What is wrong with "technology as applied science?"

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Scholars in science and technologies studies talk about a "pure science ideology" or "scientific ideology." Stereotyping applied science as dull and mindless practice that generates no new knowledge, the ideology grossly distorts both pure and applied science. What is its origin?

Perhaps you have noticed a curious phenomenon. Many engineers and scientists identify technology with applied science. From the charter of the first engineering society to today, engineers talk proudly of application of science. Many such as Robert Thurston and Charles Steinmetz happily called engineering applied science. However, some engineers consider being identified with applied scientists an insult, as one insists: "engineering applies science but is not applied science."

Why are the attitudes so different? Aeronautic engineer Walter Vincenti, who has published extensively in scholarly journals, suggested an answer. He observed that scholars "tend to think of it [engineering] as applied science. Modern engineers are seen as taking over their knowledge from scientists, and by some occasionally dramatic but probably intellectually uninteresting process, using this knowledge to fashion material artifacts."[1] If applied science meant intellectual inferiority, then technology is definitely not applied science. But does it? Who say that it does?

Two senses of "applied science"

Science generally means state of knowing or possessing knowledge that is sufficiently general, clearly conceptualized, carefully reasoned, systematically organized, critically examined, and empirically tested. According to subject matter, science can be analyzed into many sciences: natural sciences such as physics or biology, engineering sciences such as communication and control, social sciences such as economics, human sciences such as psychology.

Practicality of topics divides between basic and applied sciences. In the scientific and engineering community, the difference between them is one of focus and orientation, not intellectual quality, epistemological precedence, or historical priority. This is made clear by the U.S. National Science Foundation, which defines applied science as aiming at "gaining the knowledge or understanding to meet a specific, recognized need," treats it equally with basic science, and pours research funds into it [2]. Research thrives in Divisions of Engineering and Applied Science of Caltech, Harvard, and many other universities. New knowledge fills numerous books and journals on applied mathematics, applied physics, applied mechanics, etcetera. The intellectual excitement and information fertility of applied science are widely

acknowledged. It is in this proud sense that a carefully edited report with contributions from eighty engineers and scientists from academia, industry, and the government asserted: "*Applied science* is often regarded as a synonym for 'engineering'."[3]

A different sense of "applied science" underlies the attack on engineering and technology as applied science. Here application of science is described as "more or less mechanical" and applied science "debased," "intellectual parasitism," "introducing no new knowledge," "a humdrum uncreative activity crucially dependent upon basic science," and low in "pecking order." This disparagement of applied science is called "the scientific ideology" or an "American ideology" by scholars who allege that it pervades western tradition, especially the American culture since at least mid-nineteenth century. The allegation was introduced in the 1970s and promoted ever since by sociological historian Edward Layton [4]. It has been widely accepted in technology studies. What are the evidences of the allegation?

Is applied science disdained in American culture?

Is the disdain of applied science an American ideology? The United States spends more on applied than on pure research. America has a culture where Thomas Edison was a national hero and *Scientific American* a newsletter for patents, the inaugural editorial of *Science* extolled application, and the Land Grand Act specifically sponsored universities for applied oriented education. The preponderant practical attitude of Americans had struck European visitors such as Alexis de Tocqueville, who observed in 1835: "In America the purely practical part of the sciences is cultivated admirably, and people attend carefully to the theoretical portion immediately necessary to applications; in this way the Americans display a mind that is always clear, free, original, and fertile; there is almost no one in the United States who gives himself over to the essentially theoretical and abstract portion of human knowledge."[5] Even in formal philosophy, America is known for its pragmatism distinct from British empiricism, French rationalism, and German idealism. Such a culture is unlikely to undervalue applied science.

Is snubbing application a prejudice of scientists? Nobel prizes in physics have been awarded to wireless telegraphy, automatic regulators, transistor, integrated circuit, electronic microscope, and fast photonics, which are applied science if anything is. Emphasis on application is even stronger in chemistry and biology, as is evident in the coziness between university biology departments and pharmaceutical companies. Even the purest of pure scientists deny that applied science is devoid of new knowledge [6].

Groundless accusations

So where did "the scientific ideology" come from? Scholars referred to each other about it, but were not totally oblivious of its hearsay nature. One historian remarked: "The origin of this notion is not entirely clear. Certainly it is prominent in the rhetoric of the promoters of science from Francis Bacon and the seventeenth century academicians to James Conant and Vannevar Bush."[7] Another admitted after two decades and numerous references to it in the history of technology: "Little attention has been paid to the history of this view [the scientific ideology]

and why it (and similar beliefs) has been so pervasive in American culture." It is significant that he does not question the alleged pervasiveness even when his own historical research yields not examples but counterexamples.[8]

