annually, of which about a fourth are funded. As they are currently structured, grant applications spell out "deliverables" that, for basic research, are impossible to specify.

The research contract model is contrary to the recommendations made by the authors of *STEF*, that federal funding should go to open-ended, long-term block grants to universities, to be used to support the *ad hoc*, opportunistic, and fluid nature of the research activities of their scientists / faculties. The rationale behind this recommendation was for federal funds to *complement* the resources universities had long relied upon to support science, namely institutional and philanthropic funds. For various political reasons, most strongly President Truman's insistence that public funding of science should produce tangible public returns and be held to normal standards of public accountability, *STEF's* recommendation was scrapped

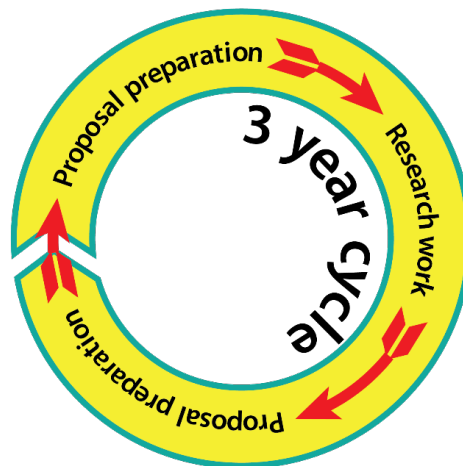
when the NSF began to issue its first grants in 1953. The research project model has since spread throughout the federal research ecosystem.

A number of undesirable outcomes have flowed from this, some of which have already been outlined:

- It ties scientists to a “grants treadmill,” diverting their time and effort away from discovery and toward an endless chase for grant revenues (Figure 12).⁶⁴
- It incentivizes universities to look at research as an exploitable revenue stream rather than part of their core missions.
- It pits the interests of scientists against the interests of their universities, funding agencies, and other elements of the Big Science Cartel, with scientists’ interests inevitably yielding to the contrary interests of the Cartel.
- It has encouraged a counter-productive ethic of production that has crowded out the ethic of discovery that prevailed prior to World War II.

The three-year project model is ill-suited to the inherently unpredictable, fluid, and *ad hoc* manner in which basic science works. Reconciling the inconsistency has led to a number of habits that effectively make the grant proposal, and the publications the work is expected to produce, a charade.⁶⁵ For example, a grant proposal’s research plan often presents work already done as work to be done, giving the grant proposal a false image of novelty.

Figure 12. The research project “grants treadmill.”



64 Lawrence, P. A. (2009). Real Lives and White Lies in the Funding of Scientific Research. *PLOS Biology* 7(9): e1000197.

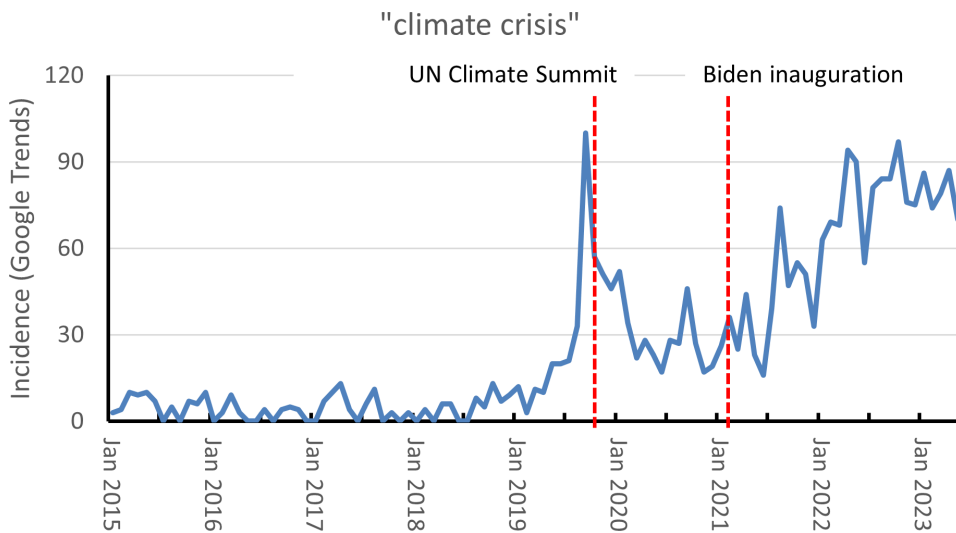
Lowe, D. (2009). "The grant application treadmill." *Science*. In the Pipeline <https://www.science.org/content/blog-post/grant-application-treadmill.2009>.

65 Medawar, P. B. (1963). Is the scientific paper a fraud? *The listener* 70(12): 377-378.

The project model for research funding also is a backdoor to the imposition of political agendas onto basic science. Scientists are dependent upon winning grants for promotion and tenure. By targeting grant programs to specific political aims, scientists are strongly tempted to shape research toward the politically-motivated funds available.

A useful example is the politics of climate change. Incidence of alarmist terms like “climate crisis” are clearly driven by political motivations, peaking at a politically oriented event like the 2019 UN Climate Summit. Beginning with the Biden inauguration, incidence of “climate crisis” began to ramp up, reflecting the administration’s political aims in advancing the “Green New Deal” climate agenda (Figure 13).

Figure 13. Incidence of “climate crisis” as shown by Google Trends 2015-2023.



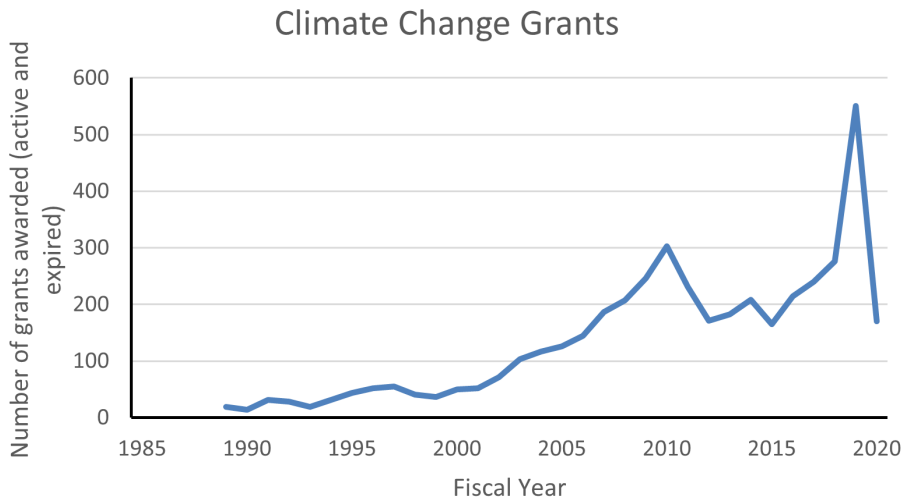
This has been paralleled by the rise of a well-funded network of activist groups and media enablers that exist for the sole purpose of mobilizing for more climate change grant funding.⁶⁶ They have been spectacularly successful: NIH funding of “climate health” related grants has risen from less than \$8 billion in 2000 to about \$280 billion by 2022.⁶⁷ In 1989 the NSF supported 19 research proposals on climate change, allocating a total of \$6 million among them. By 2019, those numbers had grown to 547 research grants and total expenditures of \$812 million. Since 1989, the NSF has allocated a total of more than \$3 billion to more than 3,400 research grants

⁶⁶ Anonymous (2017). Climate Dollars. How One Flawed Study Fooled the Media and Poisoned the Debate on Climate Change. Washington, DC, Capital Research Center: 36.

⁶⁷ Sovacool, B. K., H. Clifford, et al. (2024). Critically examining research funding patterns for climate change and human health. *npj Climate Action* 3(1): 64.

on climate change.⁶⁸ Because scientists' careers depend upon getting grant money, scientists' research programs are brought into alignment with the targeted funds governments make available to them (Figure 14).

Figure 14. Annual numbers of NSF grants awarded with "climate change" in the publicly available project summary. Source: National Science Foundation. (the final year drop off is an artifact arising from most NSF grants having a three-year term)



In this way, government shapes academic research toward political ends—precisely the politicization of university research that the drafters of *STEF* cautioned against. This was not accidental. The initial legislation authorizing the NSF, the 1948 National Science Foundation Act, was vetoed by President Truman over concerns that the new National Science Foundation would not be sufficiently accountable to the government. The 1950 NSF Act, which Truman signed into law, resolved these issues to his satisfaction. By overturning the key provision the authors of *STEF* thought would guarantee the intellectual independence of academic science, the 1950 NSF Act effectively ensured that federal funding would tie basic science to political expectations.

