Prometheus, Vol. 24, No. 3, September 2006

Engineering Organization and the Scientist in World War I: The Search for National Service and Recognition

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ABSTRACT *When the United States entered World War I in 1917, there was no elaborate framework for providing scientific advice to the government. Engineers and scientists struggled to find an appropriate mechanism, but the former found themselves subordinated to a scientific community which sought to dominate emerging structures. At stake was not merely the credit for helping win the war, but also an advantage in the coming postwar definition and expansion of industrial research. Scientific leaders sought advantage by making a distinction between 'engineering research' and engineering practice, and claiming jurisdiction over the former.*

Keywords: engineers; government industrial research; National Academy of Engineering; National Academy of Science; National Research Council; scientists; United States.

Introduction

During the First World War, the leaders of the separate scientific and engineering communities in the United States both sought to contribute their expertise to the American war effort. There was more at stake, however, than just the opportunity to advise and serve. Whichever community gained leadership in this wartime effort would be in a good position to parley that commanding position into effective control of what was expected to be a vast expansion of industrial research in the nation after the armistice. It would have appeared that the engineers should have had a distinct advantage. First, they might be thought the most relevant to industrial matters since it was almost the definition of engineering to apply science to real-world technical problems. Second, in its top ranks, engineering was already closely integrated with business leadership, in part because so many individuals served in both capacities at once. From the beginning however, the scientists had their own advantages as well. They were extraordinarily well led by individuals who seemed to have a clearer idea of what was at stake than did the engineering leadership. Second, the old Platonic prejudice that valued knowing why over knowing

Prometheus ISSN 0810-9028 print/ISSN 1470-1030 online © 2006 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/08109020600877683

how worked to make science a higher status occupation than engineering. More than one engineer proved susceptible to the flattery implied in being allowed to associate with a group that considered itself an intellectual (and social) elite. And finally, the scientists hit upon the strategy of seizing upon the ill-defined area called 'engineering research' and claiming that the conduct of research was necessarily a 'scientific' activity. The result was an almost complete victory for the scientists, one that persists to this day.[1]

'Science Advice to the President'

The incantation 'Science Advice to the President', while now carrying a heavy freight of emotion and interest, has little meaning for the period before the Second World War. Only gradually, and especially after the reforms of the Progressive Era, did the Office of the President take on those executive trappings which imply explicit policies arrived at through the advice of experts, and constituting the 'President's program'. Before then, technology and science were firmly based in a wide range of executive bureaus from the Coast Survey and Patent Office to the Bureau of Mines and the Army Ordnance Bureau. Here is where the need was, and it was here that federal bureaucrats sought and applied whatever expertise seemed both practical and politically possible. Indeed, it should be noted that even today, most of what passes for 'Science Policy', as with the American space program, for example, actually has more to do with technology than with science. Faced with the crisis of World War I, a host of agencies experienced a sudden need for technical expertise, mostly of a practical kind. Both engineers and scientists offered their services, but not with equal success.

Writing within weeks of the Armistice which ended World War I, Alfred D. Flinn, secretary of three national engineering organizations, admitted that 'we have been muddling along in an unengineering fashion', and, as a result, that 'the organization of engineers in America is chaotic, complex and illogical'.[2] Prewar efforts to unify the profession had been made imperative by the conflict in Europe and America's effort to mobilize to meet that danger. The question was apparently straightforward if not simple: how could the engineering community pull itself together sufficiently to bring its resources to bear upon the mobilization problems of a national government which itself appeared to be searching for an efficient organizational and managerial style? It turned out, however, that an equally thorny question was to define the engineering community, and describe its relationship to that of scientists. From 1915 through to 1918 a deeply divided engineering profession had been thwarted in its larger hopes for service (and public credit) both by its own fumbling and by a conscious and consistent effort by the American science community to seize the responsibility (and the credit) for the nation's technical mobilization. The success of the scientists had large and lasting meaning for the future of the nation's science and technology policy.

