Introduction

Government and science play important roles in the lives of every American; however the relationship between them today is complex and dynamic. To understand this relationship one must trace its origins and not merely look at the history of either science or government but instead at the history of their inter-dependency.

Since the dawn of organized democracy in the United States, science has moved toward a dynamic relationship with government. This gradual move has been the result of a natural inter-dependency. Throughout history, government has needed science to support its policies and endeavors. Conversely, scientists have needed the financial and, sometimes, the organizational security of government backing.

On occasion differences in goals between scientists and government have prevented a successful and productive relationship; however, where goals have been similar, seemingly impossible obstacles have been overcome. This has proven particularly true in times of national emergency. National urgency has served as a catalyst for both science and government to focus their formidable efforts and resources on specific time sensitive research, which has led to results for society.

The Manhattan Project serves as one of the most symbolic moments in the history of the dynamic relationship of science and government and in many ways represented the culmination of experiments in finding the ideal balance in that relationship.

The Relationship Between Science and Government Prior the Manhattan Project

I. From the Constitution to the First World War

The relationship between science and government dates back to the writing of the Constitution in 1787; however, this is far from the connection that is evident today. In Dupree's Science in the Federal Government, the author stresses that it be recognized that "from the beginning the federal government has rendered honor for science and profited from it".[1] In fact Dupree goes on to point out that science was already involved and influential in the thinking of the writers of the Constitution. By way of example Dupree points to Benjamin Franklin's leadership in the American Philosophical Society, which was the first community of scientific thinkers. Nevertheless it must be said that science remained an influence on government rather than the relationship being represented by any specific national institution.

The lack of national institutions did not prevent the germination of some initial cooperation between government and science. One of the first successful links was in effort to map the new country as was embodied in the Coast Survey Act of 1807, which provided resources to science to draw up detailed maps of the coast line. A further example was in the establishment of the American Association for the Advancement of Science, which led to the financing of the expedition of Lewis and Clark in 1803, to explore the new western territories of the country. However, these first links were specific and fairly small in comparison to the private based endeavors already beginning in the broad spectrum of the sciences.

[1] A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940 (New York: Harper Torchbooks, 1964)1.

Most of the discoveries of this period were made by private amateur scientists who had no link to the government and were merely trying to satisfy their personal curiosity. To understand the lack of linkage between these scientist and government we must remember that this was an extremely dynamic period for all scientific endeavors. In the late 18th and early 19th century scientists were strictly interested in the accumulation of knowledge rather than seeking to apply scientific knowledge for practical results. Therefore the efforts of the broadening group of people engaged in science were not organized toward any clearly defined goals, which could serve the wider community. [2]

It was not until the third decade of the 19th century with the creation of the Smithsonian Institute in 1829 that a government-based organization with national scope and historical importance would emerge.[3] This institution was founded to fund all types of experiments in science. It would also initiate a trend which would develop in the relationship between science and government until World War II. This trend was symbolized by the scientist looking to the government for financing but otherwise separating themselves from government in the specifics of their work.[4] Scientists did not see government as being constructive in scientific development and in many respects resisted, in what they saw as, government intrusion into the sciences. In fact, the Smithsonian Institute saw itself as a private institution rather than federal one, which to

[2] Thomas Jefferson was the embodiment of this situation. By the time he had reached office, he respected that there was a difference between the laws of nature and the laws of God (a notable view considering the time period); however he only saw science as the extension of philosophy. A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940 (New York: Harper Torchbooks, 1964)7.

[3] Nevertheless this was not necessarily because of lack of will. Dupree explains that in fact John Quincy Adams was so in favor of government funding and involvement in science that he thought it was paramount (despite the bitter disagreement of his peers) A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940 (New York: Harper Torchbooks, 1964)40.