Truman's actions reflected one compromise in the ongoing and fundamental incompatibility between science as civic virtue, and science as public good, and toward the accountability, control and regulation expected for a public good. The value of academic science as a civic virtue was thereby diminished, opening the door to the growth of the Big Science Cartel.

There are alternative models for government funding of basic science that tilt the balance in the opposite direction from Truman's, and which can restore science

68 Turner, J. S. (2020) Science and the decline of the American academy. *Heritage Foundation First Principles*, 27.

as civic virtue. These alternative models put scientists more in control of funds and their allocation, and thereby diminish the opportunity of science bureaucracies, both government and academic, to meddle in the process of scientific discovery. Implementing them will wean scientists and their institutions off the perverse incentives that prevail in the Big Science Cartel.

There are extant programs within the government science ecosystem that are intended to liberate scientists from the grants treadmill, allowing them to devote more effort on creative research. The Department of Defense runs several of these programs, such as DARPA (Defense Advanced Research Projects Agency), and service-centered programs such as the ARO (Army Research Office) and ONR (Office of Naval Research). DARPA was formed in the aftermath of the Sputnik crisis, in response to a general perception that the NSF was too slow-moving and conservative to meet the need to translate research more effectively to the nation's anticipated needs.⁶⁹

DARPA and the service research agencies put a great deal of decision making and flexibility into the hands of Program Officers who identify areas of promising research and the scientists involved that are having difficulty finding support from more traditional and risk-averse funding programs like the NSF's. Scientists asked to compare their experiences with DARPA versus the NSF rated the DARPA model more favorably, characterizing the NSF as dull and bureaucratic.

While providing scientists some breathing room to pursue creative research, such "innovation based" funding programs sustain the dependence of scientists on government funding of their research.

Another model that better insulates funding decisions from politicization is the Human Frontier Science Program (HFSP). This is a multinational consortium of national science programs of several countries, including the United States, the European Union, Israel, Japan, South Africa, and India. It was initiated in 1986 by the Japanese Prime Minister's Council for Science of Technology with the aim of encouraging "international collaboration of basic research," with a focus on the life sciences. The HFSP Organization soon expanded its membership to include the G7 nations, and several other nations since.

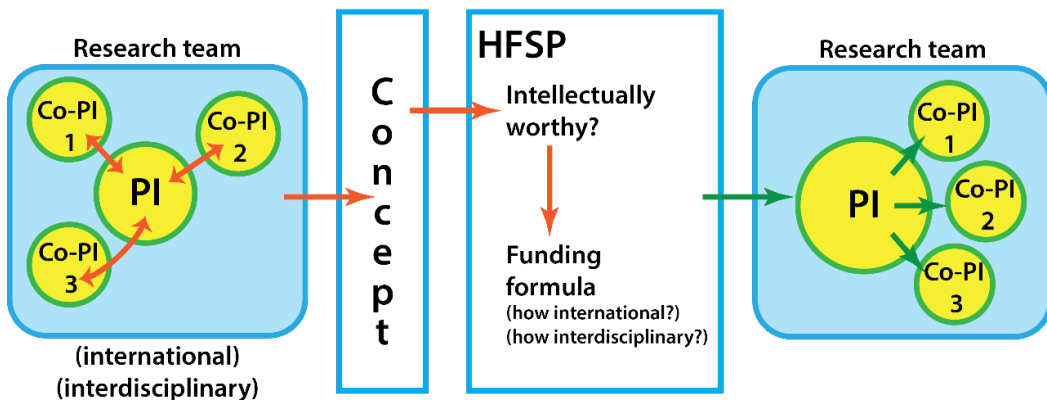
The mission of the HFSP is to foster international and interdisciplinary collaborative research. To apply for HFSP funding, teams of scientists submit a letter of intent outlining a broad problem to be explored. Once deemed compatible with the HFSP mission, teams are invited to submit a full proposal.⁷⁰

69 Piore, M. J., P. Colatat, et al. (2015). NSF and DARPA as Models for Research Funding: An Institutional Analysis. *Working Paper Series*. Cambridge, Massachusetts, Massachusetts Institute of Technology: 31.

70 Full disclosure: I was the principal investigator on an HFSP grant from 2012-2016. Our team was drawn from the US, the UK, India, and Namibia. The disciplines represented on our team were physiology, entomology, neurobiology, biophysics, engineering, and theoretical biology.

Funding of a HFSP grant is not tied to a project budget (Figure 15). Rather, the HFSP funding model is based upon the number of nations from which the team is drawn, and the different disciplines embodied in the team. Once funds are granted, the members of the team decide year-by-year among themselves how the funds are to be distributed among the team and what promising new leads to pursue, both of which can change year-by-year as the team decides. The various universities have no say in how the funds are distributed between team members. Indirect costs also are capped strictly at 10% of the year-by-year amount.

Figure 15. The HFSP model for funding innovative research.



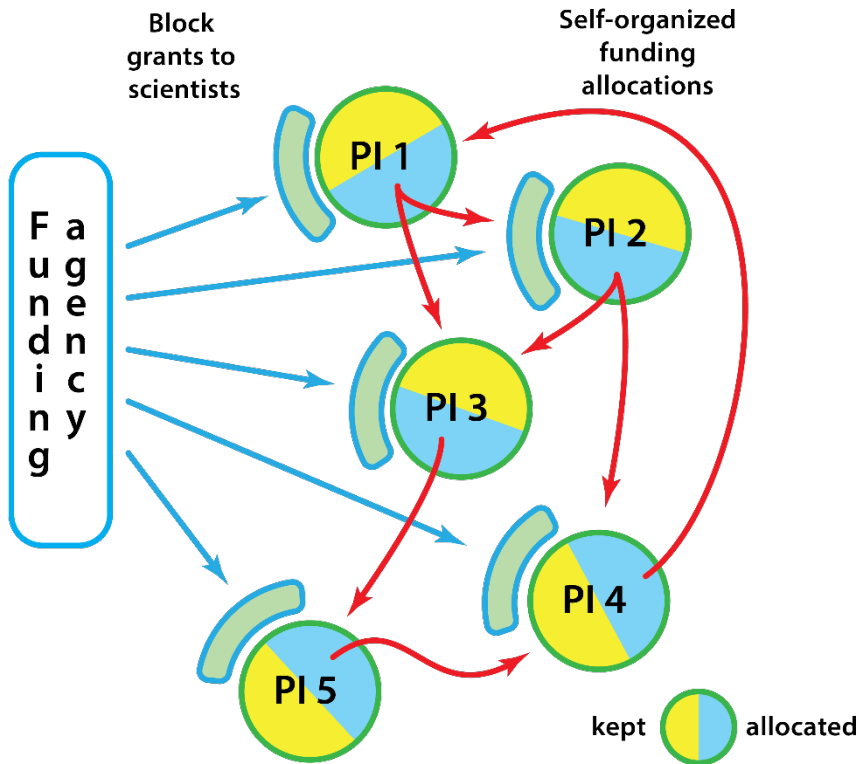
The HFSP model does not liberate scientists entirely from the grants treadmill: HFSP grants are for three years and are not renewable. Rather, they are intended to generate new lines of inquiry that can provide the foundation for funding through the more typical project-based grants system. At the end of an HFSP-funded collaboration, scientists are thus forced back onto the grants treadmill.

Self-Organized Funding Allocation (SOFA, Figure 16) is another funding model that is friendlier to the dynamics of basic science.⁷¹ In this scheme, scientists are provided a block grant that renews annually. Once qualified (assessed by appointment to a tenured university post, for example), scientists don't submit project proposals (although annual reports would still be required). From that funding, a grantee is expected to allocate some proportion (say 50%) anonymously to other scientists that the grantee wishes to support. The beneficiaries of the allocation can change from year-to-year as the grantee decides, with appropriate guard rails against conflicts of interest, discrimination, or cronyism.

Even though SOFA superficially seems like pointless shuffling of money, large self-organized systems can be powerful tools for the efficient allocation of

71 Bollen, J., S. R. Carpenter, et al. (2019). Rethinking resource allocation in science. *Ecology and Society* 24(3).

Figure 16. Scheme of self-organized funding allocation model for basic research.



resources. Allocations can be aggregative: if one scientist is perceived by many colleagues as doing important cutting-edge research, that scientist could receive several allocations that could produce a cumulative SOF allocation that provides substantial funding. Allocations can also be distributive, with one grantee spreading his allocations to several scientists working in a field that the grantee deems worthy of developing further. Allocations can also be targeted. If a scientist wishes to support a young scientist working to get a promising and risky research program off the ground, his allocation can be targeted thusly.

