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Basic Research as a Political Symbol

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Abstract The use of the phrase "basic research" as a term used in science policy discussion dates only to about 1920. At the time the phrase referred to what we today commonly refer to as applied research in support of specific missions or goals, especially agriculture. Upon the publication of Vannevar Bush's well-known report, *Science – The Endless Frontier*, the phrase "basic research" became a key political symbol, representing various identifications, expectations and demands related to science policy among scientists and politicians. This paper tracks and evaluates the evolution of "basic research" as a political symbol from early in the 20th century to the present. With considerable attention having been paid to the on-going evolution of post-Cold War science policy, much less attention has focused on the factors which have shaped the dominant narrative of contemporary science policies.

Keywords US science policy · Symbolism · History · United Kingdom

Introduction

Since the end of the Cold War in the early 1990s, observers of science and technology policies have studied in depth the on-going changes that have characterized thinking and practice (e.g., Sarewitz 1996, Gibbons et al. 1994, Guston 2000, Jasanoff 2004, Lentsch and Weingart 2011). Much of the post-War discussion and debate of science in society and politics orients itself with respect to an overarching narrative that characterizes post-World War II science and technology policy, with less attention focused on the establishment of that narrative (Kline 1995). At the core of that narrative is a concept – "basic research." This

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paper documents the rise of "basic research" as a political symbol in the early to mid-20th century, thus setting the stage for its well-documented fall and the changing nature of science and technology policies now underway.

The phrase "basic research" has been fundamental to discussions of science policy for almost 70 years. It represents both a concept and a relationship. As we will see, the phrase carries with it multiple meanings which support the expectation that public investments in science and technology are the wellspring of economic growth and prosperity. Although "basic research" entered the English lexicon around 1920, it only became a term broadly used in science policy discourse upon the 1945 publication of Vannevar Bush's seminal report, *Science – The Endless Frontier*.

"Basic research" first appeared as a phrase on the pages of the *New York Times* in 1922, in a US Congressional hearing in 1919 and in 1923 in the Congressional Record of a floor debate among members of Congress, and in *Science* and *Nature*, respectively 1924 and 1928.[1] The fact that the phrase appeared first in political discourse prior to appearing in the leading journals of science is symptomatic of the role of the phrase as an important political symbol with a meaning that has evolved over time.

From its initial years, *Minerva* was home to early discussions and debates over "basic research." Toulmin (1966) presented the "warrants for basic research." Michael Polanyi's (1962) "Republic of Science" in the journal's very first issue wrote what remains today an oft-cited defence of logic of support for basic research, which at the time was part of his long-standing debate countering J. Desmond Bernal's emphasis on mission-oriented research (Brown 2007).[2] Calvert (2006) explored the continuing use of "basic research" as a key concept in science policy. All told, almost 100 contributions to *Minerva* since 1962 have used the phrase "basic research" (according to a search of the journal's website). As the journal looks to its next 50 years, this paper contributes an analysis of some neglected aspects of the past.

Political symbols, according to Edelman (1967), "bring out in concentrated form those particular meanings and emotions which the members of a group create and reinforce in each other." More precisely, as a political symbol "basic research" represents the identifications, expectations and demands of scientists, policymakers and the public about the role of science in society (Lasswell et al. 1952). Symbols play an important function in political debate as "there is nothing about any symbol that requires that it stands for only one thing" (Edelman 1967). Thus, the public can rally around a national flag or members of a legislature around the issue of, say, "tax reform," even though in each case individuals may ascribe vastly different meanings to the idea of the nation represented by the flag or the specific meaning of "tax reform."

This paper argues that in discussions of science policy "basic research" has played an important symbolic role in maintaining a political consensus on the role

[1] The sources for the media, Congressional and scientific publications cited here are discussed in the text below.

[2] Polanyi did not actually use the phrase.

of science in society that has continued largely unbroken for almost 70 years. The political consensus has undergirded an approach to science policy that has been found wanting by analysts and scholars for decades (e.g., Sarewitz 1996). However, to date, despite the perceived weaknesses in contemporary science policy identified by academics and other observers, a new political consensus has yet to emerge to replace "basic research" as a central, organizing symbol.

To explore the symbolic functions of "basic research" in political discourse in science policy over the past century, this paper documents through a straightforward content analysis the rise (and subsequent fall) of "basic research" as a political symbol, and how the phrase has evolved and changed as the politics of science policy have changed over time. The paper proceeds in four parts. Part one provides an overview of symbols in political discourse and the methodologies of content analysis used to track symbols over time. Part two conducts a simple content analysis of the presence of "basic research" in the United States in the elite media, Congress and in the leading scientific journals *Science* (published in the US) and *Nature* (published in the UK). Part three explores in more detail the historical context which gave rise to "basic research" as a political symbol. Part four discusses some of the reasons that "basic research" has sustained as a political symbol, despite the introduction of various alternatives. Despite various proposed alternatives to "basic research" – such as transformational research or use-inspired – the concept has yet to be replaced in science policy discourse. This paper helps to explain why.

Part I: Symbols in Political Discourse

Elder and Cobb (1983) define a symbol as: "any object used by human beings to index meanings that are not inherent in, nor discernible from, the object itself." They continue:

> Literally anything can be a symbol: a word or a phrase, a gesture or an event, a person, a place, or a thing. An object becomes a symbol when people endow it with meaning value or significance.

In his classic essay, Sapir (1934) distinguishes two types of symbols, referential and condensational. Referential symbols are "economical devices for purposes of reference." So each of the following is an example of a referential symbol − @, +, &, Z, WORD, ☺. A second type of symbol distinguished by Sapir is one that carries with it "emotional tension in conscious or unconscious form." Examples of such symbols would include 9/11, a swastika, the American flag, and your name. Sapir asserts that "society is peculiarly subject to the influence of symbols in such emotionally charged fields as religion and politics."

Lasswell et al. (1952) define "key political symbols" as those which occur "in the flow of political statements," and distinguish three types: symbols of identification (referring to people and groups), symbols of demand (referring to preferences and volitions) and symbols of expectation (referring to assumptions of fact). As a key political symbol, "basic research" has been extensively studied from perspectives that correspond conceptually to the three-part typology (cf. Sarewitz 1996).