Growth of the Engineering Profession

The nation's engineering profession grew enormously in the four decades before the war, and a number of organizational reforms had been proposed over the years to unify and serve this diverse constituency. In the midst of this rich ferment for engineering unity and reform, the coming of the war to Europe both heightened awareness of the problems of diversity and unity and complicated their solution.

Those engineers most concerned with employment and status found new opportunities for both. Those more concerned with research and the extension of engineering science found a new demand for their activities as well. In terms of organizational innovation, the various efforts of the engineers themselves were now joined by those of both government and academic science.

Faced by its first major wartime crisis in half a century, both the Federal government and the engineering profession created a rash of agencies to accept and offer technical services. The first special agency set up by the Federal government was the Naval Consulting Board which held its organizational meeting in October 1915. Chaired by Thomas A. Edison, the Board was made up of 24 members nominated to Secretary of the Navy Josephus Daniels by the presidents of 11 of the largest national engineering societies. The members were officially termed 'leaders in the inventive, engineering, and industrial world'. One of them, Frank J. Sprague, the putative 'Father' of the electric streetcar, insisted on using the term engineers only, but, he wrote, 'by engineer I mean to include the inventor, whose effectiveness is largely dependent upon whether he is also a trained engineer'.[3] When it was pointed out to Daniels that he had asked for nominations from neither the National Academy of Sciences nor the American Association for the Advancement of Science, he was reported to have replied that 'it was not his purpose to overlook any of the leading scientific bodies and that it was altogether possible that additional invitations might be sent to several other societies'.[4]

In letters dated 13 January 1916, and addressed to the presidents of the national engineering societies, President Wilson complimented the work of the Consulting Board and said that 'it has been so valuable that I am tempted to ask that you will request the institute to enlarge its usefulness to the Government still further by nominating, for the approval of the Secretary of the Navy, a representative from its membership for each state in the Union, … for the purpose of assisting the Naval Consulting Board in the work of collecting data for use in organizing the manufacturing resources of the country for the public service in case of emergency'.[5] The members of these state committees undertook especially to look into problems of manufacturing and standardization, two areas of critical engineering importance in a war based so heavily on the production and consumption of vast quantities of war material.[6] It appeared that the engineers were well launched in their advisory role to the government.

A more elaborate and inclusive agency was established as the Council of National Defense in August 1916. The Council itself was made up of six members of the President's cabinet, but an Advisory Commission was also established of prominent dollar-a-year men actually to run the mobilization effort. Two of the members of the Advisory Commission, Howard E. Coffin of the Hudson Motor Car Company and Hollis Godfrey, President of Drexel Institute, were engineers, as was Walter S. Gifford, of the American Telegraph and Telephone Company, who served the Council as Director. Godfrey was also chair of an Engineering and Education Committee of the Commission.[7]

Response of the Science Community

The response of the engineering profession to the needs and opportunities of war were gravely complicated by the response of the science community. Despite the growing area of 'engineering science', organizational ties between the two communities were vague and tenuous. Among the 127 members of the National Academy

of Sciences in 1914, for example, there were only a few engineers, and their proportion of the total membership had never been high.[8] These engineers belonged to the section on chemistry or that of physics and engineering, a group made up overwhelmingly of physicists. Both proud and jealous of the chartered claim to be the scientific advisor to the Federal government, its division into sections based on academic disciplines and its small number of engineers made it less than optimally suited to advise on matters of practical urgency. Citing two calls by President Woodrow Wilson upon the Academy—to study the slides on the Panama Canal and the selection of a process of nitrate manufacture—*Engineering-News* noted that 'the membership of the Academy is confined to scientists who have to their credit some important piece of original work either in scientific investigation or in authorship. The members, therefore, are for the most part confined to the field of pure science, so called; and in both these cases where the aid of the Academy was sought by the government it was necessary to add to the membership of the commission to be appointed, men selected from the engineering profession'.[9]