[4] Don K. Price. Government and Science: Their Dynamic Relation in American Democracy. (New York: New York University, 1954) 20-22.

some extent was true because funding from government during this time was extremely limited; since the majority of United States government funding was directed towards agriculture until the First World War.[5]

II. The First World War

The development in involvement in the sciences in the first half of the twentieth century is also examined by Alfred K. Mann who expresses that "Early in the twentieth century, when funds from wealthy individuals and private foundations ceased to meet the needs of modern science in the United States, the federal government began to invest in national scientific infrastructure".[6] With the advent of the First World War a new stage in the relationship between science and government began. World War I was known as the "Chemists' War " [7]and from this the considerable influence of science on public affairs and government can be witnessed. It was also during World War I that the beginnings of the military industrial complex, which required scientists to develop a significant number of products which were going to be sold to the army.[8] After the early part of World War I when both sides reached a stalemate in the trenches, military commanders and their governments realized that to prevail in the war new methods of warfare would need to be applied. Germany, a country which had always been efficient in the sciences then developed poison gas and the submarine. However, in the United States, which was not initially involved in World War I, the progress of research was more gradual.

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[5] Don K. Price. Government and Science: Their Dynamic Relation in American Democracy. (New York: New York University, 1954) 24.
[6] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) xv.
[7] Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002)26.
[8] Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002) 29.

During the war years in the navy, the Naval Consulting Board was established, with Thomas Edison as its chairman. This was a major symbolic step in harnessing the powers of renowned scientific leadership in the war effort. However, once the board was organized and funded, the United States joined the hostilities and scientific funds lay dormant with the board being then left to merely approve designs for military contracting. In fact, before the hostilities began, it was in the civil scientific arena that the best technology was developed. Shifting the focus of these civil groups from peacetime projects to wartime problems was the main obstacle.

When President Wilson began the policy of putting the country on a wartime footing, the policy of preparedness, he created the War Industries Board and Food Administration. It was during this period that both the military and civil science groups managed to work together on the war effort. One of the major organizations that emerged from this was the National Research Council (NRC) that would last until World War II.

III. Post First World War up to the Second World War

After the Great War, the NRC became a full-time organization to manage the scientific efforts within the United States. However, not long after its creation, the NRC began to move away from a central federal government organization towards a more decentralized and loosely connected collection of separate departments. The most dramatic change during this post war period was the reduction for research, and as a result the intensity of research declined to almost pre-war levels. As a result most of the scientific research being conducted during the period between the two World Wars was in private industry, where research flourished. Meanwhile in government Herbert Hoover, a former mining engineer began his political career in emphasizing the

importance of research in basic science to keep civil industry developing with a chain of new discoveries.

In reflection therefore in the late 19th and early part of the 20th century the primary source of financing for the sciences remained in the private sector. World War I dramatically but only briefly changed this. However, it was only with the dawn of "Big Science" or, science on the scale of industries, in the late 1930's when government funding actually began to contribute to scientific development. Ironically even the discoveries that would lead to the Manhattan Project and nuclear weapons were not funded by the government at all.[9]

The government-based science that was taking place during the era of big science in the 1930's was now taking uniform structure. At this time the trend in the United States was for the scientist being put in charge of scientific organizations because the government accepted that the scientist would have the most experience in his individual field. This structure was a benefit for the scientist and engineers to develop their careers, however, their management skills were not always effective. Moreover, this trend also meant that scientific minds were taken out of the laboratories were there most creative work could be done.[10]

After the stock market crash in 1929, government expenditures on science decreased dramatically. However, some actually realized that one of the methods to get

[9] For example, Ernest Rutherford, the father of the atom, was now working in Canada on radioactivity and the prime reason for his success was because of private funding from William Mac Donald. Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002) 20-21.