As a symbol of identification, basic research is used to characterize the work conducted by scientists. Alvin Weinberg (1970) proposed an axiology of science which held that basic research is "better" than applied research. Weinberg was codifying a value structure that had long been in place in the scientific community (cf. Godin 2009, Calvert 2006). The first editorial published by *Science* in 1883 explained that the person who applies the discoveries of others to "useful purposes … stands upon a lower plane than the investigator." From the perspective of the scientific community, basic researchers stand at the top of a hierarchy of activities worth pursuing, reflecting a sense of purity and nobility (*Science* 1883; cf. Daniels 1967; Pielke 2007).

As a symbol of demand, basic research represents an invocation of the so-called "linear model" of innovation, which is typically characterized as a flow from basic research to applied research to development to application and ultimately societal benefits (Godin 2006; Pielke 2007). Bush (1945) in his famous report used the metaphor of a reservoir as a buffer between scientists and the rest of society, with the results of research akin to water that fills the reservoir, to be available to decision makers when needed. The more modern language of "upstream" and "downstream" engagement in research follows directly from the Bush metaphor. From this perspective, Bush argued that "basic research" needed special protection as demands for relevance would tend to drive out research aimed at furthering knowledge itself (cf. Sarewitz 2012).

As a symbol of expectation, basic research is viewed by many scientists as research done with no consideration of application. At the same time, such research is viewed by policymakers as fundamental to applications (Calvert 2006). Such contradictory views are reconciled via Bush's reservoir metaphor. But for many years the Bush metaphor has been viewed as problematic in practice (Godin 2009; Pielke and Byerly 1998). Dubos (1961) identified a "schizophrenic attitude" which Daniels (1967) characterized as a focus among scientists on the conceptual aspects of their work while at the same time maintaining in public – especially when soliciting research funding – that their work would lead to "useful results." In a series of analyses, Godin (e.g., 2002; 2003; 2005) documents how the linear model of science was used as a means of research accounting by governments, and crucially, by the Organization for Economic Cooperation and Development (OECD). The specificity required in allocating money was contrary to the multiple and conflicting uses to which the term basic research served as a symbol of demand.

The phrase "basic research" evolved from a referential symbol to a condensational symbol of expectation, identification and demand, ultimately serving as a (if not the) key political symbol of 20th century science policy. The next section performs a simple content analysis of the rise (and subsequent fall) of "basic research" as a key political symbol, documenting this evolution.

Part II: A Content Analysis of Trends in Elite Media, Congress and *Science/Nature*

Lasswell et al. (1952) argue that one can track symbols over time in political discourse via a "content analysis" defined as "a technique which aims at describing,

with optimum objectivity, precision, and generality, what is said on a given subject in a given place at a given time." This section of the paper performs a straightforward content analysis of the frequency with which the phrase basic research has appeared in political, media and scientific outlets over the past century.

Figures 1a and b show the number of mentions of the phrase "basic research" in the Congressional Record, which documents debate among members of Congress on the floors of the House and Senate, and in Congressional hearings, which are used to gather testimony from various witnesses and includes statements of witnesses, supporting materials, and the transcripts of exchanges between members of Congress and witnesses. The data is presented by Congress (each covering 2 full years) and was collected using the Lexis-Nexis Congressional database.[3] Searches were performed on the appearance of the specific phrase "basic research" in the full text of the database.

The first concatenation of the words "basic" and "research" in debates of the US Congress occurred in a congressional hearing in 1915 on the budget of the US Department of Agriculture where both words were used as adjectives to describe the "work" of the agency. The first use of the phrase "basic research" with "research" used as a noun occurred in a Congressional hearing on USDA in 1919. In both datasets, the number of mentions of the phrase increased sharply in the mid-1940s, coincidental with the publication of *Science - The Endless Frontier* and the was followed by a sharper increase in the 1950s following the creation of the National Science Foundation, when the phrase first appeared in the text of bills.

The phrase has seen a subtle decline in floor debate, where elected representatives speak, but saw a much more pronounced increase and then decline in congressional hearings. Presumably this is due to agency officials and interested parties who often testify to the importance of "basic research" before the relevant oversight committees and subcommittees. The peak mentions in the Congressional Record occur in 1969 and in Congressional hearings in 1979, with respective declines of more than 50% and almost 70% by 2010.

However, when the data are normalized to the dataset average (Fig. 1b) the data shows similar patterns in floor debate vs. in hearings, with the peak usage among elected officials leading that used in hearings.

Figure 2 shows the frequency of appearances of the specific phrase "basic research" in the *New York Times* collected using the paper's publicly available archival search function on its website. The time series shows some similarities and some differences as compared to the pattern of use in Congress. Usage of the phrase increased dramatically upon the publication of *Science - The Endless Frontier*, and then saw a second dramatic increase beginning in 1956, peaking in 1959, followed by a large decrease in use in 1961. There was a subsequent steady decline until 1980, which saw an upswing followed by a subsequent decline in usage. Appearances of the phrase in 2010 were 50% of the levels of 1980.

[3] Available at: https://web.lexis-nexis.com/congcomp. The database is available on a subscription basis and was accessed via the University of Colorado. Data collection was performed by Sarah Leshan and Zach Johnson, who also performed the searches discussed below.