The Academy had already become aware of this handicap. At the spring 1916 meeting the council adopted a recommendation that 'a section of engineering be developed which shall include men who have made original contributions to the science or art of engineering'. According to this plan, 'two or three engineers each year' would be elected and assigned to either chemistry or physics until such time as there were enough to constitute a separate engineering section. At the autumn meeting in 1917, it was voted 'the sense of the council that the home secretary be requested to obtain suggestions from members of the academy of names of engineers to be considered by the council for nomination at the next annual meeting'. Finally, at the autumn meeting in 1919, the home secretary of the Academy announced that 'a Section of Engineering has been established'. Of the nine members, six had transferred from physics, one had moved from chemistry, and two were newly elected: of the 164 members of the Academy that year, only seven had chosen to identify themselves as engineers.[10]

If the National Academy of Sciences was heavily weighted against engineers, George Ellery Hale, the prominent astronomer who was emerging as the leading advocate of science advice to the Federal government, found it 'depressing' that scientists were so little in evidence on the Federal government's first wartime technical committee, the Naval Consulting Board.[11] Among the 'predominance of electrical engineers, of chemists and of men with naval training', only two mathematicians appeared to represent 'science', and one of them, Robert Simpson Woodward, then President of the Carnegie Institution of Washington, was trained as a civil engineer.[12] The two mathematicians were the only members of the Academy on the Board (Woodward had been elected in 1896 and Arthur Gordon Webster in 1903), but five others were later elevated to that position, beginning with Willis R. Whitney, founder of the General Electric research laboratory, in 1917.

For several years an advocate of greater activity for the National Academy of Sciences, Hale moved quickly to ready that body for wartime service. Instead of flooding the membership with a large number of useful, though perhaps not distinguished, scientists and engineers, Hale hit upon the idea of setting up a National Research Council by Executive Order of the President under the original charter of the Academy. On the 19 April 1916, the day after Wilson sent the German government an ultimatum over the sinking of the *Sussex*, the Academy voted to offer its services to the President. In June, the new Council was established.

From its inception, Hale was anxious to involve leading engineers in the NRC. While keeping leadership firmly in the hands of men tied to the National Academy of Sciences, he reached out to those engineering leaders whose prominence in industrial circles, and whose involvement in engineering research, made them prime candidates for Academy membership. By seizing the high ground of 'research' rather than mere engineering practice, the NRC could dominate scientific and engineering mobilization and be in a strong position after the war to claim new support for science. 'The plans I always had in mind', Hale later wrote, 'looked forward to work under peace conditions'.[13] As historian Daniel Kevles has put it, Hale decided to 'ease the NRC's way in the labyrinth of the Washington bureaucracy and to neutralize the threat of the Consulting Board'. Further, despite the fact that Secretary of War Newton D. Baker had thought the appointment of Godfrey to the Advisory Commission of the Council of National Defense would gladden the heart of scientists, the Drexel engineer was seen in a different light by Hale. He feared, in fact, that the NRC might well simply 'disappear' behind the Commission of engineers.[14]

Cooperation with Scientists

Meanwhile, engineers were anxious to cooperate more closely with scientists. By the end of June 1916, it had already been decided by the Engineering Foundation that it would 'offer its services' to the Academy 'to accomplish the federation of all the research agencies of the nation, governmental, university and private, with the object of encouraging the application of scientific principles to American industries and the employment of science in the national defense'. The order of purpose was significant: with an eye toward the larger issue of reforming American industry, industrial research was the tail that wagged the dog of national defense. Concretely, it was reported that the Foundation had decided to spend its entire income from Ambrose Swasey's endowment, an estimated $8,000–$15,000 per year, 'on a competent executive secretary to assist in the above organization'.

