HIGHER EDUCATION AS AN INDUSTRIAL PROCESS:

What University Archives Reveal about the History of Corporate, Scientific America

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In recent years historians have begun to dig around in their own backyards, having tardily discovered the rich, largely untapped deposits contained in their university archives. As Edith Blendon, former acting archivist at Princeton University, noted that scholars are finding these resources valuable for far-ranging intellectual, social and political histories, well beyond the scope of the local, narrow institutional studies for which they traditionally have been used. In anticipation of, and in response to, this new activity, university archivists have been busy making these resources accessible as never before and conveying to prospective researchers the generally unappreciated value of their holdings. Meanwhile, the historians who have already been making use of these materials have become better able to recognize their broader significance and can now convey this new awareness to the archivist, who can then proceed to assemble the materials in an historically meaningful way. This article is a small contribution of the latter sort; essentially, it illustrates how university archives have been (by this historian) and might be used to gain valuable insight into modern industrial development. Examining briefly the historical process whereby higher education in this country became an industrial process in itself and an integral, functioning part of the larger corporate-scientific society illustrates how university archives are valuable resources for the historian of modern America, affording entrée to an otherwise obscured and restricted past.

The dramatic scientific revolution in material production of the last century, coupled with the emergence of the large industrial firms which attended it, brought about a profound, perhaps unprecedented transformation of social life in this country. During the early decades of the present century, the now familiar patterns of work, of science, and of education characteristic of advanced technological societies were first established. In essence, this transformation entailed the introduction of science systematically into the production process, the transformation, as Harry Braverman has suggested, of "science into capital." As scientific knowledge increasingly became a crucial determinant of industrial advance and thus competitive strength, the large industrial firms which had been created to dominate and extend markets, stabilize prices, integrate productive activity, and provide ready returns for speculators and financiers, undertook also to secure control over science.

In the vanguard of this new enterprise were the large firms which early dominated the science-based electrical and chemical industries: General Electric, Westinghouse, DuPont, American Telephone and Telegraph, and similar, if lesser, giants. Rooted from the outset in the soil of science and thus unprecedented in their demand for scientific knowledge and knowledgeable people, these companies sought at once to stimulate and regulate the growth of industrial science. They carried on their efforts along a number of fronts. Corporate reformers sought control over the means of scientific industry through the establishment and enforcement of industrial and scientific standards; over the products of scientific industry through the monopoly of patents and reform of the patent system itself; over the process of scientific invention and discovery through the organization of industrial and university research and, finally, over the practitioners of industrial science through the transformation of technical and higher education. These reformers were themselves predominantly scientifically-trained engineers who shifted routinely between positions as managers and executives in the large firms and as professors, deans, and presidents in the colleges and universities. In light of their wide-ranging activities, it is easy to see why the scientific transformation of America cannot be understood except as an aspect of the corporate transformation of America. It is also easy to see why the archives of universities, the sites for much of this activity, would come to reflect the nature and contours of this dual transformation.

When campus critics of the 1960s railed against the so-called "knowledge factories" in which they were apparently being routinely processed for industrial consumption, few actually suspected how consciously those factories had been created, how colleges had been redesigned and integrated into the industrial structure some decades earlier. From roughly the turn of the century on, the universities were substantially retooled to play a major role in the development of science-based industry, as publicly subsidized service centers charged with the tasks of scientific research and the systematic production of technical and managerial manpower. By examining the changes which took place during this time within the universities themselves — with a focus upon the relationships established with industrial firms and agencies — it becomes possible to glean insights into the details and scope of the larger social transformation of which these were a part.