SOFA has been proposed as a more efficient mechanism for funding research than our present wasteful system of short-term grants and contracts that chain scientists to the grants treadmill. The most important attribute of a SOFA system is that scientific decisions are put firmly in the hands of communities of scientists, not science bureaucracies. This means of allocation better reflects the *ad hoc* and fluid dynamic of basic science as it actually works. Advocates also argue that SOFA would impose considerably less cost in time and resources that currently go into developing, writing, reviewing, and administering the current system of project-oriented research funding.

These efforts are laudable in that they recognize that our current system of research funding is not producing scientific discovery, as it was promised it would do. Such “innovation-focused” funding mechanisms remain largely unimplemented. To my knowledge, SOFA has never been implemented, although the Dutch parliament has advocated a limited test program. DARPA and other innovation-focused programs remain the minority model. There seems therefore to be a powerful political constituency keeping the present bureaucratic and cumbersome model of grant funding in place. That constituency is the self-aggrandizing, rent-seeking Big Science Cartel.

What is wrong: The current system of project-oriented short term research grants is extraordinarily wasteful of scientists’ time and effort. It diverts an enormous proportion of scientists’ time and energy into preparation of grant proposals which have only a limited chance of success (20%-30% at the NSF, less than 10% at the NIH). By coupling research funding to political ends, this undermines the intellectual autonomy of scientists and their ability to do basic research. It also subordinates their interests to the political and economic interests of governments and the proliferation of rent-seekers that compose the Big Science Cartel.

Solutions: Over the intermediate term (5-10 years), federal funding of academic science should phase out the current project-centered grants treadmill, and replace it with a system that grants more autonomy to scientists for how research monies are spent and allocated among researchers: in short, to correct the balance toward science bureaucracies that was established by President Truman in 1950.

- The President should issue an Executive Order directing the National Science Board to develop a plan to phase out the current system of short-term project oriented research grants, and to mainstream models for funding, like the HFSP or SOFA models, that respect the autonomy and intellectual independence of academic scientists.
- Armed with the NSB’s recommendations, the President should lead an initiative in Congress to repeal the NSF Act of 1950, and to craft legislation to refocus all federal funding of academic science toward fostering basic research in universities.

5. Refocus University Science on Basic Science.

Background: The original vision of *Science: The Endless Frontier* was to stimulate *basic* science, which the drafters differentiated from the various forms of the so-called *applied* sciences. The rationale for funding basic science was to stimulate discovery of new knowledge that could inspire innovation in the applied sciences. In

this way, American leadership in science and technology could be strengthened and sustained, and so secure American national security and prosperity. A considerable part of *STEF* was therefore devoted to how government funding could translate discovery into technology, that is useful and profitable products and processes.

There have always been two broad approaches to this question: social engineering (sometimes called industrial policy or science policy), and *laissez-faire*.

In the Small Science Ecosystem, *laissez-faire* was the common way to move new knowledge to useful application. Private companies were the natural venue for taking new knowledge and developing it into profitable enterprise. The government science agencies were the natural home for mission-oriented research. Universities were the natural haven for curiosity-driven science, which would provide the intellectual seed corn for both applied and mission-oriented research. This segregation of basic, commercial and mission-oriented research did not build walls between the different sectors. Rather, knowledge moved between them through interchange of personnel, the scientific literature, and donated, loaned or shared equipment.

STEF's proposal for a National Research Foundation sought to foster the ongoing *laissez-faire* approach by carefully insulating basic science from commercial or political pressure.

Operating agencies have immediate operating goals and are under constant pressure to produce in a tangible way, for that is the test of their value. None of these conditions is favorable to basic research. Research is the exploration of the unknown and is necessarily speculative. It is inhibited by conventional approaches, traditions, and standards. It cannot be satisfactorily conducted in an atmosphere where it is gauged and tested by operating or production standards. (p.34 *Science: The Endless Frontier*.)

The 1950 National Science Foundation Act paved the first steps into a social engineering approach to the interplay between basic, applied, and mission-oriented science. Where *STEF* sought to insulate the basic sciences, the 1950 NSF Act explicitly authorized the NSF to support applied research as well (Section 3: (b)). Where *STEF* sought to engage the best scientific minds, the 1950 NSF Act mandated spreading the funding as a form of patronage, “to avoid undue concentration” of funding to certain political constituencies, like states (Section 3: (e)). Meanwhile, the 1950 NSF Act charged the new agency with evaluation of federal science programs of mission-oriented research (Section 3: (5)). A significant aim assigned to the NSF was developing and manning the “scientific workforce,” to correct a supposed “shortage” of scientists and engineers, which has never disappeared, and has mostly led to over-production of scientists over the years.

In short, the 1950 NSF Act sought to undermine the rationale for support of basic science outlined in *STEF*.

The panic that followed the Soviet Union's launch of the Sputnik satellite exacerbated the illusion that American science was somehow behind its geopolitical rivals, and prompted ever more engagement of the NSF and other federal science agencies in funding academic research.⁷² The 1968 Daddario-Kennedy amendment to the NSF charter brought the NSF more firmly under political imperatives determined by the Congress.⁷³ Among its consequences was a directive for the NSF to fund social and behavioral research, which grew into its own Directorate for Social, Behavioral and Economic Sciences. The introduction of Broader Impacts as a merit review criterion was another consequence of the Daddario-Kennedy amendment. Recently, the NSF has also inserted itself more explicitly in funding applied science, creating a Directorate for Technology, Innovation and Partnerships, reflecting the provision in the NSF Act of 1950 to promote applied science, again at odds with the focus on basic research outlined in *STEF*.

Since the beginning of the era of government funding of academic research, funding agencies have aggressively pursued a social engineering imperative to the relationship between science and society. Far from simply supporting the basic sciences, the NSF and other federal science agencies now bend science to political ends related only tangentially, if at all, to discovery.

The Directorate for STEM Education, for example, has evolved from an office for managing and issuing fellowships to graduate students into a mechanism for intruding DEI ideology into the sciences. The politicization is not limited to the STEM education directorate, however. Under the political leadership of the NSF and other government science agencies, DEI ideology has penetrated into the NSF's other directorates supposedly dedicated to basic science. Project ADVANCE (Organizational Change for Gender Equity in STEM Academic Professions) is an umbrella initiative of the NSF that extends to all the NSF's scientifically-oriented directorates. In the Geosciences Directorate, for example, Project ADVANCE has spawned the Geosciences Opportunities for Leadership (GOLD) program, which explicitly calls for proposals to advance DEI ideology in the geosciences. Many of the NSF's other directorates host similar initiatives. In this way, DEI ideology infiltrates the basic sciences where it has no business being.

Solutions: The NSF, as well as all federal science funding, has been caught between two models for how science can benefit society, with government-driven

72 The National Science Foundation: A brief history. <https://new.nsf.gov/about/history/narrative#chapter-i-the-past-is-prologue-b23>

73 Mann, A. K. (2000). *For Better or Worse: The Marriage of Science and Government in the United States*. New York, Columbia University Press.

social engineering prevailing over the *laissez-faire* model favored by the drafters of *STEF*. The result has been a steady mission-creep of federally funded science to the point that funding of basic science in the universities has become a secondary concern. To rescue basic science, these trends need to be reversed.

The Trump administration has been taking action against the pernicious distraction that DEI ideology has imposed on the academic sciences. The administration's 2026 budget request zeroes out or substantially reduces funding for DEI related activities at the NIH, NSF, and other federal agencies with research programs. It has taken similar actions against funding for "green energy" research, and is refocusing research priorities on artificial intelligence and quantum computing.

While these actions parallel many of our own recommendations, they do not address the principal problem of academic science being transformed into a form of social engineering. Academic science, where a *laissez-faire* culture should naturally prevail, is still tightly bound to government and commercial priorities—again, precisely what the authors of *STEF* warned would destroy basic science.

Restoring the *laissez-faire* culture to academic science will mean reversing the experiment begun in 1950, and defederalizing academic research. To that end:

- The president should sign an executive order for NSF leadership and the remaining directorates to evaluate their research portfolios and present a plan to restore basic science as the core of the NSF's mission.
- The president should restructure the National Science Board with members that will guide the transition of academic science funding to independence from federal funding.
- The president should sign an executive order directing the NIH to submit a strategic plan for phasing out their extramural research programs, and to focus the NIH's mission-focused research to in-house research programs.
- The president should sign an executive order directing all other mission-oriented science agencies to submit a strategic plan for phasing out their extramural research programs, and to refocus their scientific missions to that specified by law.
- The president should work with the Congress to revise the NSF charter to re-focus support of basic science, including repeal of the Daddario-Kennedy amendment.
- The president should also work with Congress to develop a strategic plan to phase out all support of academic science, over a period of twenty years.