The principal engineers through whom the National Research Council worked in obtaining these extraordinary funds—the entire income of the Engineering Foundation—for its own purposes were Gano Dunn and J. J. Carty. Neither was as yet a member of the Academy, but Carty was elected in the following year, 1917, and Dunn in 1919. An important link between the two groups, at least symbolically, was Michael Pupin, the academic physicist and inventor, who had been a member of the Academy since 1905. Carty was the chief engineer of the American Telephone and Telegraph Company and a strong supporter of industrial research. He was said to 'obtain a double satisfaction from the fact that the laboratory—the collective research mind—whose work he directed was developing a nervous system for the nation as a whole, so that it in turn might function more smoothly as a well-integrated organism and reach that higher goal which represents perfectly coordinated cooperative effort'.[15]

Gano Dunn was credited with taking the first American degree in electrical engineering, at Columbia University. Pupin was said to have called him 'the most versatile and gifted' of his students, and by 1913 he had helped organize and become the first president of the J.G. White Engineering Corporation, the world-wide engineering consulting and construction firm. Also in 1913 he had become president of the United Engineering Societies, and served as the first chair of the Engineering Foundation, 1915–16.[16] In his autobiography, Pupin proudly wrote

that 'my former pupil, Gano Dunn, was in 1916 the chairman of the Engineering Foundation, and I was one of the two vice-chairmen. It did not cost me much effort to persuade Dunn that one of the biggest tasks which the Engineering Foundation could take up was to grubstake the National Research Council during its formative period'.[17]

At the organizing meeting of the NRC on 20 September 1916, Hale was named chair and Gano Dunn vice-chair. Cary T. Hutchinson, secretary of the Engineering Foundation, was duly made secretary also of the NRC as 'a part of the understanding between the Research Council and the Engineering Foundation'. Dunn, Carty, and Pupin were all appointed to the Executive Committee, Carty was made chair of a special Committee on Research in Industrial Institutions and an Engineering Committee was planned for, 'to be composed, at the outset, of the members of the Research Council who are engineers; their function will be mainly advisory with respect to engineering questions that arise in connection with research problems under investigation'.[18]

The Engineering Committee of the NRC was late in forming. On 1 March 1917, Hale wrote to Hutchinson that in terms of the membership, he had 'no doubt that great care will be taken to secure real *research* men, who will do active work, which is greatly needed now. The Laconia outrage and this morning's news regarding the German plot in Mexico should leave no doubt about war'. Again he emphasized the point: 'we have passed the talking stage and should *start research*'.[19] By late April the presidents of the so-called Founder Societies of engineers were being asked to each nominate 'two engineers skilled in engineering research' for appointment to the committee.[20]

Dunn, who was appointed chair of the Engineering Committee, explained to the Founder Societies that the NRC was 'to bring into cooperation existing Governmental, educational, industrial and other scientific and research organizations with the purpose of encouraging investigations of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the National Defense, and such other applications of science as will promote the National security and welfare'. The new Engineering Committee of the NRC, he emphasized 'brings to the aid of the National Defense Research Council directly through its Director, the professional services of engineers in the realm of engineering research, and it constitutes the connection between the Council of National Defense and the various National Engineering Societies through which services offered by those Societies to the President of the United States may be called upon in the solution of problems in scientific and engineering research'.[21] In short, the engineers had spent their money to create a body of scientists through which they were now to direct their future contacts with the Federal government.

Dunn was careful to emphasize that the NRC was claiming jurisdiction only over 'those services involved in science and engineering *research* with the addition of such general engineering services as are auxiliary'.[22] For his part, Hollis Godfrey, Chair of the Committee on Science and Research of the Council of National Defense, publicly claimed that 'the task of organizing the research work in extending the boundaries of our present knowledge has been done so admirably by the National Research Council that the desire of the Committee on Science and Research on this question is merely to aid in their labors'. He made a particular exemption, however, of 'engineering as a profession, quite apart from the relations of engineering research. The work of developing the relations of the engineering

profession and the Government is progressing now with rapidity, and the definition of their functions is steadily becoming clearer'.[23]