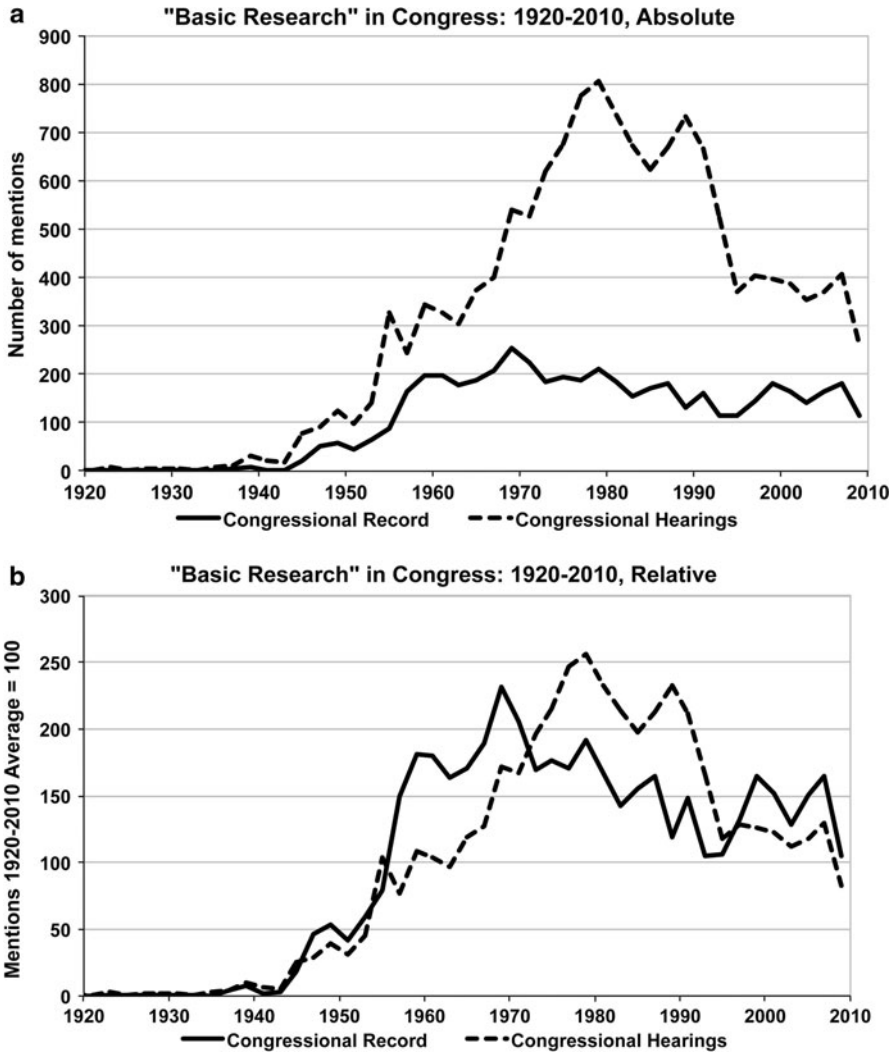

Fig. 1 **a** The number of mentions in the Congressional Record and Congressional Hearings from 1920 to 2010. **b** The relative number of mentions in the Congressional Record and Congressional Hearings from 1920 to 2010, with the long term average equal to 100

Figures 3a and b show the frequency of uses of the phrase "basic research" in the two leading journals of science, *Science* and *Nature,* obtained using the search functions available on each website (requiring a subscription to access). The patterns of usage within the scientific community are starkly different than those in Congress or the *New York Times*, showing increasing usage in absolute and relative terms before falling steeply in the 1990s following the end of the Cold War.

To summarize, the usage of the phrase "basic research" rose and fell in each of the databases explored here. Specifically, in Congress, usage peaked in the late

Fig. 2 The number of mentions in the *New York Times* from 1920 to 2010

1960s in floor debate and about 1980 in hearings. In the *New York Times*, usage peaked in the late 1950s with a secondary, and much lower, peak around 1980. In *Science* and *Nature*, where scientists (and those who cover science) generally write for each other, usage peaked the latest, in the 1990s. All databases show a significant decline in usage to 2010.

The next section seeks to explain the rise of basic research as a political symbol and its significance for science policy, drawing on theory in symbolic politics and studies of US science policy.

Part III: Making Sense of the Rise of "Basic Research"

The notion of "basic research" as "pure science" existed long before the publication of *Science - The Endless Frontier* popularized the phrase. Substantially similar appeals for government support of research had been made in the US and the UK since at least the 1920s. Such arguments did not gain much traction until World War II. Leadership of science at the highest level of government moved from agriculturists to physicists. In accepting the importance of science, politicians never deviated from their expectation that science would be instrumental. The introduction of the flexible phrase "basic research" was able to accommodate all of these changes and became institutionalized as the basis for science policy practice. But it was not until World War II, and the demonstrated power of science via the atomic bomb and other technologies, that basic research came to dominate science policy discourse.

Symbolic Transformation: From Pure to Basic

The phrase "basic research" entered the American vocabulary in the 1920s, though there is evidence that the phrase was used on a few occasions in Congressional

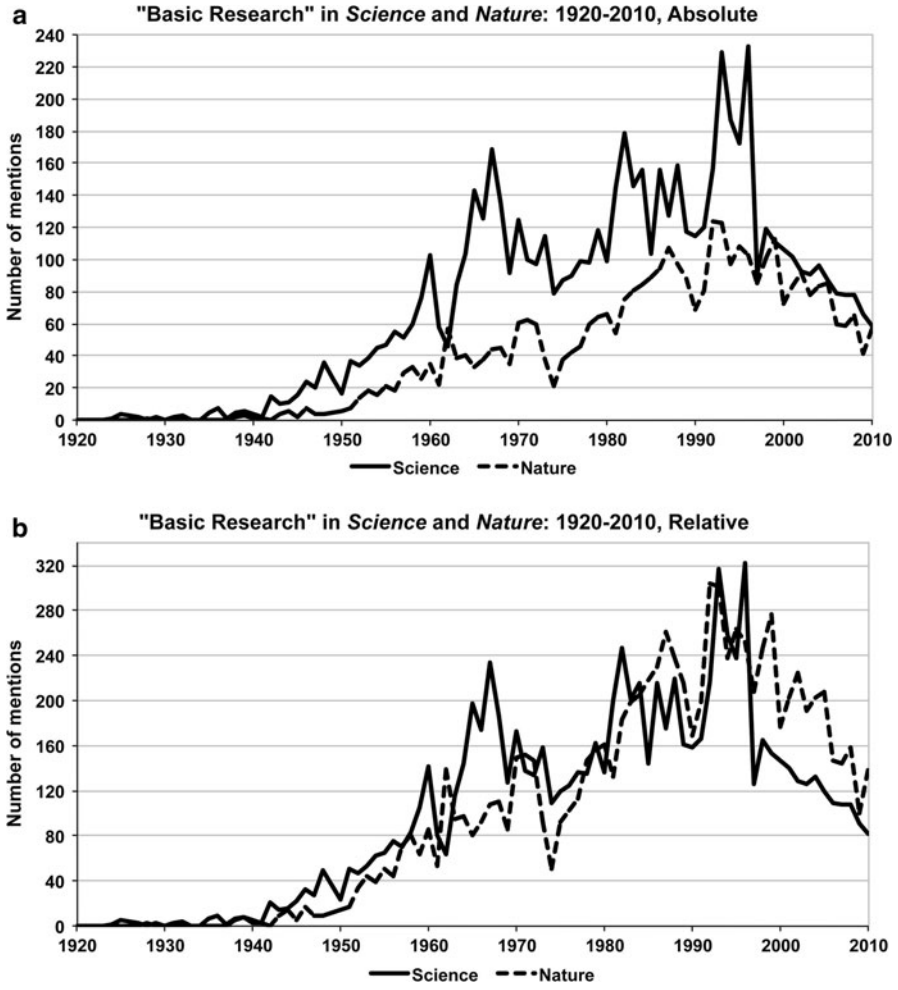

Fig. 3 **a** The number of mentions in *Science* and *Nature* from 1920 to 2010. **b** The relative number of mentions in *Science* and *Nature* from 1920 to 2010, with the long term average equal to 100

discussions involving the US Department of Agriculture (USDA) prior to 1920. However, despite appearing in the *New York Times* and in Congressional deliberations, the phrase did not become a key political symbol until after World War II.