[10] In contrast to this in Europe the exact opposite was happening, scientists could not advance in the government institutions and civil servants who did not know the true nature of their work were managing the institutions. This difference can be traced back the beginning of the United States because institutions were being built along with the government whereas in Europe the power base already existed and so institutions were built around this power base. Don K. Price. Government and Science: Their Dynamic Relation in American Democracy. (New York: New York University, 1954) 34.

through the depression would be to use science to organize bureaus and identify new activities. This effort was symbolized by the Scientific Advisory Board in 1933 that was created in order to help the economy. However, it suffered from a lack of funds and Karl Compton, who was brought in to run the board, retired two and a half years after he was brought into office.[11]

The significant change in government spending on the sciences would not last very long. In 1936 with President Roosevelt's New Deal creating organizations such as the Works Projects Administration and the Tennessee Valley Authority, government spending rose back to levels leading up to World War I. This New Deal period represented a major shift with scientific organizations attempting to move back towards the government to obtain federal funding. By the late 1930's research and government were so intertwined that any change of policy would dramatically affect all the sciences.[12]

IV. The Second World War

Just as before World War I, the involvement of government in science reached new heights in the lead up to World War II. President Roosevelt created the National Defense Research Committee (NDRC) in1940 as his personal advisory committee for the sciences. This close connection of scientific thinkers to the power base of federal government led to the most dynamic of periods in the relationship of science and government. Now, science would not just rely on the government for financing but would influence government decisions as well. One of the principal founding members of the NDRC was Mr. Vannevar Bush. Bush extended the influence of science by persuading

[11] A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940. (New York: Harper Torchbooks, 1964) 358.
[12] A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940. (New York: Harper Torchbooks, 1964) 366.

Roosevelt to create the Office of Science Research and Development (OSRD) in 1941.[13] The OSRD would be the link between science and government for the rest of World War II and it would be responsible for every major development in technology and science except for the Manhattan Project. Three major developments of the OSRD were the radar, the proximity fuse and blood transfusion developments. These three developments helped to tip the balance of the war in the favor of the Allies.[14]The OSRD introduced the collaboration of global scientific minds since Bush brought in scientists from all over the world to work on his projects and recruited many different scientific organizations to work for the OSRD. At that time the OSRD was held up as an example of a productive relationship for science and government because it was not just another organization that had it own laboratories and performed its own research, it also united the capabilities of all the Allied forces and was a union of the committee and executive type organization.[15]

[13] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 8.
[14] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 8-9.
[15] Don K. Price. Government and Science: Their Dynamic Relation in American Democracy. (New York: New York University, 1954) 43-44.

The Manhattan Project

The OSRD may have represented a fine example of an organization harnessing the creative forces of science and the financial resources of government. However, what makes science important is its discoveries and developments, the Manhattan Project was the ultimate embodiment of scientific discovery. As Dupree explains, "By the time the bombs fell on Hiroshima and Nagasaki, the entire country was aware that science was a political, economic, and social force of the first magnitude".[16] The Manhattan Project was therefore the pinnacle of the relationship which began at the time of the writing of the Constitution.

However, one would think that the ultimate government science development would have been the product of a series of government-based scientific discoveries. This was not the case: in fact none of the nuclear science developments were funded by national governments. Ironically, most of the discoveries were not made in United States and most of them had their origins in Europe. Ernest Rutherford a Britain working in Canada is known as the "father of the nuclear age" due to his discovery of the atom. Following from this in 1938 a German scientist realized that one could split an atom using neutron transmutation. However, it was Leo Szilard and other theoretical physicists who realized the potential for splitting an atom and creating a sustained nuclear fission reaction. They also realized that considering German ability in science, the Nazis had probably realized this too and were taking action. Szilard decided that in order to inform the President of this threat he would need a more reputable name than his own. This

[16] A. Hunter Dupree. Science in the Federal Government: A History of Policies and Activities to 1940. (New York: Harper Torchbooks, 1964) 369.

name would be Albert Einstein.[17] When informed of the potential for a sustained reaction, Albert Einstein wrote a letter to Roosevelt. As a result of this letter, Roosevelt authorized funding for experiments to test the possibilities of building a nuclear bomb. The Manhattan project had begun.