Of course the chief site of this larger transformation was industry itself, especially the sprawling domains of the large corporate firms which dominated scientific production. Why not look there? The paramount problem confronting the critical historian of industrial society is not the unavailability of resources but their inaccessibility. They exist, but remain under lock and key. Corporate archives are notoriously difficult to get into (and stay in). Although they employ a very large proportion of Americans and wield an influence over social life equalled only by the institutions of government, and although they played a very significant role in the shaping of twentieth-century America, the "publically-owned" private corporations stand careful guard over their part in the nation's history, no less than over the workday activities of millions of employees. (It is no wonder that Americans in general have such a dulled sense of their own history.) In their 1974 survey, for example, the Business Archives Committee of the Society of American Archivists sent questionnaires to over one thousand firms, requesting information about archival holdings and records of historical value; after a follow-up inquiry, the response remained poor. The resulting Directory of Business Archives contained less than two hundred listings. Of these, moreover, well over half indicated either that the archives were closed to scholars or that access was severely restricted.

These archives are privately controlled, despite the fact that they contain the collective memory of social production, the record of much of our most important social activity. Historians, of course, are not alone in their forced exile from this large part of the American past; the frustrations experienced by government investigators of corporate practices throughout the century are legend. The reasons for such strict historical surveillance vary. Many firms fear that they will lose a competitive edge or jeopardize their bargaining position with labor unions if their finances and strategies are revealed. More often they fear litigation: if the Justice Department knew of the existence of records, the files could be subpoenaed and examined. Firms also are unwilling to keep an archives because of the cost and effort required. Finally, there is the oft-expressed fear of embarrassment to the public-relations minded firm: if a history is to be written, the company will do it itself.

All this tight security surrounding business archives has taken a heavy toll on critical scholarship. Those archives that are open to scholars usually require that the scholars be "verified" by the company brass. Who gets the nod and who doesn't? Recently this author managed to get into the library (not the archives) of the General Electric Company in Schenectady, New York. He was required to obtain formal permission every day and there was no guarantee upon leaving one day that he would be allowed back the next. This fortunate fellow had a Ph.D. in history, was the author of a book and several articles, was on the staff of the Massachusetts Institute of Technology and had gained entrée through the good offices of a former GE Research Lab Director who became a professor at MIT. One wonders how far he might have gotten without the connections, without the institutional affiliation, without the formal credentials. Are archives that are open only to "verified scholars" really open? This tight control is reflected in the scholarship produced; a subtle censorship, self-censorship, becomes the norm for the scholar who has gained access but wants to retain his/her "verified" status. The historiography in the field of business history during the last two decades fully reflects this sitatuion; historians who have become professionally dependent upon access to business archives must be careful not to burn bridges when they put pen to paper.

This lamentable situation can only be reversed if and when all industrial archives are legally opened to the public so that the history contained therein can be rightfully reclaimed by the people who made it. Short of this, scholars must find ways of approaching this history indirectly, with or without access to industrial vaults. University archives, like government archives, provide precisely this indirect route into a crucial area of the nation's history. As universities became integrated within the industrial structure, university archives became, in effect, industrial archives themselves, containing valuable information on the development and daily workings of the corporate industrial system as a whole. The following brief synopsis of parts of a major study of the concurrent emergence of modern scientific technology and corporate capitalism in America illustrates how such archives might be used to great advantage in understanding how the industrial system developed. Perhaps more crucial, it highlights the great importance of keeping university archives as free of restrictions as possible. For so long as industrial archives remain, on the whole, closed to public scrutiny, university archives must take on an added burden as gateway to an imprisoned past.