When "basic research" was first used as a term by scientists and leaders in the USDA, it carried a meaning much more closely aligned to what we today call "applied research." The phrase itself was a condensation of a longer descriptive phrase, which is found in the 1921 Year in Agriculture Report of the Secretary of Agriculture to the President. The report explained that "the basic work of the [Agriculture] department is in the field of research" (USDA 1921). It was this report that provided the impetus for the first appearance of the phrase "basic research" in

the *New York Times* several months later. The NYT article on the USDA report used a condensed form of the longer phrase, shortening it to simply "basic research."

Throughout the 1920s and 1930s the phrase appeared occasionally in Congressional testimony, at first exclusively by USDA officials and then later in testimony from the Departments of Interior and Defense. In the hearings of the 1920s, the phrase is used to describe research in support of the agency mission and generally in support of US industry. For instance, in the first instance of the phrase being used in a congressional hearing, Henry S. Graves, USDA Chief of Forest Service, explains to the Agriculture Committee that "It is essential that the Forest Products laboratory [of USDA] have information regarding industrial processes in making their basic research available" in order for the research to be applied in industry (Graves 1919). Again, the usage is consistent with what today we call "applied research" rather than any notion of curiosity-driven investigation led by the scientific community.

Several years later in 1924, a scientist with the USDA Bureau of Chemistry explained in a Congressional hearing how basic research into dyes (for coloring materials) supported American industry that was facing international competition, an argument for investment in research that continues to present days. The testimony provides an example of the justification used by scientists for federal support of science at the time:

> Recently we have been concentrating particularly on the optical properties of dyes. Two dyes may look alike to the eye but they are entirely different in their properties. One will not be as fast as the other; and we are endeavoring to find, and are finding right along, means of telling which these dyes are. That comes under the class of analytical procedures. It involves the examination of all the dyes that we can get hold of, comparing them with pre-war dyes and the American dyes at the present time. Then, in the intermediates there is the same question of telling what intermediate you have got when you have it. The literature is full of these compounds with long names, but they do not tell how to know them when you have them. We have had to examine methods, study the properties, the difference in optical properties, the solubilities, and other determinations in order to know just what we have, and to aid industry in developing new uses for those intermediates and possibly new ways of making them. It is on such basic research that the dye industry of Germany was built, and it is on such research that the American manufacturer must rely to meet the increasing competition of European manufacturers (Ambler 1924).

During this period, "basic research" was being presented to the US Congress as that research which would support agency missions and the broader needs of US industry. There was no mention of science for science sake in these discussions.

Kline argued that the language used to describe science changed as a result of World War I:

> The change in rhetoric is evident in debates about science and industrial research during World War I. Because the topic became a matter of national defense when the United States was cut off from German dyes, fine optics, and

> other products early in the war, scientific and engineering journals carried numerous articles about improving U.S. research capabilities (Kline 1995).

The scientific community had long resisted efforts to justify public support in terms of the practical benefits from research. Kline (1995) quotes Willis Whitney, head of industrial research for General Electric, speaking to the American Chemical Society in 1916, criticizing the view of "some scientists … that making a utility of the God-given discoveries of the truly beautiful phenomena of Nature was a prostitution to be deprecated, and that research could only be pure when it was sterile." However, in the broader scientific community, especially in physics and chemistry, the "pure science" ideal was alive and well (Kline 1995). For instance, in 1926, Arthur Kennelly of Harvard University presented an argument that would become conventional wisdom two decades later, explaining on the pages of *Science* magazine:

> [M]any cases of scientific research which have been made without any suspicion of applicability have subsequently come to be applied to very practical use. It would seem that the only differences which necessarily separate a scientific research of the basic or non-applied type from one of the applied type lie in the aims and motives of the researcher… Useless scientific knowledge is now a contradiction in terms.

The phrase "basic research" was beginning to gain traction in the scientific community and simultaneously being used in political settings. However, the usage of the phrase in science and in politics conveyed very different, almost opposing meanings about science, with scientists appealing to practical benefits of "basic research" to politicians, while reinforcing the "pure science" ideal among their peers.

One aspect of my investigation into the origins of the phrase "basic research" involved ascertaining whether it (in the English language) originated in the United States or in the United Kingdom, as both countries saw their respective science policies evolving along similar paths early in the 20th century. All evidence points to the phrase as originating in the United States, and I found no evidence of the phrase originating in the United Kingdom.

However, there is ample evidence that the underlying logic which ultimately came to be expressed by Vannevar Bush in *Science - The Endless Frontier* evolved in parallel on both sides of the Atlantic.[4] A 1924 report by the National Union of Scientific Workers, a left-leaning organization of scientists in the United Kingdom, foreshadowed many of the arguments that were later expressed by Bush (on the NUSW, see MacLeod and MacLeod 1979). As was typical of the era, the NUSW, however, emphasized the importance of "pure science" rather than a more symbolically malleable expression (NUSW 1924a).

The NUSW advocated for government support for research with no consideration of application or return on investment.[5]

[4] That said, the scientific community was to some degree a global community even then, and ideas and arguments quickly crossed the Atlantic in both directions.

[5] Godin (2009) cites several other examples of similar arguments for the practical importance of "pure research," none of which used the phrase "basic research."

> [The NUSW] must be prepared to do work for which there is no direct economic return, and to exert itself, alone or in co-operation with other bodies for the encouragement of scientific research and the general advance of science (NUSW 1924a).

