A Builder-Philosopher's Thoughts on Science Policy

George Percivall, August 2026

Science and Technology (S&T) can improve our quality of life. S&T Policy is a method that governments use to enable that improvement. The recent report Science: A New Golden Age (SNGA) reexamines America's research and development ecosystem in light of changes brought on by the 21st century. SNGA[1] was written by the Office of Science and Technology Policy (OSTP) to advise on the scientific, engineering, and technological aspects of national policy and the work of the executive branch. SNGA identifies four overarching goals; two of those goals are discussed in this note:

- The Federal Government should set clear scientific goals and build the industrial muscle to translate scientific discovery into technological strength.
- We must prepare our research enterprise for the AI revolution. AI will accelerate and radically transform the way we do science.

The role of a builder-philosopher is to design and develop technology that improves lives and enables "the good life" as envisioned by each person in their own way. This note draws from the philosophy of engineering and technology in developing comments on SNGA. The SNGA report critique of scientific and innovation processes fails to recognize the role of the builder-philosopher in securing the pursuit of happiness as declared in the US Constitution. The report needs to better consider socio-technical aspects and the role of the Federal Government to address those aspects for S&T Policy.

This note is organized in these topics:

1. Role of Builder-Philosopher in Living Well
2. Design: Creating new order with technology
3. Innovation: freedom and risk
4. Science and technology response to AI

1. Role of Builder-Philosopher in Living Well

America's culture of intellectual freedom is implicitly tied to the ideal of allowing individuals to choose the "good life" and realization of self that they individually choose. In our age, S&T plays an outsized role in defining the methods by which a person can pursue their good life. People utilize technology in pursuit of the good life. Technology mediates the relationship that humans have with the world (Verbeek, 2005). This mediation thereby shapes experiences and existence.

SNGA (Chapter IV) identifies that the Federal Government should ensure that S&T betters the lives of all Americans. America's scientific creativity and entrepreneurial culture position us to translate breakthroughs into technologies that enrich every American's life. To better the lives of all Americans, technologies must advance quality of life in their use.

SNGA critiques the approach to S&T Policy defined by Vannevar Bush as a linear sequence of discovery and innovation stages that is no longer adequate. SNGA claims the linear model is broken

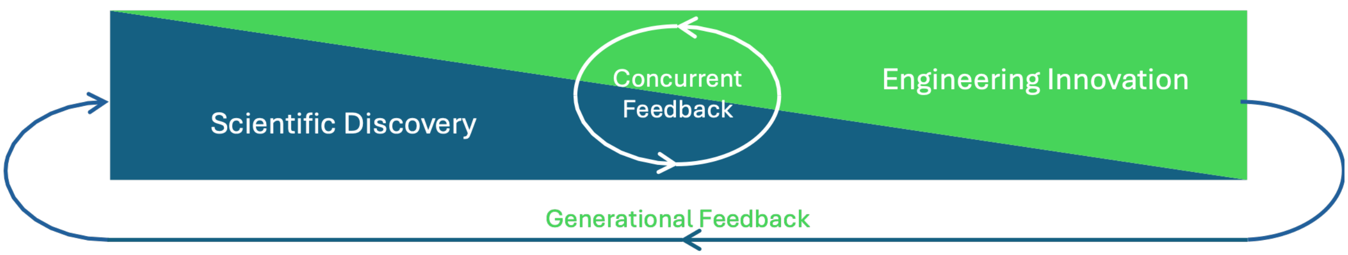
---

[1] Thanks to Zach Pirtle for bringing my attention to SGNA. See [his blog about SGNA](): "A better mythology for science?"

because “discovery” is happening in industry. But SNGA’s examples only show that “innovation” in industry is possible due to “discovery” in science.

SNGA confuses private sector development with research. SNGA (Chapter I) cites the transistor and the AI transformer architecture as coming from “corporate laboratories.” The discovery and first working implementation of the transistor were done at Bell Labs; a lab with a steady source of funding which made research for the public good part of its reason for being. Innovation of the transistor and the subsequent integrated circuit were done in commercial companies. The AI breakthroughs were developed by Hopfield and Hiton as university researchers – later awarded the Nobel Prize – developments that were years before the LLM revolution. The researchers discovered that computing is possible using neural networks. Innovations on neural networks, including the transformer architecture, were done by engineers in corporate development for commercial application. SNGA’s examples do not break the linear model; in fact, they support more than ever the rubric: “Scientists discover nature’s secrets; Engineers create new order.”