Engineering Research vs Engineering as a Profession

The distinction between engineering 'research' and 'engineering as a profession' was obviously of central importance, but as always, the devil was in the definition of these terms. At the first meeting of the Engineering Committee of the NRC, on 3 May 1917, Dunn took pains to explain that 'the work of the Engineering Committee, which is to be engineering incidental to research work, and not original engineering work unconnected with research; although at the same time, it was pointed out that the line of demarcation between these two fields is not very clear'. At this same meeting Hollis 'explicitly disclaimed any intention of doing research work or of passing upon research work in his Committee;—that all research work, whether of engineering research or scientific research, will be referred to the National Research Council'.[24] No satisfactory definition of engineering research was put forward which would clearly distinguish it from either scientific research or the 'art' of engineering. In actual practice, the ambiguity allowed the NRC to throw the mantle of science (and therefore of its own authority) over as much of industrial and military research as it chose to claim credit for, and keep 'engineering as a profession' marginal to this enterprise.

No sooner was the problem of relations with the Council of National Defense apparently laid to rest than the question of renewal of the NRC's advantageous relationship with the Engineering Foundation came up again. The physicist Robert A. Milikan, then vice-chair of the NRC, had to warn Pupin that 'it was highly desirable that none of us who are connected with the Research Council overshoot the mark in urging abrogation of power by the Engineering Foundation', and reported that the Executive Committee of the NRC had, on 22 August, merely affirmed that 'it seems exceedingly desirable to maintain the close relation between engineers and research workers which the Research Council has for the first time succeeded in establishing'.[25] It was reported to Millikan that at an informal meeting of the Foundation, on 5 September, 'one or two of the members of the Foundation asked pertinent questions as to the tangible results accomplished by the Research Council; in other words, they were anxious to find out what good the money spent by the Foundation had done'.[26]

The Engineering Foundation met on 20 September to decide what to do about replacing Hutchinson as Secretary (Flinn was now named secretary of all three engineering agencies), and the question of relations with the NRC inevitably arose. In a telegram to Millikan, Gano Dunn reported that 'there was considerable discussion and in some quarters failure to appreciate great accomplishments and future of Council, but action favorable maintenance relations finally taken and referred to me to embody in resolution I now drafting. Continuance financial assistance for organization purposes uncertain. Continuance financial support for investigations practically assured'.[27] In a following letter the same day he explained the source of the anti-NRC sentiment among the engineers: 'The opposition was due primarily to ignorance and lack of appreciation of the Research Council's present and future work. I regret to say that many engineers do not take a broad view of these relations and regard those of us in The Engineering Foundation who have been trying to bring about, as you know, closer rapprochement between science and engineering as being advocates of a dream and to a certain extent as apostate from the Chauvinism

of engineering. Time will work these matters out all right, and there are influences from other directions which I can talk to you about better than write about'.[28] The income of the Foundation was not again voted over to the NRC, but a resolution was passed which declared that 'it will be its policy to continue the cooperation between the two bodies in all practicable ways …, and in addition a recognition of community of purpose that shall promote in the field of engineering research increasingly intimate relations between engineering and science'.[29] Hale was 'inclined to regard the state of affairs as a little disturbing', but hoped that it would come out all right in the end.[30]

National Hegemony of the NRC

The NRC's attempt to assert its national hegemony over the rather ill-defined field of engineering research was, of course, potentially compromised by the establishment of a new unity organization, the Engineering Council, soon after the outbreak of the war. The restlessness of the Founder Societies was expressed by Calvin W. Rice, secretary of the American Society of Mechanical Engineers, when he asked Howard Coffin of the Council of National Defense to 'call a conference of all organizations having to do with engineering and science and see if we cannot get down to business and stop this needless duplication of effort'. There was, he asserted, 'an urgent necessity that the Council of National Defense, the National Research Council and the Naval Consulting Board co-operate and define their scope of activities and commence immediately to develop an organization of the entire profession'.[31] At a meeting of the NRC's Engineering Committee in September, Gano Dunn noted the formation of a War Committee of Technical Societies by the Engineering Council, and the group agreed that 'there were more committees than it was advisable to have in relations of the Engineering Societies to the National Government and that a simplification ought to be brought about'.[32] Perhaps any committees other than itself seemed supernumerary to the NRC engineers, but the vast majority of engineers who were not engaged in engineering research still felt the need for some access to service and power.