The NUSW commissioned a report in 1921 titled "On the Encouragement of Fundamental Research" based on "the opinion of the [NUSW] Research Committee that fundamental scientific research is not adequately supported by the State, local authorities, or the general public" (NUSW 1921). The resulting report, published in 1924, presented an argument virtually identical in logic and structure for the support of government support of research that would later appear in *Science - The Endless Frontier* (NUSW 1924b). Several of its arguments highlighting the intrinsic importance of pure research, however, do not appear in Vannevar Bush's seminal report, nor does the phrase "fundamental research" marking a substantive and symbolic shift in the arguments used by the scientific community to justify public investments in their work.

The NUSW Encouragement report did not use the phrase "basic research." Throughout, it used the phrase "fundamental research," explaining that, "by fundamental research, then, we mean research undertaken without any immediate expectation of results of practical value" (NUSW 1924b). The NUSW offered a justification for its emphasis on fundamental rather than practical research grounded in its leftist political orientation:

> In a community of perfectly enlightened "economic men", practical research would need no encouragement. In a community so little enlightened as our own, encouragement is certainly needed; but it must be given to those who have the control of capital and can employ others to work for them, rather than the scientific workers who actually do research (NUSW 1924b).

The NUSW eschewed patents, prizes and grants for research, instead arguing that scientists should be provided with a salary, few obligations and little accountability.

Perhaps somewhat ironically, in the United Kingdom, a contradictory approach to science in society was advanced in the years that followed from J. Desmond Bernal – a leading British scientist and, like many of those scientists in the NUSW, with communist leanings – who argued that government science needed to focus on practical outcomes (Brown 2007). Bernal's perspective was countered by Michael Polanyi who argued for a free market "invisible hand" approach to research (Polanyi 1962), an argument that resonated with the linear model/reservoir metaphor used by Vannevar Bush. Bernal's views were ultimately superseded by Polanyi's with the adoption of the linear model/reservoir logic. However, in post-Cold War years, Bernal's views have seen a re-emergence coincidental with the decline in usage of "basic research" as a key political symbol (Byerly and Pielke 1995).

The NUSW Encouragement report presented several reasons to justify it call for greater public investment in fundamental research. One justification was in terms of the practical value of the investment: "[F]undamental research should be encouraged because, though not directed purposely to practically useful results, it

does actually lead to them" (NUSW 1924b).[6] A second justification invoked the inherent value of science for science sake: "[F]undamental research undertaken without any ulterior motives of utility is essentially desirable for its own sake for its effect in developing the intelligence and imagination of the individual and the race" (NUSW 1924b). A third justification was offered, arguing that "the community benefits directly by the presence within it of able and intellectually active citizens" (NUSW 1924b). Of these various justifications it was only the practical value argument that appears in *Science - The Endless Frontier*, which did not rely on appeals to science for science sake.

Perhaps ironically, the practical orientation of government to research in the United States did not go unnoticed by the NUSW, one of its members offered a caution in focusing on research directed by government needs:

> America was not a country of farmers but of industrialists working upon the land. Consequently they were less tied by tradition, and more ready to look to science for help. On the other hand, the State legislatures which supported the biological work were very apt to demand immediate results, and some promising work was spoiled by premature publication. We, in this country, should take warning of the danger of allowing the legislature to get direct control of scientific research.[7]

The concern was that applied research would drive out the pure, an invocation of the same principle expressed two decades later in *Science - The Endless Frontier* (Sarewitz 2012). Yet, it was the appeal to application and benefit that would ultimately secure large-scale government support for science on both sides of the Atlantic.

The United States too had seen a long history of support for "pure science" from within the scientific community which was increasingly challenged during World War I and the years that followed, as scientists sought greater financial support from government and industry (Kline 1995).[8] Writing in 1929 in the then-influential magazine *The Country Gentleman*, US Secretary of Agriculture Arthur M. Hyde laid out a rationale for government support of basic research that is very similar to that advocated by Bush in 1945.[9]

Hyde (1929) argued that in the USDA "technical men" did not have a program of research under their control, which meant that:

[6] This view was widely shared at the time. Kline (1995) quotes astrophysicist George Elery Hale writing in *Science* in 1914 on this point, "we must show how the investigations of Faraday, pursued for the pure love of truth and apparently of no commercial value, nevertheless laid the foundations of electrical engineering. If we can disseminate such knowledge…we can multiply the friends of pure science and secure new and large endowments for physics, chemistry and other fundamental subjects." Almost 100 years later, Faraday remains a trusted anecdote in science policy discussions.

[7] Comment of Sir A. Daniel Hall, FRS, upon the occasion of a member of the NUSW, W. B. Brierley of the Department of Mycology at Rothamstead, visiting the United States (The Scientific Worker 1921).

[8] Kline (1995, p. 205): "The wartime discourse pitted those who preached the new 'gospel of industrial research,' nurtured by Arthur Little and others in the chemists' crusade, against adherents of the older 'gospel of high culture and pure science.'"

[9] On the influence of *The Country Gentleman*, see Pursell (1968).

> Item by item, the department's proposed expenditures must be explained to the Budget Bureau Committee and to the appropriations committees in Congress. Since it is impossible to forecast the results of any particular research problem, details cannot be furnished in advance. It is difficult, therefore, to convince the lay mind of the fact that such studies are indispensably prerequisites to the practical values which flow therefrom.

Hyde argued that a "lump sum appropriated for fundamental research" would solve this problem. Hyde anticipated many of the arguments later used by Bush, appealing to the practical benefits from undirected and largely unaccountable research, and even alluding to the metaphor of a "flow" from research to application.

The changing language of science policy during this era has been discussed by Kline (1995), who observes:

> Several important changes in terminology occurred in the interwar period. Although engineering science had not become an everyday expression, the terms basic science and fundamental science began to replace pure science in the rhetoric of many scientists and engineers.[10]

The change in language reflected a change in practices as well – symbols matter. Kline (1995) states that the changes in terminology represented

> … modifications to the pure-science ideal - amounting to what may be called a "basic-research" ideal - seem to have been overlooked by most readers of *Science, the Endless Frontier* - then and now. By focusing so much attention on how to increase the nation's "scientific capital," the only sure basis for long-term "technological progress," the report promoted a hierarchical applied-science model of technology that greatly influenced the early funding patterns of the NSF and postwar science policy in the United States.

The first documented use of the phrase "basic research" in public speech by a US president was Harry Truman on August 14, 1946 in making remarks on a Congressional bill supporting basic research in agriculture. He said,

> Now, as we move into a new period of peace, basic research and the application of the results become even more important (Truman 1946).