Feedback between discovery and innovation is the basis for SNGA’s critique of the linear model. "Modern discovery, however, is increasingly shaped by continuous iteration between fundamental and applied work." (Ch. I) "We must face the reality that more innovation is happening in industry than ever before, the linear model of discovery and technical progress no longer holds…" *(Ch. I).* SNGA’s statements are accurate, but they reinforce — rather than refute — the relationship between scientific discovery and technological innovation and call for a refinement of the feedback between them.



Technology development has always been an iteration between scientific discovery and engineering innovation. SNGA (Chapter III) recognizes this as "Technological leadership helped forge modern America. Science alone did not produce this leadership; it required the deliberate cultivation of engineering talent, institutional capacity, and industrial might to turn discoveries into capabilities." Discovery of novel concepts of science must be decoupled from the push for innovation. Innovation has always been better in industry. Now more than ever, S&T Policy must support the engineering innovation of technology in industry.

Where science discovers truths about the natural world, engineering creates entities that never existed before. It is this engineering creation and innovation that place the moral onus on engineering. OSTP recognizes that "technology exists in three forms: tools, explicit instructions, and process knowledge." *(Ch. IV),* and that "This tacit knowledge cannot be fully codified." *(Ch. IV).* "This process knowledge, embodied in an experienced workforce, is the true keystone of technological capability." *(Ch. IV).* While Ch. IV is about skilled craftspersons the role of tacit knowledge is even more relevant to engineers. It has long been recognized (Polanyi, 1966; Vincenti, 1990) that engineers exercise significant, often tacit, power in shaping societal infrastructures, such as cyber-physical systems-of-systems, internet and web architectures, automated commercial products, and AI-driven agents.

Today’s scientific discoveries increase the need for enabling engineers to better anticipate and design technology with an eye toward how it benefits the good life, while assessing the risks and avoiding the harms of the latest technology developments. S&T Policy needs to take a broader view of the socio-technical aspects of S&T by examining how the broad fields of the natural and social sciences can benefit technology innovation. The next section discusses the role of engineering in creating new order. The following section discusses the methods for engineers to balance the rewards and risks in technology innovation.

2. Design: Creating new order with technology

Design is the process of creating an engineering entity that achieves functionality through physical implementation. An entity's function and physical structures are distinct, and balancing them is an ethical act as much as a technical one. Design of artificial entities is a skill of mankind (see Hebert Simon below). Design must consider more than innovation for commercial value. In order that entities may promote the good life, practical wisdom must be part of engineering design.

In "Science Is Not Enough" (1967) Vannevar Bush discussed how science has a simple faith, which transcends utility (P191): "It is the faith that it is the privilege of man to learn to understand, and that this is his mission." "Knowledge for the sake of understanding, not merely to prevail, that is the essence of our being." SNGA focuses the role of science on support for commercial innovation. S&T Policy should not only embrace this broader mission of scientific understanding but should also clarify the distinct role of innovation in creating means for the good life. This latter role of innovation is at the heart of engineering design.

To understand how S&T Policy can enable engineering design, we must lay out the ways in which design creates new order. Aristotle observed in Metaphysics I.2 that it is the mark of the wise to order (phronesis); Aquinas reformulated it as *sapientis est ordinare*. Design is the engineer's act of creating order — and the association of order with wisdom is an onus the engineer must take on.

A philosophy for design must address design practice, wise ordering, and emergent forms together. That need is taken up in natural philosophy's three themes: change as a constant stream of events, form as persistent structures that emerge, and agency as adaptive form.

S&T Policy needs to address how technologies are increasingly embedded in social ecosystems. SNGA recognizes this for science discovery but fails to see how it affects engineering innovation. SNGA calls for social technologies to improve the R&D process but makes no mention of research on social technologies to improve science and technology themselves.

There is need for both more research in social sciences and their application to socio-technical research and innovation. SNGA Chapter V critiques psychological research as facing a reproducibility crisis, but SNGA does nothing to describe the value of psychological research – and other social sciences – as relevant to the new golden age of science. Nor does SNGA recognize the need for research and technology innovation connected to the social sciences.

Science policy needs to provide guidance on how social sciences can be utilized in support of engineering and innovation. The social sciences differ from the non-social sciences due to reflexivity: their objects change under description and intervention. Reflexivity leads social science to prefer interventions that are small, reversible, and falsifiable, and to design for error-correction rather than optimality. That is a recognizably engineering sensibility — robustness and feedback over a computed optimum.