6. Graduate Student Education Reform

Background: Just as it proposed to do for basic science itself, *STEF* sought to boost federal support for graduate education, mostly in the form of fellowships and grants. These would be grants to students, independent of specific research funding, but would draw from the long-term and open-ended grants to universities that *STEF* envisioned.

With the preferred granting mechanism of government funding being turned to short-term project-oriented grants, the means of support for graduate education has shifted accordingly (Table 6). Students funded by the open-ended fellowships and grants mechanism envisioned by *STEF* are now the minority in all fields, with the highest proportion found in the life sciences. Roughly half of graduate students now are supported as research assistants on specific short-term research projects, with the lowest proportion found among graduate students in the life sciences (although this field has the largest proportion of funding by “Other” sources, often meaning unfunded by either university or research funds).

Coupling graduate education support so strongly to research projects has had a number of deleterious consequences, among the most serious being a disruption in the mentoring relationship between student and faculty scientist. Research assistantships, like teaching assistantships, are ostensibly half-time appointments, on the rationale that students will spend the rest of their time and effort on pursuing their degree. Included in those pursuits is a close mentoring relationship of student and scientist: an apprenticeship, in practice.

In fact, it rarely works out that way. Graduate research assistants usually put in more than full-time to their research tasks, and the stipends are far from remunerative (roughly \$25k annually). Because their remuneration is tied to a specific research project, and their place in graduate school depends upon keeping their appointment, the research assistantship has been compared (not without justification) to a form of demoralizing indentured servitude.

The predictable result has been a remarkable rise in graduate student unions (133% since 2012). Universities themselves have little interest in resolving the problem, because research grants are a significant source of university revenues. The National Education Association (America’s largest higher ed lobbying group) settles the question of the status of graduate students simply by declaring them to be “employees” with collective bargaining and workplace rights. Students and scientists are now pitted against one another, with erosion of trust on all parts. Largely gone is the close mentoring relationship between scientist and student that in the past

often prompted students to work in a scientist's laboratory for free, mindful of the opportunity for intellectual growth such a relationship provided.

Table 6. Percent of United States graduate students funded by various mechanisms.⁷⁴

Funding	Engineering	Life Sciences	Physical Sciences
Grants and fellowships	22	36	19
Teaching Assistants	12	16	28
Research Assistants	49	27	45
Other	16	22	7

There have been larger cultural and demographic consequences as well. The employer-employee relationship of university and faculty scientist characteristic of the ethic of production is mirrored in the relationship between a project PI and the graduate students working as research assistants. In this way, the ethic of production is passed from scientist to student, who then carry it into their own research careers.

An alternative to this form of indentured servitude already exists in the form of Graduate Research Fellowships, or GRFs. In this program, the stipend supports the student, not a project. Eligibility is evaluated on the student's prior academic performance and letters of recommendation. Once granted, the stipend thus follows the student, which allows the student the versatility and mobility that a research assistantship does not provide. Conferring choice and mobility to graduate students will undercut the ethic of production that now permeates graduate education, and will foster a restoration of an ethic of discovery among both students and mentors.

Solutions: Restoring the ethic of discovery to graduate education will mean removing the perverse incentives that are fostering the ethic of production in graduate students, and to refocus graduate student education on fostering the intellectual independence and autonomy of graduate students as incipient colleagues, motivated by an ethic of discovery rather than production.

Over a period of five to ten years:

- Eliminate the practice of employing graduate students as research assistants on federal research grants.
- Technical and laboratory assistance for research projects should be funded by straight contracts of employment, that carry no expectation of a graduate degree.

⁷⁴ Knight, D., T. Kinoshita, et al. (2018). Doctoral student funding portfolios across and within engineering, life sciences and physical sciences. *Studies in Graduate and Postdoctoral Education* 9(1): 75-90.

- Convert all graduate student support into fixed-term grants and fellowships, similar to the NSF's already existing Graduate Research Fellowships program.
- Graduate degrees should be awarded through evaluation and recommendation of an independent body of prominent scholars, such as members of the National Academy of Sciences. A university awards the degree based upon that recommendation as well as recommendation of the university's faculty.

Sidebar 5: Incentivizing abuse of graduate research assistants

The Carnegie Classification of Institutions of Higher Education rates universities on a number of criteria, including strength of their research missions. Research universities are classified into two tiers, R1, and R2. R1 universities bring in considerably more grant revenues (and hence indirect costs dollars) compared to universities ranked R2. Naturally, R2 universities covet R1 status, and are incentivized to climb out of R2 purgatory and up into a perceived R1 Valhalla. The Carnegie Classification offers universities a road map for their quest. The R1 tier is determined by various metrics of research performance, including numbers of doctorates awarded, grant monies obtained, and other, including the common metrics of science "productivity." Institutions that do not meet those criteria are relegated to the R2 tier.

Although the Carnegie Classification insists that the tiers are simply means of making fair comparisons, and in no way indicate the quality of a university's research mission, the dollars say otherwise. It frequently becomes the mission of an R2 university to build the numbers that might qualify it for the step up to R1. The result is a so-called "Tier One push"—pushing faculty to acquire more grants, more PhD students, more papers published—motivated not by scientific discovery but by the simple pursuit of attaining or keeping R1 status.

Exploitation of graduate research assistants is the common result, as they are pressured to add to the university's "productive profile" by working more than full time to support grant-supported research. Because they are not considered as employees, graduate students are left with little stake in the outcome, and often with a reasonable sense of grievance.⁷⁵

75 Wright, A. L. (2017). The rhetoric of excellence and the erasure of graduate labor. *Contingency, exploitation, and solidarity: Labor and action in English composition*. S. Kahn, W. B. Lalicker and A. Lynch-Binieck. Boulder, Colorado, University of Colorado Press: 271-278.

Cultural Reforms

Despite the policy origins of the perverse incentives of the Big Science Cartel, the academic sciences also have a cultural problem. The ethic of production has prevailed long enough to span at least three generations of academic scientists. While pockets of the ethic of discovery are still to be found, the network of incentives set by the ethic of production now largely sets the course of academic careers, embedding the ethic of production ever more deeply in the culture of basic science.

Federal funding of research has therefore become something like an addictive drug, and this has profoundly distorted the culture of science. As with all addictions, the biggest obstacle to reform will be the scientists themselves whose professional lives are organized around keeping the funding coming. As is also common with addictions, scientists are embedded in a vast sea of enablers, pushers, and enforcers that keep them bound to their addiction. Breaking free from the addiction to federal funding will mean scientists themselves taking a critical look at the cultural *milieu* of modern science.

Policy reform can help in promoting this critical self-examination, but it can only go so far. In the current cultural landscape of science, scientists will face two very large obstacles to the needed cultural reforms.

The first obstacle is the already large and growing power of the Big Science Cartel, in which all parties—universities, governments, academic publishers, and increasingly scientists themselves—are fully invested in sustaining the corrosive ethic of production. The second obstacle is demographic. As the ethic of production extends its hold on scientists, the scientific community will find itself increasingly populated by colleagues who have built careers around an ethic of production, are fully invested in it, and increasingly see no point in re-orienting science's ethical landscape. Scientists seeking to restore the ethic of discovery will face an increasingly uphill (and increasingly lonely) quest, with ever-diminishing allies that can help the revival along.

Restoring the ethic of discovery may involve some radical rethinking about the meaning of science, how it is to be supported, and what role the academy plays in the profession of science. These are cultural issues at root: these can drive policy, but policy alone cannot solve the cultural issues.

We recommend three broad aspects of cultural reform in the academic sciences:

- Take back control of the academic professions, including academic publishing, which now values publications as tokens to be exchanged as currency for promotion and reward.
- Reconsider the relationship of scientists with the research university and explore alternate ways that intellectual freedom can be secured.
- Explore how private philanthropy can support basic science and wean basic science off of government support.

1. Take Back Control of the Scientific Professions

Many of the issues roiling the academic sciences—the politicization, the suppression or narrowing of scope of legitimate discussion, censorship of unpopular topics, the grants treadmill, and several other pathologies—are rooted in the increasing power of institutions over scientists, owing to the large revenue streams involved.