Truman's remarks reflect what had become by then a fairly common understanding of basic research by policymakers as a tool for achieving practical ends:

> Our greatest peacetime agricultural problem is the efficient marketing of adequate quantities of the right kinds of foods and other farm products. The basic research provided for in this Bill will help solve the problem, and will be of great value to future generations (Truman 1946).

[10] Kline attributes the popularization of the term "basic research" in the mid-1920s to Arthur Kennelly. Based on the analysis that I present here, Kennelly's use of the phrase is to be viewed as part of the broader expansion in use as it gained in symbolic importance. See Kennelly (1926). Of note, Vannevar Bush was a student of Kennelly's and in the 1940s claimed credit for coining the phrase (according to Kline 1995). Bush's claim is clearly incorrect. Success has many parents.

Truman's remarks coming after the war but before the establishment of the NSF show that at the highest political level, nothing like the "pure science" ideal had been accepted in government. Science was indeed ascendant, and "basic research" helped to pave the way.

To summarize, the basic framework and logic of arguments appealing for government support for research were well established in both the UK and US by the end of the 1920s. However, such arguments did not lead to much policy action. Nonetheless, with the advantage of hindsight, there were signs that change was underway. A short news article on the NUSW report in *Science* on January 29, 1925 was the first occasion that the phrase "basic research" appeared in the journal. In its description of the NUSW report, the *Science* story replaced the phrase "fundamental research" as used in the report with "basic research" (*Science* 1925). Here we see initial indications that the phrase was being adopted to circumstances beyond its initial reference to mission-oriented research in the USDA to refer to a broader set of identifications, expectations and demands. "Basic research" was becoming a key political symbol.

From Farmers to Physicists: Political Evolution in Science Policy Leadership

Up until World War II, leadership in science policy had been firmly in the hands of agriculturalists, with the focus of government support for scientific research found in the US Department of Agriculture. The transition of "basic research" from a term referring to applied research in agriculture to a condensational symbol expressing expectations, identifications and demands for all of science occurred in parallel with the political evolution of science policy. By the time that atomic bombs had exploded over Hiroshima and Nagasaki, science policy was dominated by physicists, and the focus of attention had shifted to the newly formed National Science Foundation, but also in areas such as energy, health, and very soon thereafter, space.

Pursell (1968) argues that "by any standard, the decade of the Depression was an outstanding one for agricultural research." In the 1930s, when the agriculturalists were still in charge, advocates for increased government spending on agricultural research decided to "press not only for more research funds, but for a freer hand in allocating them" (Pursell 1968), in a manner consistent with that called for by Hyde (1929) in *The Country Gentleman*. Such pressure led in 1935 to the passage of the Bankhead-Jones Act, creating new appropriations for agricultural research (beginning at $1 million per year, rising to $5 million) and new research facilities across the nation.

The institutionalization of agricultural research at such a prominent level represented a marked change in government support for science. Pursell (1968) characterizes the passage of the act as a "stunning victory" for the advocates of government support of science:

> Congress (however inadvertently) had accepted the argument that fundamental research was a reasonable object for government support. The precedents set

> by these victories were not lost upon other science administrators in the government nor upon the scientific community at large.

He attributes this success "more to specific opportunity than to general policy," meaning that it was the political connections and acumen of the agricultural community rather than a wholesale acceptance by policymakers of the importance of research. As Pursell (1968) explains:

> The New Deal, as such, never realized the potential of science for dealing with either the temporary or long-range problems of the nation. Agricultural research enjoyed a favoured position because it was long established and had paid off enough to win important friends in high places.

At the forefront of this agricultural community in the late 1930s was Henry A. Wallace, who was President Franklin Roosevelt's Secretary of Agriculture. Wallace was a long-time champion of agriculture and science, and a rising political star (Culver and Hyde 2000).[11] His political fortunes had further to rise, before suffering a dramatic fall. In the context of science policies, the exalted role of the agriculturalists was to be replaced by the physicists against the backdrop of war.

As the former Secretary of Agriculture who had overseen the dramatic expansion of research in the agency, Wallace was naturally a go-to person on scientific matters for the President. Roosevelt appointed Wallace to lead the preparation of a report on the prospects for American agriculture under the contingency of a cessation of trade with Europe due to the war (Culver and Hyde 2000). The President also asked Wallace to serve on the National Advisory Defense Commission, originated in 1916, to oversee the government's war role.

On June 12, 1940 Vannevar Bush, then head of the Carnegie Institution of Washington, proposed to Roosevelt to create the National Defense Research Committee (NDRC), which Roosevelt enacted via Executive Order 15 days later, with Bush as its chair (Zachary 1997). The work that would eventually lead to the atomic bomb was conducted by this new body (which later evolved into the more widely known Office of Scientific Research and Development). For his part, Bush explained the motivation for advocating the creation of the NDRC (Bush 1970):

> There were those who protested that the action of setting up NDRC was an end run, a grab by which a small company of scientists and engineers, acting outside established channels, got hold of the authority and money for the program of developing new weapons. That, in fact, is exactly what it was.

A similar strategy used by the agriculturalists in the 1930s to gain passage of the Bankhead-Jones Act was now being used by the physicists when the stakes and rewards were much larger.

In Roosevelt's cabinet, Wallace was the "only member with a scientific background" (Culver and Hyde 2000), so the President asked him to serve as his

[11] An interesting side note: Wallace's father, Henry C. Wallace, was the Secretary of Agriculture in the early 1920s and oversaw the report of the USDA from which the *New York Times* distilled the phrase "basic research." If the phrase "basic research" can be traced to any one individual, Henry C. Wallace is a leading candidate.

personal liaison to Bush and the new weapons effort. In Washington, DC, Wallace lived one floor above Bush, who recalled "sometimes we would take a walk together on a Sunday morning" (Bush 1970), and expressed that he had Wallace's support and returned the trust (Zachary 1997).

When Roosevelt ran for a third term later in 1940, Wallace was on the ticket with him as the vice presidential candidate. When Bush decided, in October, 1941 to press for going ahead with the Manhattan Project, he arranged a meeting with Roosevelt via Wallace, and the three met together on October 9, 1941 to discuss the proposal. The President did not commit to the project at that time, but he did empanel an advisory group – the "Top Policy Group" – that included, in addition to Bush and Wallace, the Secretary of War Henry L. Stimson, the Army Chief of Staff George C. Marshall and Harvard President James B. Conant (Culver and Hyde 2000). By December, the atomic bomb project was underway. Wallace continued to serve as "an informal link" between Bush and the President during the War.