SNGA does address an example of socio-technical research in Metascience, which studies the social machinery of science. In Chapter II, Metascience is identified as generating rigorous evidence of what actually works in science. Metascience is described as based on "The economic field of mechanism design, recognized with the 2007 Nobel Prize…". Economic science is key to S&T Policy.

S&T Policy should promote research that improves the ability of engineers to conduct quality design. Engineering-Philosophy gives this practice its depth. Herbert Simon's work focused on the science of design as a type of psychology. Simon identified design as man's relation to the environment in which he seeks to survive and achieve (The Sciences of the Artificial, 1969/1996). Simon went so far as to declare that the proper study of mankind is the science of design. In his view, design, like science, is a tool for understanding as well as for acting. Christopher Alexander derived order from functional analysis and fitness to the environment (1964, 2004), and at OOPSLA 1996 charged that "software engineers should take aesthetic-moral responsibility for the wholeness of what they build."

Characteristic of the liberal-democratic vision of society is a particular way of bringing together the notions of freedom, equality, and self-realization. The liberal democratic ideal is that the nature of the good life must be the responsibility of the individual alone. *Design of technology then necessarily becomes a moral matter.* Designers engage in "ethics by other means"; their products codetermine the outcome of moral considerations, which in turn determine human action and their definition of "the good life" (Verbeek, 2005). US S&T Policy must address the moral questions associated with technology development and innovation as engineering design.

3. Innovation: freedom and risk

We should not fear scientific discoveries of nature's secrets; but we must be hesitant when creating new order. Innovation can lead to technologies with little or no benefit; and even more concerning, innovation can lead to technology that is detrimental to the safety and security of the good life. Risk, which is always present in innovation, must be explicitly considered as an engineering topic. Freedom to innovate must be balanced against the risk that innovation creates.

SNGA frames the discussion of innovation as permissions — "A permissionless approach to innovation does not mean the reckless development of technology. Prudence in broad deployment is wise, and it is the foundation of society's trust in our technologies." (Ch. III). Permissionless innovation holds that experimentation with new technologies should be permitted by default (Thierer, 2014), with problems addressed as they develop. This framing of innovation as permissions is odd to an engineer. Permissions are elements of regulation and not elements of engineering judgment.

All innovators should be assessing the positive and negative values of their innovation. Innovation progresses by displacing current technologies (Schumpeter, 1942; Aghion, 2014). When permissionless innovation occurs in industry, the overwhelming factor for risk assessment is profit and postponing consideration of negative impacts that may come later. Engineers are ethically charged with considering the balance. Recent industry approaches have undercut this role with battle cries like "move fast and break things" and "evergreen development" that shift risk from the corporate developer to the consumer who is unaware and unable to assess the risks.

Freedom to innovate should have a more rigorous discussion. Restraints on innovation to reduce risk must be balanced with liberty. J.S. Mill's On Liberty (1859) offers one approach to scoping limits: the sole end for which mankind is warranted in interfering with the liberty of action is self-protection. Who should decide the limits on innovation, and when those limits are imposed, are judgments involving prediction and uncertainty.

S&T Policy should address the balance between freedom and risk that engineers should consider during innovation. Institutions are needed in which these principles are assessed during technology development. Corporations have shifted that assessment to other parties.

SNGA emphasizes a form of practical wisdom: “Prudence in broad deployment is wise, and it is the foundation of society's trust in our technologies” (Chapter III). Institutions should promote and practice practical wisdom regarding risk and freedom in innovation. Governing this ineliminable tension between freedom and risk is precisely the remit of practical wisdom (phronesis). Risk management, a long-standing engineering practice for identifying possible harms during development, provides the working basis for those judgments. Development and innovation is the time to have those discussions and make those judgments.

What are the best venues for the engineering tradeoffs associated with freedom and risk? Chapter III identifies that "Within broad technological trajectories, multiple futures are possible. The question is which one America will fight for." *(Ch. III).* Neither scientists nor industrialists are well suited to make those assessments alone. "Pre-Competitive Consortia" *(Ch. III) including feedback between innovation, discovery and policy are well positioned in making the tradeoffs.* "The pre-competitive consortium model worked because it targeted the right problems where the science was understood, but the engineering had not yet been done, where shared technical risk was the barrier" *(Ch. III).* Consortia fit between research and innovation. They are an excellent example of the genuine need for coordinated innovation before the full force of market pressures determines economically optimized outcomes. Compare the Human Genome Project and SEMATECH with social media and AI. Both social media and AI were quickly overtaken by market pressures that optimized for economic engagement; with AI, the lack of consideration of outcomes outside corporate ranks is a major concern.