At a recent conference on Censorship in the Sciences, several scientists recounted their experiences with cancellation, censorship, harassment, and an academy whose commitments to free inquiry had shifted under their feet. A common theme was surprise, combined at times with a naïve supposition for how to turn the tide around. To paraphrase the sentiment: “If only I can raise the alarm, if only I can make a persuasive plea to colleagues, if only I can reason with administrations, funding agencies, and colleagues, then we all can go back to science-as-usual.” That will not happen: the erosion of scientific values has been going on for decades, and it has been driven by the self-interest of a cabal of institutions that do not share scientists’ values.⁷⁶

As a result, scientists have essentially lost control of their professions. All the institutions that traditionally have defended the interests of scientists against anti-science pressures – academic self-governance, the professional guild associations, accreditation societies, and academic publishers—all are presently compromised, so that none can any longer be counted on to support science’s essential values. While the policy reforms suggested above can help reverse the pernicious growth

⁷⁶ Gross, P. R. and N. Levitt (1997). *Higher Superstition: The Academic Left and Its Quarrels with Science*, Johns Hopkins University Press.

of the ethic of production, it cannot be the whole solution. What is needed, frankly, is for scientists to disabuse themselves of a suicidal illusion: that they are valued *as scientists*, and that as long as they are left alone to “do science,” all will be fine.

In the Small Science Ecosystem, independent professional societies were an essential bulwark defending the ethic of discovery. That is no longer the case. The American Association for the Advancement of Science (AAAS), for example, is no longer dedicated to the advancement of science: rather, the AAAS has become a political lobbying group, tending the interests of science funders rather than their scientist members. The AAAS is a crucial cog in the Big Science Cartel, in other words. As DEI ideology has risen as a political imperative, the AAAS has adopted DEI ideology as its central purpose. Other professional societies have largely followed the AAAS’s lead, nearly all supporting or having DEI programs that undermine the security and interests of their older, and largely white male, members. Many senior scientists choose to ignore these trends, preferring to keep their heads down until retirement.

Among the professional societies’ traditional roles has been publishing a journal for their members. These were generally specialized to reflect the interests of their members, with circulation limited to members and academic libraries, and produced at low costs subsidized by member dues. That bulwark of independence has largely disappeared. In recent years, academic publishing has increasingly become the province of a few major publishing houses, which charge very high subscription charges that put journal subscriptions out of the reach of most individual members, and of academic libraries.⁷⁷

As the academic publishing industry has consolidated, it has become easier to enforce DEI ideology on academic publishing, through uniform editorial guidelines that apply to all journals under the publisher’s imprint. Academic publishing has also enabled the growth of the ethic of production. As a marketing strategy, scientific journals advertise themselves through prestige rankings like the *h*-index, which attract authors whose prospects for advancement and tenure depend upon publication in high *h*-prestige journals. Scientific papers are no longer instruments for scientists to discuss discovery. Rather, they have become tokens to be exchanged for rewards such as promotion and tenure, dragging scientists into the ethic of production. There have also been more subtle malignancies at work, including the proliferation of trivial journal publications, an explosive increase in the number of scientific journals, and heightened temptation to scientific fraud.⁷⁸

77 J S Turner. 2022. Scientific publishing is a scam fed by the government. *RealClearScience*. https://www.realclearscience.com/articles/2022/04/27/scientific_publishing_is_a_scam_fed_by_the_government_829132.html

78 Neff, M. W. (2020). How Academic Science Gave Its Soul to the Publishing Industry. *Issues in Science and Technology*. Phoenix, AZ. 36: 35-43.

Academic publishing, once the province of independent subscribers, is now subsidized by federal research dollars, through publication charges that are a line item in grants' direct costs budget. This both acts as a pass-through taxpayer subsidy to academic publishing behemoths (e.g. \$11,000 to publish a single paper in the journal *Nature*, an imprint of Springer).

Recommendation:

- To restore the ethic of discovery, scientists should mobilize for their professional societies to take back control of academic publishing.
- The president should sign an executive order eliminating the pass-through subsidy of page charges as a direct costs line item in research grant applications.

2. Is the University the Natural Home for Basic Science Anymore?

In 2011, Peter Wood put the question succinctly: universities need scientists more than scientists need universities.⁷⁹ So, why should scientists stay?

As universities have become increasingly unfriendly places for the basic sciences, perhaps it is time to revisit Wood's question.⁸⁰ The academic sciences have become increasingly politicized, undermining the ethic of discovery that is supposed to reign in the academy. The security of tenure and the attendant freedom to take intellectual risks is becoming increasingly flimsy. To restore the ethic of discovery, perhaps it is time for academic scientists to rethink their long-standing relationship to the research university? Indeed, to rethink the entire concept of the research university? Perhaps there are other venues where science could prosper, career security could better be protected, while upholding the Humboldtian ideal of melding teaching with research?

Presently, academic scientists are employees of universities, who no longer can count on the perquisites of academic freedom, tenure and intellectual independence that have long made the university professorship an attractive career. To the contrary, the research university is evolving into a censorious and increasingly burdensome venue for scientific careers, driven by the growth of the Big Science Cartel. Restoring the ethic of discovery may require scientists themselves to exit from the research university and create alternate professional venues where the ethic of discovery can once again be fostered.

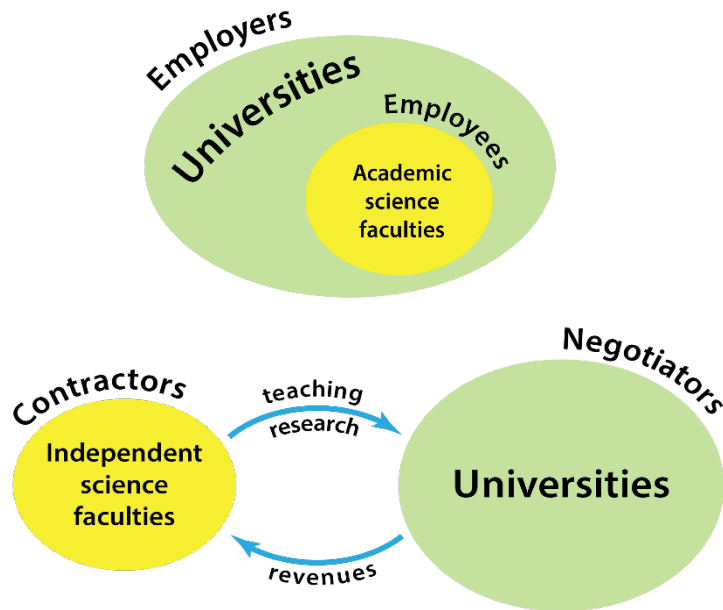
⁷⁹ https://www.nas.org/blogs/article/could_science_leave_the_university

⁸⁰ <https://www.mindingthecampus.org/2023/06/01/science-should-leave-the-university/>

One possible means would be for groups of scientists organizing into Independent Science Faculties, or ISFs (Figure 17). To quote from a recent article of mine:

“Imagine that a group of academic biologists working at (for the sake of argument) Simplicio University (SU) decide to leave and organize themselves into an ISF firm (for the sake of argument), Salviati Life Sciences, LLC (SLS). SU now faces a choice. It could hire, at great expense and disruption to its mission, an entire new life sciences faculty. Or it could enter into a contract with SLS to provide the educational and research services its formerly on-board biologists had provided. SU could continue to offer its students a biology curriculum, and SLS could deliver the top-notch education its members had always provided.”

Figure 17. Shifting the professional relationships between academic scientists and universities. Left: Academic scientists as university employees. Right: Academic scientists as contractors to universities for teaching and research. Upper: Academic scientists as university employees. Lower: Academic scientists as contractors to universities for teaching and research.

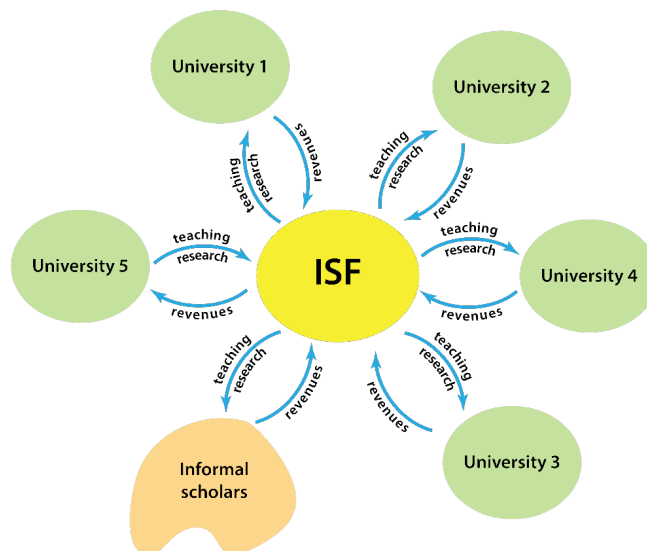


In an ISF, scientists would still have a relationship to a university, but the relationship will have shifted radically. Rather than being subordinate employees of universities, scientists now act as independent contractors to universities to provide educational services and research. Universities may no longer impose policies on scientists, as they increasingly now do, but must now negotiate terms of a contract with the ISF. This puts scientists onto a more equitable power relationship with universities compared to their present status as subordinate employees.