Despite the pivotal role played by Wallace in the evolution of US science policy and the early years of the war effort, he seems to have been air-brushed out of science policy history. In his memoirs, Bush recalled somewhat cryptically how Wallace left the scene (Bush 1970):

> "[O]ne day I went in with a report to the President… When I gave it to him I said, "Mr. President your policy committee has approved this with the exception of Mr. Wallace, who is not available." He grinned at me and said, "Well, Henry's out West making political speeches. I do not think we need to worry him." That was my cue and I never went near Wallace on atomic energy matters after that."

Bush is likely referring to early 1944, when Wallace had begun to challenge Roosevelt on matters of policy, and was being asked by his supporters to challenge for the Democratic nomination for presidency in the upcoming election, should Roosevelt not run (cf. Culver and Hyde 2000).

Whether it was bureaucratic infighting, a drift to the political left, or his support for the creation of a United Nations body, Wallace and Roosevelt had a professional if not personal falling out. Culver and Hyde (2000) write, "no one could say for certain what had triggered Wallace's fall." In a remarkable period of political manoeuvring and intrigue, Wallace was defeated in his effort to be renominated by the Democratic Party for the vice presidential slot under Roosevelt. Wallace later ran for president for the Progressive Party and became tarred by the political debates over communism of the late 1940s and 1950s. He has very little presence in contemporary scholarship on science policy, a notable oversight.

What can be said with certainty is that by the time the atomic bombs exploded over Hiroshima and Nagasaki, the political center of gravity in US science policy had shifted from the agricultural community to the physical scientists. The shift is most apparent in the fact that all science advisors to the US president through Barack Obama have degrees in some subfield of physics (except the first, George Killian, who was not a scientist, see Pielke and Klein 2010). The change in the symbolism of science policy was accompanied by a change in the composition of its

leaders, and eventually a change in the institutions of science. The next section of the paper explores the significance of the symbolic shift.

Part IV: Why Basic Research and Why it Sustains

This section of the paper explores the significance of "basic research" as a political symbol in two parts. The first part explains the theoretical basis for why the phrase, and the underlying framework that it represents, was successful in defining the modern era of science policy. The second part examines the conditions which have enabled "basic research" to survive for generations as a key political symbol, specifically, a marriage of science policy with economic theory, institutionalization via R&D statistics and the lack of alternative frameworks.

The Importance of Semiotic Innovation

Much has been written about Vannevar Bush and his seminal report, *Science – The Endless Frontier*, with some of the debate over the originality of Bush's arguments (see, e.g., Godin 2006; Guston 1997). But as shown here and elsewhere, the basic framework proposed by Bush was not particularly new in the history of appeals for government investment in science – similar arguments had been made by the NUSW and were found in appeals for funding in the US agricultural community. Bush's signature innovation was to revolutionize discussions of science policy, with revolution defined by Lasswell (1951) as "changes in the composition and vocabulary of the wielders of power."

In producing that report, Bush explained that he made an explicit decision to use the phrase "basic research" because of its malleability in political discourse. Bush wrote in his memoirs of this explicit decision (Bush 1970):

> To persuade the Congress of the pragmatically inclined United States to establish a strong organization to support fundamental research would seem to be one of the minor miracles… When talking matters over with some of these [people on Capitol Hill], it was well to avoid the word fundamental and to use basic instead.

Bush's semiotic innovation is well grounded in political theory. Lasswell (1969) observes "ambiguity is an aid to concerted action." He continues, "A high degree of generality is essential to popular appeal; symbols must be sufficiently vague to enable the individual to transfer his private loves and hates and hopes and fears to the slogans and catchwords of the movement."

Nor was Bush the first to use the phrase "basic research" in an explicit science policy context. In 1934, British social scientist Julian Huxley proposed a taxonomy of research that had four categories: background, basic, ad hoc and development (Godin 2006). Godin (2006) suggests that Bush "borrowed" the term from Huxley. The historical record is ambiguous over how Bush came to appreciate the concept of "basic research" – whether from Huxley, Wallace, Kennelly or simply from its

general increasing usage at the science-policy interface. Whatever the intellectual provenance that underlay Bush's inclusion of the phrase in *Science - The Endless Frontier*, science policy discussions were changed forever as "basic research" became almost universally accepted as an essential feature of the politics of science.

"Basic research" succeeded as a political symbol because of its malleability to a wide range of contexts. Calvert (2006) explains that "The term is therefore more than just a label. It performs social functions – such as protecting autonomy and defining self-image." It has been plastic enough a concept to embody the vastly different conceptions of science espoused by British scientists with communist leanings and American conservative politicians separated by almost a century. It also encompasses the identifications, expectations and demands of mission-oriented government scientists and those scientists in academia looking for government support without accountability to agency missions.

That consensus breaks down on the meaning of "basic research" when discussions descend from generalities to specifics is not surprising (e.g., Calvert 2006). As Elder and Cobb (1983) argue, "A symbolic consensus rests on the mutual attribution of significance to a symbol and on common affective sentiments toward it—not on agreement about its substantive meaning." They continue (p. 121),

> A symbolic consensus is viable and can sustain the political community only as long as the content attributed to politically significant symbols is not brought into question. People may be talking past one another when these symbols are used, but this is of little consequence as long as their referent is, for most, remote, abstract, ambiguously defined, or poorly understood. As actions initiated in the name of a symbol become more proximate, immediate, and clearly understood by more people, the shallowness of the consensus is revealed and the unifying power of the symbol is destroyed.

This dynamic of breakdown in a symbolic consensus is readily seen in the fall of "basic research" as a political symbol documented in the trends in usage in the US Congress, *New York Times* and *Science* and *Nature*..

The symbolic consensus on basic research did not resolve the debate between those advocating a greater hand of governments in directing research and those advocating greater autonomy which has spanned generations and continents. In the United States, the debate saw Kilgore vs. Bush and in the United Kingdom, Bernal vs. Polanyi. The debate has never been resolved intellectually. However, despite this lack of resolution, one of the functions of "basic research" as a political symbol has been to help stabilize expectations about why science is important and why it deserves support. Such is the potent power of a political symbol.