SNGA makes the claim that regulation is the roadblock. Let us assume that regulations should be aimed at the social good and not at unnecessarily handcuffing innovation. S&T Policy should include an emphasis on discovery and innovation that makes assessing the impacts of technology easier, thereby making regulatory compliance — as a means of ensuring the good life — a normal course of innovation.

SNGA’s claim that "The most talented builders increasingly migrate toward software, where the regulatory burden is lightest" *(Ch. III)* should be a call to restore the engineering role of ethical design. The alternative is a generation of builders who see the only measure of technology as corporate profit. Corporate profit is an excellent engine for innovation, but without practical wisdom it does not meet the objective of the good life.

We have blinked at this revolution before. The benefits of social media technology were claimed with little support by the industry building the technology. The lack of socio-technical consideration led to social media addiction and harm, recently costing social media companies large penalties and a redesign of their platforms. We can do better.

4. Science and technology response to AI

Many aspects of S&T are being redefined by Artificial Intelligence technology. SNGA singles out the effect of AI on the science process. AI also affects our understanding of the natural world, which in turn affects how we design technology; both the process of design and the practical wisdom of design. AI motivates us to consider the effect of technology on what it means to be human in the world.

From a science process point of view, SNGA (Ch. V) observes that "for millennia, scientific knowledge and technological progress were bounded by the cognitive faculties of the human mind." Chapter V of SNGA seems to imply that the role of human practical wisdom is decreasing in importance. On the contrary, in the age of AI we must redouble our efforts to guide science and technology based on human society considerations. SNGA correctly identifies that "The coming abundance of cognitive capability demands a corresponding transformation of our scientific institutions." (Ch. V). SNGA recognizes the need for "AI-native scientific institutions, with rules, infrastructure, capital models, and cultural norms built around the use of powerful AI systems." (Ch. V) — but discussion of those norms is needed even more for innovation in industry. Where SNGA seems to place that transformation in the hands of industrialists, AI demands more than ever that we consider socio-technical considerations in engineering design (c.f., IEEE Ethically Aligned Design).

AI brings new perspective to what we mean by agency. Agents sense and respond to their environment and take action toward goals. We have long studied agency in the world; now we are creating it in earnest, and that is changing our understanding of the world (Tomasello). Agency is increasingly seen as a key element of natural philosophy, with levels of agency extending beyond humans. AI has redefined cognitive space itself through the spatial embedding of concepts; the epistemology of agents now plays out in networks — social physics — and neurosymbolic AI combines neural intuition with symbolic representations. The engineering of autonomous agents in cyber-physical ecosystems must include philosophical considerations (IEEE 2874 Spatial Web).

Earlier phases of the AI revolution were paired with inquiry into how the computing aspects of AI would relate to the human aspects. The latter was a research program in cybernetics. The eponymous cybernetic moment ended 'when information was becoming the keyword of our time' and cybernetics had become flattened to 'the all-purpose adjective of cyber' by the 1980s (R. Kline, The Cybernetics Moment, 2015). The socio-technical topics addressed by cybernetics, now addressed by a range of natural and social sciences, need to become a primary point of emphasis in S&T Policy for AI.

AI Technology is increasingly mediating our social, professional, and private lives. The boundary between human agency and algorithmic prescription is blurring. Dennett (From Bacteria to Bach and Back, 2017) identified the real danger of AI: that we over-estimate AI tools and prematurely cede authority to them. The tension between freedom and risks in AI design and innovation is perhaps the defining element for S&T Policy in our time.

In closing, let’s revisit those two goals of SNGA we set out as our scope:

- “The Federal Government should set clear scientific goals and build the industrial muscle to translate scientific discovery into technological strength.” Yes, but US S&T Policy must go further. It clarify the difference between scientific discovery and technology innovation. Based on that clarity the roles of engineering design and balance of reward and risk in innovation becomes clearer. As the engineering of innovation becomes more associated with socio-technical ecosystems research and innovation in the natural and social sciences is needed.
- “We must prepare our research enterprise for the AI revolution. AI will accelerate and radically transform the way we do science.” Yes, but we must not lose the role of human wisdom plays in defining that iterative path of AI discoveries and innovation that provides everyone the opportunity to define how technology plays a role in achieving what they consider the good life.