ISFs could be organized to do what universities are diminishingly inclined to do: protect scientists' intellectual independence. A model already exists in other professions, like law firms or medical practices, that might better protect intellectual independence and autonomy. These organizations have systems of evaluation and promotion of promising talent that are very similar to those in academic faculties. The major difference is that such decisions are firmly in the hands of the ISF partners, rather than being subject to the increasingly intrusive administrative meddling that now prevails in the research university. There may even be stronger protection of tenure and risk-taking, because professional security of partners is secured by an equity stake in the firm rather than on increasingly weak promises of tenure.

An additional benefit of scientists' organizing into ISFs is the ability to escape from the constraints of bloated and sclerotic university administrations, which act more to constrain innovation than to promote it. The business model of the research university is not well-suited to the increasingly networked digital world. ISFs are better suited. An ISF need not contract with only one university, or teach only students who are matriculated into the institutional silo of one university. Rather, it can engage with many universities or even communities of formal and informal learners that traditional universities presently do not serve well (Figure 18). Diffuse networks of engagement also introduce a competitive incentive to scientists in an ISF to innovate and explore alternate ways of teaching and doing science, which universities have mostly proven unable to do.

Figure 18. The ISF as a scientific node in an increasingly networked education and scientific world. Multiple ISFs can create a competitive landscape that can fuel innovation and creativity in the scientific and educational missions of faculties.



Scientists leaving the university to form ISFs is not such a radical idea as it may seem at first glance. There already exist numerous independent research institutes, such as MIT's Whitehead Institute, or California's Breakthrough Institute which are organized as non-profit entities with a research mission. These are supported by a portfolio of charitable donations and research grants, which can be managed as an ISF's portfolio. An ISF would simply expand on the mission of these research institutes to include services for teaching.

The Oxbridge universities (Cambridge and Oxford) already are organized similar to ISFs. Each college at Cambridge University is a separately chartered corporation. The Cambridge University administration has comparatively limited authority to impose its will on these colleges compared to the typical American university in which the purported colleges are subordinate to university administrations.

3. Rebuild Philanthropic and Private Funding for Science

Prior to World War II, philanthropic funding accounted for roughly 27% of science funding (Figure 3).⁸¹ Presently, only 4% of academic science is funded by private philanthropy. The worry expressed in *STEF* that federal support of research would crowd out other sources of funding, like philanthropic giving, seems to have been realized. Academic scientists presently labor under a prevailing assumption that science cannot happen without a large infusion of government monies.

There is more capacity for expanded philanthropic support of science than is presently assumed. In 2023, philanthropic spending amounted to roughly \$560 billion.⁸² The annual government expenditure for scientific research is roughly a fifth of that, and expenditure on basic research, roughly a tenth (Table 1). Over the next two decades, roughly a trillion dollars of private wealth will be transferred from the present generation to the next. This money will be looking for a place to land, and philanthropy is expected to be a major beneficiary of that transfer. So there is considerable potential to tap these funds to support scientific research, sufficient in fact to replace entirely government spending on scientific research.

Prior to World War II, university science was funded largely by institutional funds. Universities had research committees who could consider requests for funds from faculty, or requests could be made directly to the administration. Charitable contributions, either targeted to specific research questions, or to specific individuals, served as well.

81 Fitzpatrick, S. M. and J. T. Bruer (1997). Science funding and private philanthropy. *Science*. Washington DC, American Association for the Advancement of Science. 277: 621

82 <https://www.nptrust.org/philanthropic-resources/charitable-giving-statistics/>

In the early 20th century, there developed a system for channeling income from patents to fund university research. The challenge there was to insulate university researchers from commercial pressure, and so preserve the character of basic research. The Wisconsin Alumni Research Foundation (WARF) was the prototype, established in 1925 by a University of Wisconsin researcher, Harry Steenbok. He had developed a process for making vitamin D from irradiated ergosterol, which enabled food manufacturers to incorporate vitamin D easily into foods as prophylaxis to childhood rickets.⁸³ Steenbok patented the process and conferred management of the patent, including managing licensing and royalties, to the WARF, which then channeled return on investments to support research at the University of Wisconsin.

The WARF model inspired other universities to do the same. Edward Cottrell was a chemist at UC Berkeley who invented a device to clean smokestack emissions. He patented his device, and set up the Research Corporation with a similar aim of channeling royalty income to fund basic research. While Cottrell initially partnered with the Smithsonian Institution, Cottrell was also a personal friend of Robert Sproul, then chancellor of UC Berkeley. Sproul had ambitions to make Berkeley a world center for physics, and the Research Corporation would prove to be the vehicle that made it so, either through direct infusions of cash, or working industrial firms to donate equipment or materials as research needs arose. The development of the first cyclotrons was funded in this way, for example.⁸⁴

Today, about 1,400 colleges and universities have incorporated non-profit research foundations.⁸⁵ Their character has changed markedly from pre-World War II days. The State University of New York, for example, has incorporated the non-profit SUNY Research Foundation. Rather than being funded from wealth, these research foundations operate largely as a pass-through for research grant monies, the majority of which come from government sources. Most universities maintain portfolios of patents, but their ability to transform discoveries made in university research labs on campus into marketable products is less than stellar. Vesting patent rights in universities may even be a hindrance, fencing off patents from likely developers, or taking over inventors' intellectual property.

Even so, private funding plays an ongoing, if currently limited role in funding basic research. Scientists who are able to generate income independently, as from unrelated family enterprises or patents claimed from outside the university, may use these funds to support their own research or that of colleagues and students.

83 Apple, R. D. (1989). Patenting university research: Harry Steenbock and the Wisconsin Alumni Research Foundation. *Isis* 80(3): 374-394.

84 Hiltzik, M. (2016). *Big Science: Ernest Lawrence and the Invention that Launched the Military-Industrial Complex*, Simon & Schuster.

85 <https://www.case.org/connect/college-and-university-foundations>

One example is the Cocos Foundation, which generated income for a small circle of innovative biomechanics researchers at Duke University. The patent there was for the bicycle chain link. Such sources of funding can help support innovative research that has difficulty finding support in the prevalent crowd-following tendency in an ethic of production. Such funding also better defends Intellectual freedom, not allowing federal grants to be the “tail wagging the dog.”⁸⁶

In any discussion of science funding, a cultural obstacle inevitably arises: government science funding is presently so large that it is inconceivable to many that science would even be possible without it. What about space exploration, the Hubble Telescope, particle physics, conquering disease, development of new gadgets to make everyone’s lives better? Such things would not be possible without the deep pockets of government to fund them, so the argument goes. Since nobody wants to cripple scientific progress, government is effectively bullied into funding science.

Very little of this argument stands up to scrutiny. The Hubble telescope and its successor, the James Webb telescope are unquestionably pushing back the frontiers of our understanding of the universe. But would programs like this be impossible without government funding? The Webb telescope is the project of a mission-driven government agency, NASA, which carries an annual budget of between \$25-\$30 billion. The total cost of the Webb telescope over its expected working life of 24 years is expected to be about \$10 billion, or about \$420 million per year. This makes the Webb telescope one of the most expensive scientific projects in history. Would we not have the Webb telescope without that \$10 billion taxpayer subsidy (taxpayer accrued debt, truthfully)?

Hawaii’s WM Keck Observatory provides an interesting counter-example of ground-breaking astronomical research that is privately funded. It was established in 1985 with a \$70 million donation from the WM Keck Foundation. Since then, the Keck Foundation has pioneered innovative telescope designs and other instrumentation. The Keck Observatory accomplishes its pioneering work with an annual operating budget of about \$49 million. Operations support is through university partners (CalTech and UCLA), some of it through Keck Foundation grants to the universities. NASA also offers operations support, but development and construction of the observatory’s telescopes and instrumentation are supported by the Keck Foundation. The new Vera C Rubin telescope, which is dedicated to a decade-long survey of the dynamics of the visible universe, is supported in large measure by the Simonyi Foundation.

Space exploration is another big-ticket item that it is argued would be impossible without government support. NASA is the government agency that oversees space

86 Cohen, J. (1998). Scientists Who Fund Themselves. *Science* 279(5348): 178-181.

exploration, with a budget of about \$23 billion. About 32% of that goes to science programs (about \$7.4 billion). The bulk of NASA's budget (about 45%, a little over \$1 billion) goes to its human spaceflight programs. There is perpetual internal conflict between these two divisions, not just for distribution of funds but by the inevitable intrusion of politics into NASA's Congressional funding.⁸⁷ The rise of private space exploration, exemplified spectacularly by SpaceX's innovations in launch technology and logistics is certainly challenging the assumption that a government agency like NASA is the best, or even only, sponsor of these endeavors.