The next few months went slowly because there was no organizational driving force for the project. However, as soon NDRC became involved the project began to pick up pace.[18] This evidenced that for the project to be successful government involvement could not be purely financial and it would be necessary to take an organizational and security role.

The Manhattan Project began in Columbia University in New York (where it received its name). This is where Szilard had taken a job and was working on the project. However as soon as Enrico Fermi arrived and plans to create a sustained nuclear reaction began, the project moved to the University of Chicago where the sustained nuclear reaction would take place.[19] In early December 1942, Fermi and his team achieved the first sustained nuclear reaction. This meant that the bomb could and would be built. As a result of this experiment, Roosevelt increased funding dramatically into the billions of dollars ($2 billion was the final cost of the project) and now since the project was too large for the OSRD it became an organization in its own right.[20]

After determining the feasibility of constructing a bomb, the next step was to build it and this was a further reason for the dramatic increase in funding. Finally, instead

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[17] Daniel Cohen. The Manhattan Project. (Brookfield, Connecticut: Twenty First Century Books, 1999) 15.
[18] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 20.
[19] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 20.
[20] In fact at one stage the project employed 130,000 people and was equivalent in size to the entire American automobile industry. Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002) 9.

of a scientist being bought in to run the project, the government realized that despite their genius they lacked the required leadership skills. Therefore General Leslie Groves was appointed to run the Manhattan Project. However, Groves was not a scientist and it became clear that he would need to appoint a scientist to jointly help the running of the project. His unlikely choice was Dr. Robert Oppenheimer. Together, they would have to choose a new location for the project because Groves, when appointed, had seen all the different locations of research and realized that if any progress was to be made it would all have to be in one place. Together, they chose Los Alamos, New Mexico, and by the end of the project it would grow to be the size of a town.

Oppenheimer and Groves represented the union of science and government. The two men could not have been any more different from each other and neither liked the other, but both realized that in order for this project to succeed they would need to cooperate. Without the government, this project could never have succeeded for many reasons. Firstly, the experiments that were being done were on a scale that would have previously been thought impossible and only a government could have funded this. Secondly scientists were being brought in from all around the world to work on this one project and there is no way that a single country could have achieved this. In order to research nuclear weapons, plutonium and uranium are needed and so the federal government established factories to produce these materials in Hanford and Oak Ridge.

At the beginning of the project the most valuable information was obtained from the British, who had established a nuclear weapons project of their own. However since the British could not afford the resources to continue to fund its own nuclear weapons

project they decided to combine their knowledge. Overall the project proceeded to plan and a bomb became ready for testing by the summer of 1945.

On May 8th 1945, Eisenhower informed the president that Germany had agreed to an unconditional surrender. Even though the project had begun to defeat Hitler's Germany, there were other reasons now for the project to be completed. Truman went to Potsdam on July 15th to discuss the future of the war in the Pacific. On July 16th Trinity (the name of first atomic weapon) was tested in the desert and was a full success. The project was essentially over after this test. $2.2 billion had been spent (more than the size of United States automobile industry at this time).[21] Nothing like this was ever attempted before the project and nothing has been attempted since, this day marks the fruition of the union of scientific and governmental effort.

Truman was informed of the success of the testing at Potsdam and a political decision was made to use the bomb to bring the pacific war to an end. This is significant because for the first time science had influenced a president's political wartime decision. On August 6th the Enola Gay dropped the first nuclear bomb on Hiroshima, and the White House released a press statement describing the bombing as "the greatest achievement of organized science in history."[22] Three days later another bomb was dropped on Nagasaki and shortly after the Japanese surrendered.

[21] Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002) 97.
[22] Jeff Hughes. The Manhattan Project: Big Science and the Atom Bomb. (New York: Columbia University Press, 2002) 93.