The Basis of Symbolic Sustainability

In political discourse symbols come and go over time. "Basic research" has proven to be a remarkably robust symbol, despite its relative decline in usage in recent years. Three factors account for this sustainability over many decades. One is the use of a theoretical model by economists that embeds basic research as a core factor

in the origins of growth. The second is the institutionalization of accounting and statistics on R&D that use "basic research" as a formal category (Godin 2006). And the third factor is the lack of development of a politically acceptable substitute, which might succeed the concept in science policy discussions.

The timing of the publication of *Science - The Endless Frontier* occurred after Joseph Schumpeter advanced his thesis of how "creative destruction" in the economy leads to economic growth and before Robert Solow formalized a model of economic growth (Schumpeter 1912; Solow 1957). Both perspectives were readily adapted (and, arguably, modified substantially) by the science and technology policy community to elevate the importance of basic research as the linchpin of economic growth.

In 2007, the US National Academy of Sciences published an influential volume on science policy, titled "Rising Above the Gathering Storm," which repeated justifications for the government support of basic research that had been often repeated over a half-century.

> Early in the 20th century, Joseph Schumpeter argued that innovation was the most important feature of the capitalist economy. Starting in the 1950s, Robert Solow and others developed methods of accounting for the sources of growth, leading to the observation that technologic change is responsible for over half the observed growth in labor productivity and national income (National Research Council 2007).

While such observations are sometimes accompanied by qualifications[12] – inevitably the resulting policy recommendations focus on more support for R&D, and especially basic research.

In addition to recommending greater resources for S&T education, the 2007 NRC emphasized funding basic research invoking the linear model of innovation, and echoing the "flow" analogy first proposed by Bush in 1945, recommending that the government: "Sustain and strengthen the nation's traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life… (National Research Council 2007)."

Ironically, the frequent invocation of both Schumpeter and Solow in the context justifying government support for basic research finds little support in what the two economists actually argued. Schumpeter described the roles of invention, innovation and diffusion in the economy, concepts which others adapted to a linear model of innovation (Godin 2006). But Schumpeter explicated that he rejected any such linear model:

> It should be noticed at once that that concept [of innovation] is not synonymous with "invention"… It is entirely immaterial whether an innovation implies scientific novelty or not. Although most innovations can be traced to some conquest in realm of either theoretical or practical knowledge, there are many

[12] In this case, "over long periods the contributions of technologic change and other causes of growth–such as worker skills, capital deepening, and institutional change—are highly interactive and difficult to separate" (National Research Council 2007).

> which cannot. Innovation is possible without anything we should identify as invention and invention does not necessarily induce innovation, but produces of itself no economically relevant effect at all (Schumpeter 1947).

Similarly, Robert Solow used the term "technical change" to refer to any change in the economics of production, and not as a specific reference to "technology" as conventionally understood. Solow explains in 1957:

> I am using the phrase 'technical change' as a shorthand expression for any kind of shift in the production function. Thus slowdowns, speedups, improvements in the education of the labor force, and all sorts of things will appear as 'technical change' (Solow 1957).

The integration of post-war science policy with a misinterpretation of neo-classical economic theory led to the creation of a mythology of innovation that persists today (e.g., Lind 2012).

Godin (2009) explains that the justifications for the primacy of basic research have been the dominant framework underlying contemporary science policy for decades, and have led to an inordinate focus on it to the neglect of other aspects of innovation:

> The problem is that the academic lobby has successfully claimed a monopoly on the creation of new knowledge, and that policy-makers have been persuaded to confuse the necessary with the sufficient condition that investment in basic research would by itself necessarily lead to successful applications. Be that as it may, the framework fed policy analyses by way of taxonomies and classifications of research and, above all, it was the framework most others compared to.

Godin argues that such justifications have been codified in the accounting practices recommended by the OECD and this diffused throughout the globe (Godin 2003). The formalization of R&D statistics has created a feedback loop.

Godin (2009) argues that "the long survival of the model, despite regular criticisms, is due to statistics." He explains,

> Having become entrenched with the help of statistical categories for counting resources and allocating money to science, technology, and innovation, and standardized under the auspices of the OECD and its methodological manuals, the linear model functioned as a "social fact." Rival models, because of their lack of statistical foundations, could not easily become substitutes.

There is a long list of phrases that have been proposed to replace "basic research." These include: Opportunity-oriented, Strategic, Fundamental, Transformational, Translational, Use-inspired, Collaborative assurance, and Mode 2 science. There has been no lack of alternative conceptions to "basic research" proposed over the years. What has been missing, however, is an alternative theoretical foundation to support the proposed new formulations. The result is that these terms sometimes replace "basic research" but have never displaced it as a key political symbol in science policy discourse.

Conclusion

"Basic research" has functioned as the key political symbol in discussion of science policy since the end of World War II. However, its origins as a phrase in the English language go back several decades further to the 1920s. The phrase only became a key political symbol condensing considerations of identification, expectation and demand following the publication of *Science - The Endless Frontier*. The rise of basic research as a political symbol was coincident with the transition in the locus of political power at the highest levels of government within the scientific community from agriculturalists to physicists.

This paper has documented, through a straightforward analysis of content, the rise of basic research as a key political symbol in discourse in the US Congress, the *New York Times* and the two leading journals of the scientific community, *Science* and *Nature*. In each case, attention rose and then has fallen, first in the *New York Times*, then in Congress (first among elected members, then in the broader context of hearings), and lastly in the journals. This pattern is consistent with the use of basic research as a means of marketing science to politicians rather than a representation of a change in the intellectual foundations of science policy. It was only after basic research achieved public and political success that the scientific community adopted it, and only after it had fallen out of favor in public and political discourse did the scientific community begin to abandon it and look for substitutes with equal potency.

Yet symbols matter. Institutions, mechanisms of accounting and organizations have all been developed around the concept of basic research and the accompanying theory of how science and society are related. One reason for the well-documented transitions on-going in science policy since the end of the Cold War is that this underlying theory is not grounded in a solid foundation, but rather a misreading of neo-classic economics that places public investments into science and technology into a black box. Dissatisfaction with this model of how science policy relates to societal outcomes is arguably one of the key factors which has led to a search for a new model of science policy.

However, no such model has yet displaced the post-World War II model. "Basic research," despite falling out of favor in discourse, has yet to be replaced symbolically or intellectually. Of course, many of the proposed alternatives are simply synonyms that represent the same ideas using different words. For several decades now, it has seemed that science policy is evolving. However, the lack of a symbolic revolution akin to that which took place at the end of World War II means that change is not yet upon us. When change does occur it will be symbolic, as well as political and institutional.

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