Such arguments uncover another problem: it valorizes very expensive science (particle accelerators, space telescopes, fusion reactors) as indicative of all science. Most basic science does not cost as much. In 2024, the NSF issued 10,590 grants, with a maximum award of just under \$8 million (Figure 19). Nearly all awards were considerably less, with an average value of about \$460,000, and a median award of just under \$300,000. These are typically for three year awards for an average annualized expenditure of \$150,000, and a median annualized expenditure of about \$100,000.

There are also numerous private foundations that support basic research. The American Heart Association, for example, funds roughly \$3.6 billion in grants, for an average award of about \$156,000.⁸⁸ There are similar medically-oriented foundations for diseases such as cancer, juvenile diabetes, and autoimmune diseases. Even so, there are vast areas of scientific research, particularly in fields such as ecology, conservation biology, and natural history that cost much less to fund. Many of these organizations fund their work through contracts, individual donor networks, and private contributions that allow them to do solid scientific research.

Given that the principal consequence of the federalization of academic science has been to squash the ethic of discovery and subsidize in its place a counter-productive ethic of production, it follows that restoring the ethic of discovery therefore means weaning academic sciences off government support, restoring the Small Science Ecosystem, and the funding mechanisms that fostered a thriving ethic of discovery.

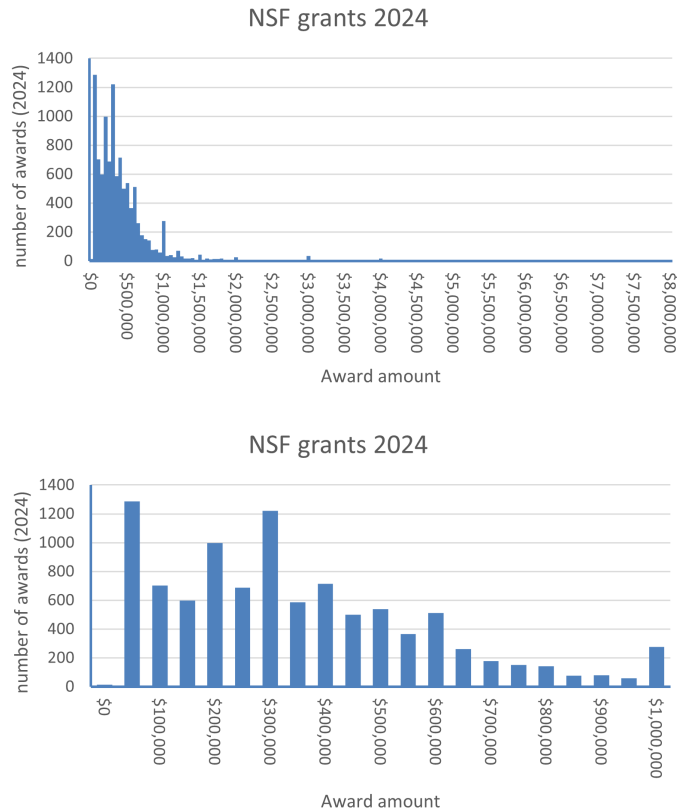
It's worth a reminder that a survey of seventy Nobel laureates whose prizes were awarded between 2000 and 2008 showed that funding came from a mix of both public and private funding. Remarkably, a substantial number of the landmark papers that won them their Nobel prizes were not funded at all.⁸⁹

87 Exemplified by the history of the space shuttle program: Hersch, M. H. (2023). *Dark Star: A New History of the Space Shuttle*, MIT Press.

88 <https://heart.dimensions.ai/discover/grant>

89 Tatsioni, A., E. Vavva, et al. (2010). Sources of funding for Nobel Prize-winning work: public or private? *The FASEB Journal* 24 (5): 1335-1339.

Figure 19. Distribution of NSF awards in 2024. Top: All awards. Bottom: Awards of \$1 million or less. Source: NSF by the numbers: <https://new.nsf.gov/about/about-nsf-by-the-numbers>



The notion that philanthropy cannot fill the demand for research dollars that government presently provides is now being put to an interesting test. As the Trump administration has been moving aggressively to cancel or curtail research grants, Harvard University seems to be tapping its endowment and donor networks to step in and fill the gap. İş Private Equity, a Turkish venture capital group, recently announced a commitment of \$39 million to fund the laboratory and work of a Harvard professor of genetics and metabolism. The commitment provides the resources, but raises some interesting questions about the role of foreign sources subsidizing research in American universities.

Sidebar 6: Is public funding of science necessary?

The “public-private partnership” trope—that science is advanced when private funding is partnered with public funding—is another oft-invoked justification for massive public spending on science. The economics of such partnerships are based mostly on salesmanship and wishful thinking. There is, in fact, very little evidence that a net positive value emerges from the partnership, because every dollar spent on public funding of science is a dollar taken away from private funding.⁹⁰ There’s also an issue of different cultures and expectations at work. For example, an anti-cancer initiative by a citizen’s group, the National Breast Cancer Coalition (NBCC) was undertaken in partnership with Department of Defense (DoD) researchers in the hope that DoD expertise could be leveraged to find better treatments for breast cancer. The partnership didn’t work because the DoD scientists kept taking the research further and further away from the NBCC’s desired goals.⁹¹ The NBCC ultimately decided to directly fund researchers who could advance the NBCC’s goals.

Funding inevitably comes with expectations on the part of the funder. Funding science publicly carries with it the false assumption that government is the only logical funder of science because only government can serve as an honest broker. Research funded by self-interested donors is therefore automatically suspected of bias. That government is a disinterested party in this arrangement is a falsehood, however.

The important issue is whether funding, no matter what the source, can stimulate different or new approaches to a scientific problem? If government is the dominant source of funding, the science will reflect the political biases of whichever party is in power. This is why certain scientific issues are so strongly polarized: climate change is a Democratic priority, therefore considerable funding gets directed to “climate science,” producing what David Randall has characterized as “policy-based evidence making.”

Arguably, private funding would be more likely to stimulate healthy *scientific* debate. Now, funds would come voluntarily from donors across a wide political spectrum, rather than funds taken forcibly from taxpayers and distributed according to political priorities of governments. Polar bear research, for example, is richer for it being funded by a diversity of private sources.⁹²

Sidebar 7: Science without government: The Namibia Experience

Namibia is a developing country on southern Africa’s west coast, bordered by South Africa to the south, Angola to the north, and Botswana to the east. It provides an interesting example of how a robust program of science can be supported without large government subsidy.

Prior to World War I, Namibia was a colonial possession of Germany, which it lost after World War I. Under a League of Nations mandate, South Africa governed Namibia until Namibia’s independence in 1990.

Namibia is host to a number of remarkable ecosystems, most notably the Namib Desert, which hosts a diverse biota of endemic species that have an interesting evolutionary story to tell. It offers obvious attractions to scientists working particularly in the fields of natural history, ecology, evolution, geology, and climatology.

During its time as a mandatory territory, many South African scientists worked in Namibia, bringing with them financial and infrastructure support for research. Independence for Namibia changed that relationship. Financial support from South African institutions dried up, and South African scientists found it more difficult to conduct research in Namibia. What followed was a proliferation of NGOs dedicated to research, mostly related to wildlife conservation, but some dedicated to particular species or broader aspects of natural resource development. A sampler of these organizations is provided in Table 2).

Many of these efforts rely on donations and contracts, and support robust research programs. The Cheetah Conservation Fund, for example, draws on a worldwide network of charitable donors to support their work, which includes research on cheetah conservation ranging from population genetics to veterinary care. In some instances, as in the Rhino Trust, research is supported as an adjunct to eco-tourist operations.

I am most familiar with the Gobabeb Namib Research Institute, which was established in the 1950s at a remote location in the Namib Desert. The site was determined by an expedition in the 1950s sponsored by mining and

90 Kealey, T. (2013) The case against public science. *Cato Unbound. A Journal of Debate*. August 5, 2013.

91 Sarewitz, D. (2016). Saving science. *The New Atlantis* 49(Spring/Summer 2016): 4-40.

92 J S Turner. 2023. Minding the Sciences—Smarter than your average bears. *Minding the Campus*. 5 October 2023.

petroleum companies.⁹³ For a time, it was run as a branch of the Transvaal Museum in Johannesburg, but that funding was cut off at independence. Since then, Gobabeb has supported itself through various contracts for meteorological and satellite services. Pioneering research on the population biology and ecology of *Welwitschia mirabilis*, an iconic endemic plant species, mostly comes from Namibia's prosperous mining industry. The station supports two senior full-time scientific staff, who carry on a robust research program into all aspects of the ecology of the Namib. Gobabeb has developed associations with Namibia's two national universities as well as partnerships with universities in South Africa to provide training internships for students, who carry out the contract work as well as work on their own research projects for their own degrees. In short, Gobabeb functions along very similar lines to the Independent Science Faculties proposed above.