Relationship Between Science and Government to Today

After Hiroshima, the relationship between science and government could not revert to what it was before the war. Vannevar Bush was the first scientific advisor to the president and ever since there has always been an advisor.[23] Bush wanted to emphasize the importance of basic research, saying that it was the future of the United States economy and technology. The major underlying reason for the permanently changed relationship of science and government was atomic research. Science could not distance itself from government nor could government divorce itself from science because atomic energy became too important for security and industry to allow science to go back to private industries and research in Los Alamos continued under governmental auspices. In early years after the war, the National Science Foundation (NSF) and the Atomic Energy Committee (AEC) were created. The idea of the NSF was to coordinate some central direction in scientific research. This idea had been around since the beginning of scientific involvement in the government, however at the outset of the foundation sought to separate itself from government control.[24] However, during this period the Soviets exploded an atomic weapon. Therefore just at the time when the United States had been turning its attention to basic scientific research, Truman now had to authorize continued research into the hydrogen bomb, and therefore pulled applied science back into the full focus of the government. On October 31, 1952, the United States dropped a hydrogen bomb on Bikini Atoll, and that year Eisenhower also ended the Korean War with a nuclear threat.

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[23] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 34.
[24] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 92.

Further into the Cold War, however, science became a matter of pride as well as national security. The creation of North American Space Agency (NASA) in 1958 which in addition to the AEC and the NSF was the next step to creating the links of government and science which exists today. With the Soviet launch of Sputnik in 1957 the United States had to have a reply, and after a complicated beginning the response was Project Apollo in 1962, the plan to put a man on the moon. The primary functions of the AEC during this time were to make nuclear power profitable and safer by selling the technology to industry and to begin atomic research talks with other countries. The NSF during the period up to 1965 remained the link between government and basic science and served an important role continuing basic research in schools and universities.

However with the advent of the Vietnam war in the 1960's financial resources again became very scarce for pure scientific research. Policy makers thought that if scientific organizations were being funded by the government, they should become adjuncts of the government.[25] They then were expected to cooperate. As always the scientist would not accept this authority.

Again geopolitical circumstances intervened. The Organization of Petroleum Exporting Countries (OPEC) placed significant restrictions on the export of oil and this led to the nation's energy policy being influenced by scientists engaged in atomic energy. New scientific organizations were created again symbolizing government's intention to rely on science to mitigate national problems.

A second significant public success was the moon landing on July 20th 1969. This accomplished a goal set by President John F Kennedy during his presidency to land a

[25] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 134.

man on the moon within a decade. This project placed science in the fore front of the global community but unlike the Manhattan Project has not led to same enduring effect on mankind.[26] Therefore while being another product of the union of science and government it has yet to influence government policy to the same degree as atomic research. Despite the successes of science in the decades from 1960's to recent times the link between government and science has changed yet again. No longer was there any trust between the parties like there had been during WWII because of the lack of urgency. The relationship remained important and dynamic but the will of both sides to separate from each other made the links that were present in the years of the Manhattan Project impossible.[27]

[26] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 148.
[27] Alfred K. Mann. The Marriage of Science & Government in the United States. (New York: Columbia Press University, 2000) 150.

Conclusion

Time has progressively moved the relationship between science and government away from more philosophical roots towards their interaction in the latest frontiers of man's endeavors. Progress in this relationship was not always steady and results varied due to world situations. In World War II adversity provided the catalyst that the government and scientists needed to achieve the massive success of the Manhattan Project. Some will argue that negative effects have ensued and risks to mankind have emerged; however, scientifically the collaboration was a resounding success. After the Manhattan Project, joint ventures again found success, as with the achievements of NASA. As science progresses into the 21st century, the capacity for more governmental and scientific collaboration is perhaps as endless as our universe is proving to be. Without urgency progress might not necessarily be as forthcoming as it was in the Manhattan Project. In the early part of this new century with new threats emerging it can only be hopped that government and science can collaborate to respond to these new urgencies.

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