One possible solution, of course, was to build yet another super-committee to oversee all the others. In October 1917 the General Engineering Committee of the Advisory Commission to the Council on National Defense suggested to the War Industries Board just such a group, and argued that the 'members of the proposed Board, nominated by the various societies and active agencies, be appointed by the Council of National Defense, also that if permissible this Board be recognized as the official connecting link between the Government and the Engineers …'.[33]

In order to bring some sort of sense out of this chaos, Calvin Rice wrote to an elderly Ambrose Swasey, the putative Father Abraham of American engineering and financial benefactor of the Engineering Foundation, for help. 'As we have not yet a supreme and recognized body of all the engineering societies and activities in the United States, it is the hope that we will not be exceeding your kindness or imposing on your strength if we ask you, in your own person, to issue the invitation for a Conference which all of us trust will develop the co-operative movement you consider so essential to the welfare of our country in this crisis and to the advancement of the profession'.[34]

When this unity meeting did take place, on 26 September 1917, at the Bureau of Standards in Washington, John J. Carty, representing the NRC, was firmly in the chair. An *ad hoc* committee was appointed, also chaired by Carty, to advise on what

was best to do, and in January 1918, this group finally resolved that 'in the judgment of this Committee, the time has gone by when it might have been helpful to the Government for the engineering societies, upon their own initiative, to conduct all their relations with the Government through a central committee representing the engineering profession'.[35] This victory for the *status quo* was a significant one for the Research Council, for it preserved *de facto* control over wartime research by the scientists, while leaving a weak and divided engineering community to fight over such lesser tasks as making a complete survey or inventory of the nation's engineering talent.

The abortive (but for the NRC satisfactory) outcome of the Swasey conference marked the virtual end of any large scale challenge to the research hegemony of the NRC. Within a few weeks a new Executive Order from the White House gave it a permanent basis and the stability it needed to make plans for the encouragement of postwar research. Always shy of accepting direct government funds, the NRC encouraged larger appropriations for federal scientific bureaus but placed most of its own efforts into the stimulation of industrial research. Here, in peace as in war, it had the advantage of engineering colleagues who were prominent in both the engineering Founder Societies and the larger world of American finance and industry. At a dinner on 29 May 1918, at the University Club in New York City, attended not only by the likes of Gano Dunn and John J. Carty but also by 'messrs. duPont, Eastman, Mellon, Pritchard, Root, Swasey and Vail', George Ellery Hale unfolded a bold plan to stimulate industrial research. The corporate elite assembled that night was to be constituted by the Research Council as an Advisory Committee on Industrial Research to help raise the funds and excite public opinion on behalf of applied science in the postwar period.[36]

Internal Problems of the NRC

From this point on, internal problems within the NRC caused more concern than any direct threat from the major engineering societies. The reorganized Council contained both an Engineering Division (upon which sat representatives from the large national engineering societies) and an Industrial Research Division to which Messrs. duPont, Mellon *et al.* were now advisory. The Engineering Division had very close ties with the Engineering Foundation, and indeed there was significant sentiment in the latter group which 'urged strongly that there should be absolute merging of the Engineering Foundation and the Engineering Division'. The Division of Industrial Research, on the other hand, lacked close formal ties and saw itself more as a fund raising, coordinating, and proselytizing body.[37]