Most importantly, Namibian science was able to make a difficult transition at a time when the Namibian government was not equipped to fund a national research program, nor would be for several years. It worked, however, because there was already a strong civic tradition of supporting research, through donations from companies, groups of individuals, and publications.

Table 7. Selected private research foundations in Namibia.

Organization	Mission
Cheetah Conservation Fund	"... to be the internationally recognized center of excellence in the conservation of cheetahs and their ecosystems."
AfriCat Foundation	"... to conserve large carnivores in Namibia."
Giraffe Conservation Foundation	"...to address the lack of knowledge and conservation efforts for giraffe, working tirelessly to raise awareness, conduct research, and protect these magnificent animals."
Namibia Nature Foundation	"one of Namibia's oldest and largest homegrown environmental organizations."
N/áankuse Foundation	"...a holistic approach that intertwines the preservation of natural habitats, the well-being of wildlife, and the empowerment of local communities."
NACSO	Conservation of natural resources in communal areas of Namibia
Kalahari African Wild Dog Conservation Project	"...committed to the conservation of Namibia's African Wild Dogs."
Save the Rhino Trust	"...to protect the desert-adapted black rhino in order to ensure security for these and other wildlife species, a protected habitat, and a sustainable future for local communities ..."
Mohamed bin Zayed Species Conservation Fund	Conservation of Namibia's national plant, <i>Welwitschia mirabilis</i>

⁹³ Full disclosure: Over the course of thirty years, I have carried out a number of research projects at Gobabeb. In addition, I spent 2022 at Gobabeb as a Fulbright Scholar.

To Rescue Science

Each of the reforms proposed here, both policy and cultural, would make the academic sciences less beholden to the creeping politicization and corruption they have been experiencing over the past few decades. The overall aim of the reforms is to restore the ethic of discovery, which the generous federal funding has crushed under the demands of a misguided ethic of production.

1. Indirect costs reform would reduce the incentive for universities to use science faculties as a cash revenue stream and would force changes in the auditing rules that have allowed indirect costs revenues to grow to the highest rates of all countries with national research programs.
2. Returning merit review criteria solely to Intellectual Merit and eliminating Broader Impacts statements would refocus funding on discovery, and cut off an avenue for political imperatives to shape funding decisions.
3. Funding research separately from overhead would allow scientists to take at least one step off the “grants treadmill” and refocus their efforts on scientific research.
4. Phasing out the current funding model of short-term project oriented proposals, and phasing in alternate funding models of block grants, SOFA, or a modified HFSP model, would put decision-making power over granting more firmly in the hands of scientists, not funding agencies, or science bureaucracies.
5. Reining in and reversing the mission creep that has allowed applied and commercial research to dominate university funding of science would refocus the university as a haven for basic research and the ethic of discovery.
6. Funding graduate education by student-centered graduate fellowships would liberate graduate students from the grants treadmill and restore the mentor-student relationship to its traditional—and very successful—focus on the ethic of discovery.

These policy reforms, along with the cultural reforms we propose, address a deeper issue in the relationship of science and society, to wit: is science a public good, is it intellectual property, or is it a civic virtue? Strong arguments can be made for all viewpoints. The Small Science Ecosystem as it had developed by the mid 20th century had struck an effective balance.

- Science as a public good resided mostly in the government sector, in the mission-oriented agencies.
- Science as intellectual property found its natural home in private sector research and development.
- Science as a civic virtue was largely represented in the research universities, which provided a safe haven for curiosity-driven, or basic, research, insulated from political and commercial imperatives.

The overall effect of the federalization of the academic sciences begun in 1950 has been to convert all science—government, commercial, and basic - into a public good. Any notion of science as civic virtue has slowly been crushed under the insistent demands that come with any public good. Among the casualties has been the ethical norms of academic science, which have transformed from an ethic of discovery into a meaningless and corrosive ethic of production.

Rescuing science will therefore mean rebuilding and defending the ethic of discovery in the academic sciences. This can only be done by taking government entirely out of the funding of the academic sciences.

There will be formidable political opposition to any such attempt, exemplified by the hysterical reactions that accompany any challenge to the *status quo*, prompted most recently by the Trump administration's aggressive re-ordering of the landscape of public funding of academic science. It's noteworthy that the most strenuous opposition is coming from parties fully invested in continuation of the Big Science Cartel, like the American Council on Education, the National Association of College and University Business Officers, and the American Association for the Advancement of Science. According to these parties, the Trump administration's action amount to "institutional destruction," the classic false choice of *status quo* or doom. There will also be no shortage of scientists who are so immersed in the ethic of production that they can easily be stampeded into the doom-mongering.

With the second Trump administration, we are seeing a replay of the hysteria unleashed when the first Trump presidency launched some comparatively restrained attempts to reform science funding at the NIH. Now, the stakes are much higher. The FY 2026 proposed budget contains steep spending cuts throughout the government science landscape, including a 43% reduction at the NIH, a 56% reduction at

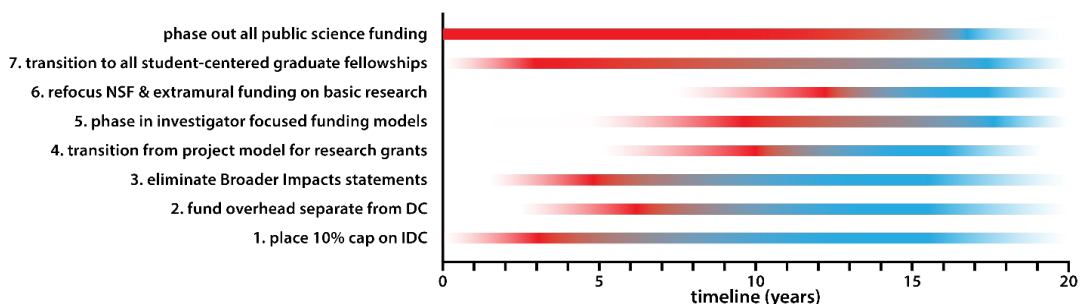
the NSF, and similar cuts throughout the roughly two dozen federal agencies that have both intramural and extramural research programs. The second Trump administration also proposes a reorganization of the NIH's numerous institutes into just eight, with three being eliminated altogether. Similarly, research on renewable energy is substantially reduced or zeroed out. Numerous programs that cloak DEI ideology in the guise of research are also largely gone. Spending on computing infrastructure, quantum computing, artificial intelligence and fossil fuel exploration are either left untouched, or increased slightly. Defense research spending is slated for very large increases. The academic community is treating these proposals as a "war on science," but in fact they represent the inevitable consequence of coupling science to government and its changeable political priorities.

While many of the Trump administration's current actions parallel recommendations in this report, they are motivated by different aims. Our concern in *Rescuing Science* is focused specifically on the academic sciences and on dismantling the perverse incentives imposed by the Big Science Cartel, and on restoring the ethic of discovery that is at the core of basic science. The only possible way to accomplish this is to eliminate government funding of academic science as much as possible, in fact to eliminate it altogether.

The Trump administration's actions, bold as they are, are pursued with an aim contrary to ours. At the end of the day, the Trump administration's actions will not eliminate the Big Science Cartel, they will only shift its priorities. For these reasons and others, our support for the Trump reforms is tempered by whether they will make our ultimate aim of freeing academic science from the Big Science Cartel easier, or harder.

The political challenge will be how to do this without destructive disruption of those parts of the modern science ecosystem that *are* working: that dwindling cadre of scientists who are still steeped in the ethic of discovery, despite all the disincentives against it. That cadre will have to be emboldened and empowered to take back the science ecosystem and reshape it toward discovery.

Figure 20. Possible timeline of policy reforms to free academic science from federal funding. Red indicates initiation of reform, and blue represents completion.



The proposed reforms, both policy and cultural, are intended to do just that, to incentivize discovery. Each reform can stand on its own, and enhance the ethic of discovery. Full restoration will implement them all over a timeline spanning roughly twenty years (Figure 20).

Will the academic sciences muster the political and cultural resolve to see this project through? It took generations of perverse incentives to build the Big Science Cartel. Disentangling science from those will itself be a generational project. It must be undertaken, though, because the future of science depends on restoring the ethic of discovery and the social and political norms that sustain it. In the end, reform will come not from politicians, but from the determined will of scientists who see the ethic of discovery as the beating heart of basic science and will work to revive it.



NATIONAL
ASSOCIATION
of SCHOLARS

X @NASorg
✉ contact@nas.org