The groundlessness of "the scientific ideology" is apparent from the piece of text most frequently offered as its certain and prominent evidence: Bush's *Science – the Endless Frontier*. Bush was an engineer whose own research was all applied. His article is posted approvingly in the website of the National Science Foundation, which takes great pain to put pure and applied sciences on equal footing.[9] Written in 1945, it was a report to the U.S. president recommending a specific policy: the need to create public funding for basic research. In contrast to general treatises, requests for funding tend to focus sharply on the benefits of the proposed project. Omission does not imply disapproval; asking for too much would invite rejection. To win public support for basic research that has no apparent material benefits is not easy now and was more difficult then. Bush was careful to limit his objective. He did not ask funds for applied research, which had been supported by mission oriented agencies in the government, not to mention in the private sector for profit motives. He argued that basic research produces new knowledge but never suggested that it produces all knowledge so that that technology contains no knowledge. He argued that basic science is necessary but never suggested that it is sufficient of knowledge.

Consider Bush's sentence: "A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial and weak in its competitive position in world trade, regardless of its mechanical skill." Layton quoted and accused it for implying the "intellectual parasitism" of applied science and denying "symbiotic relationship" between applied and basic sciences. The accusation has no justification, because the proposal nowhere asserts that basic research produces the *only* crucial knowledge. We can compare Bush's notion of basic research as "pace setter" to paratroops that stake out the ground. Suppose the military urges the creation of air born units, arguing that without them one would lose the rapid deployment edge, no matter how fast ground troops move. This in no way implies that ground troops are parasitic on paratroops, which will perish if not linked up with the main army.

Bush did not denigrate application. Neither did other promoters of sciences as alleged. They argued for the *value of research without apparent applications*, not the *disvalue of research with applications*. Research requires much human and material resource. In attracting funds, pure science is disadvantageous because it promises no immediate return. Pure scientists working on a shoestring are more likely to explain the benefits of their works, as expressed in the title of Henry Rowland's "A plea for pure science." It appeared in 1883, ten years before the birth of *Physical Review*, when pure research was almost nonexistent in America. To distort such desperate pleas into a deprecation of application perverts the whole nature of science, pure and applied.

A case of muddled thinking

When analyzed, alleged evidence of the prevalence of "the scientific ideology" turns out to be conceptual muddles that interpret *necessity* as *sufficiency*, *some* as *all*, "*A* is important" as *B* is worthless, "*A* is good" as *B* is bad, "*A* has something" as *B* has nothing. Applied science is

stereotyped without any attempt to study its actual practice or analyze its technical contents. Counter examples are ignored.

Confronted with growing insistence of numerous engineers to describe their practice as application of science, Layton shrugged: “it is enough to recognize that such claims [by engineers] are ideological in nature and not to be taken as literal descriptions.”[10] Such disregard of evidence is not uncommon in postmodernism – “interpretive flexibility” is a central tenet in social constructionism. A sociologist described the treatment of scientists by her postmodern colleagues: “a certain ‘Besserwisser’ approach prevails, with the sociologists smugly overruling the scientists. It was as if the sociologists were the self-appointed psychoanalysts of scientists, knowing their ‘true’ motives, unbeknownst to the scientists themselves.”[11]

Layton introduced “the scientific ideology” not as a positive doctrine but as a target of attack. Unfortunately, it is a wrong target. An elitist culture did exist in which “the idea of utility has long borne the stamp of vulgarity,” as observed by historian Leo Marx. “*The* intellectual world” spurned the concept of technology until after 1918, more than half a century after the foundation of Massachusetts Institute of Technology.[12] As late as 1959, when engineering research was wide spread, a scholar declared that no word existed for the improver of technology comparable to “scientist” as the improver of knowledge.[13] This was the elitist culture that stood against the scientific culture in C. P. Snow’s analysis of the gap between two cultures; its definition of “intellectual” excluded not only engineers but physicists and mathematicians.[14] Snow’s description was echoed in 2002 by Harvard’s president Lawrence Summers, who criticized “a culture where it is unacceptable not to be able to name five plays by Shakespeare but where it is fine to not know the difference between a gene and chromosome.”[15] This culture – not the scientific culture – is the breeding ground of the misnamed “scientific ideology.”

Bush, the alleged prime advocate of "the scientific ideology," actually advocated its negation: “In all associations between engineers and scientists, engineering is more a partner than a child of science.”[16] This thesis has long been a commonplace among engineers. However, Layton proposed it in 1970s as a novelty in technology studies, accompanied by the alleged prevalence of “the scientific ideology” in scientific culture and American culture at large. He argued for a valid old thesis with an invalid new reason. The falsity of his allegation was dimmed by the tendency of elitists to regard their small club as the whole world.

The false allegation is harmful because it attributes bigotry to the wrong people and distorts the whole picture. "The scientific ideology" hurts applied scientists and engineers. Its alleged prevalence adds harm to pure scientists and the American people who are thereby stereotyped as narrow-minded bigots. It creates animosity among engineers and scientists. By distorting legitimate arguments for basic science into an objectionable prejudice, it undermines support for basic research.

References

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