Once again, the engineers found that while they could do their practical engineering with NRC blessings, 'research', and now in the postwar era especially the growth area of 'industrial research', was to be the exclusive province of scientists. The duPonts, Mellons and other industrial magnates, who had it in their power to support or stifle industrial research, were formally attached to the Division of Industrial Research (dominated by scientists) rather than the Engineering Division. When Alfred D. Flinn, still secretary of the Engineering Foundation, urged that the Division of Industrial Research be abolished and its functions parceled out to other divisions, including engineering, Hale warned that 'in the case of engineering the residence of so many prominent members in New York, and their association with the men from whom funds are most likely to come, is a very important element in the problem …'. 'Any serious check on the engineers or on the

chemists', he emphasized, 'might result in their breaking away from the Research Council and going ahead on their own'. The danger of that, of course, was that since engineers still had closer ties with corporate leaders at the level of actual industries than did scientists, they could in theory divert financial support that the NRC wanted to direct toward science. In fact, the whole area of industrial research was looked upon by the scientists as contested territory, a prize to be won away from engineering for science. 'Truly', Hale fretted, 'the problems of peace are greater than those of war!'[38]

James R. Angell, chair of the NRC, agreed. 'In general', he wrote to Millikan, 'I may say that the members of the Industrial Research Division have shown most admirable spirit in this whole affair, and are willing to concede a great deal to the prejudice of the engineering group. The latter are really confronted with a very difficult situation, owing to the magnitude of their constituency and the temperament of many of its leaders, and there is no question in my mind that if the Division is to retain its connection with the Council, it must be given very large leeway and be considerably humored at the outset in matters of this kind'.[39]

The need for the NRC to keep vigilant lest the engineering community gain further advantage in research funding was underlined the following year, when the latest version of legislation to support the idea of state-based engineering experiment stations came again before the Congress. Worrying that the NRC was 'frowned at by the Cabinet and practically unknown to Congress', Hale charged that 'the engineers have been very clever in identifying [Herbert] Hoover with their organization, and by this and other means they seem to be establishing themselves very firmly in Washington. Of course', he conceded, 'we should be content, as in the past, to leave engineering in the general aspects to them. But we should be able to find the way to make the Research Council a really authoritative body on all questions of research, in close touch with the powers at both ends of Pennsylvania Avenue'.[40]

Two years later, in 1922, Herbert Hoover, the former mining engineer then serving as Secretary of Commerce, was elected to membership in the National Academy of Sciences, but still the problem of who would dominate industrial research, the scientists or the engineers, was a difficult one politically, made all the more so by the lack of any clear distinction between the two growing out of the work itself. The struggle to win subsidy and prestige for science, indeed the whole effort to establish what historian Ronald C. Tobey has called an 'American ideology of national science', was to continue.[41] From the failed attempt (headed by Hoover himself) to establish a National Research Endowment (proposed in 1926) through the organization of the National Science Foundation in 1952 to the latest attempt to stimulate industrial innovation through an improved science policy, the successful stretching of the term science to cover large areas of engineering has been a triumph of Hale's policy of keeping science 'in close touch with the powers at both ends of Pennsylvania Avenue', that is the Congress and the White House.[42]

The Continuing Struggle

The engineers, on the other hand, have continued to struggle against the domination of science. The plan for their own national academy, thwarted in 1916, re-emerged in the 1960s.[43] In 1964 the engineers were induced to drop their dream of independence and accept a new National Academy of Engineering established through and firmly under the control of the then century-old National Academy

of Sciences. NAS president Frederick Sitz welcomed the first 14 members with the news that the NAS would be 'your home in perpetuity, the relationship springing in a natural way out of the century-long cooperation between scientists and engineers specified in the charter of the National Academy of Sciences'. He harked back to World War I and spoke of the support given to the new National Research Council by the Engineering Foundation, and stated that the decision of the Academy in 1916 to create a Section of Engineering was indicative of 'the depth of appreciation' of the NAS membership for that support.[44] Within a decade, however, it was reported that the Academy of Engineering wanted a divorce, based on the fact that 'each Academy is deeply suspicious of the vision and impartiality of the other'.[45] The problems were systemic, growing out of the high stakes and ambiguous boundaries involved. By the end of World War I, the political struggle for recognition and power between science and engineering was well underway.

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