Development of Industrial Research

The decisive factor in the development of modern technology was the linking of science with the tradition-bound useful arts, the laboratory, with the workshop, the search for truth about Nature with the utilitarian and pecuniary objectives of "manufactures." Until the last quarter of the nineteenth century, this link was made, in haphazard fashion, largely through the efforts of well-heeded gentlemen who cultivated an interest in both. By the end of the century, however, those new firms which were grounded, and thus dependent, upon modern technology found it necessary to invent ways of establishing the connection on a regular basis, of routinely bringing the laboratory and the workshop together in a manner that allowed at once for both the stimulation and superivision of "progress". Although firms in the mining, petroleum, electrical, steel, and chemical industries had occasionally hired university-based consultants during the latter half of the last century, it was not until the 1890s that they undertook to establish scientific research laboratories as an organized activity within the firms themselves. The pioneers were the large, well-endowed corporations such as GE, AT&T and DuPont; it was here that the first "synthetic genii," as Philip Alger of GE called them, were formed — teams of assembled specialists "held together by bonds of sympathy and understanding, as well as by the company management." Such laboratories quickly became enormous enterprises, employing hundreds of highly trained scientists, engineers, and technicians and fostering, through careful supervision and a military organization of work, what Frant Jewett of the Bell Labs termed "cooperative effort under control."

Unlike the large, heavily capitalized firms like GE and AT&T, smaller science-based companies could barely afford to set up their own laboratories or bear the risk of uncertain, long-term research. Thus, they relied upon independent research contractors, such as Arthur D. Little, to do their research work for them and minimized both an individual company's risk and cost by establishing cooperative trade association laboratories. In addition, they relied upon the service activities of new government agencies, particularly the National Bureau of Standards, created at the behest of industrial leaders and scientists, in 1901.

Private contractors, trade association labs, and government agencies, however, could neither meet the growing demand for research nor satisfactorily link the world of science with that of industry. What was required was closer cooperation between the traditional domain of science where the bulk of research activity was being done, the universities, and the industries which aimed to put the results of that effort to profitable use. "American industry", observed Dugald Jackson, head of MIT's electrical engineering department and a leading utilities industry consultant, "finds it increasingly profitable to become interested in and to aid by means of money and counsel, research in universities. . . . The more influential of the men of the technical industries have come to recognize the desirability of cooperation in the joint processes of education and industry." Jackson, like his colleagues in the electrical manufacturing, telecommunications, chemical and chemical process industries, had a rather broad view of industrial society; there would be no need to try to duplicate the research work, the facilities, the personnel, the university enterprise of science within private corporations if it were possible to "integrate universities [themselves] as research centers within the industrial structure."

By 1920, various schemes of industry-university cooperation had been developed, all of which tied the universities firmly into the industrial arena and redefined the patterns and ends of the scientific efforts of faculty, staff, and students. Industrial fellowships were created in support of graduate study in science and to allow faculty more time for research. The most famous of these was the plan developed by Robert Kennedy Duncan which became the foundation for the Mellon Institute in Pittsburgh. Extensive cooperative research programs were undertaken at universities throughout the country, primarily at the departmental level in engineering schools. The plant of the nation's colleges was expanded dramatically with the construction of new chemistry, physics, and engineering buildings at private industry's expense. Engineering experiment stations, like the agricultural stations created by the Hatch Act, were established, primarily at state schools, to provide extension services for local industries. Networks were established to facilitate the interchange of personnel and ideas between the schools and the industries; industrial advisory committees, industrial sabbaticals for professors, formal consulting arrangements, and the like. Increasingly, through such cooperative institutional ties, industries "put-out" their research tasks to universities, usually for a modest fee, and were thereby spared the overhead costs of facilities, staff, libraries, and training of research personnel.

The university as industrial service center was perhaps illustrated best and earliest by MIT. The physical chemistry laboratory set up in 1903 by A. A. Noyes and Willis Whitney (a founder of Cal Tech and first director of the GE laboratories, respectively) was, in MIT President Henry Pritchett's words, "the first effort of any technical school in the country to offer research work distinctive from that of the colleges and directed toward engineering subjects." Pritchett's endorsement was hardly surprising. Two years earlier he had founded the industrially oriented National Bureau of Standards. The next decade saw a tremendous growth in industrial research at MIT, primarily in the departments of chemical engineering (presided over by William Walker, former partner of Arthur Little) and electrical engineering (presided over by Dugald Jackson). By 1920, these departmental efforts coalesced in the establishment of a centralized "division of industrial cooperation" headed by Walker. The new division was created to administer what was known as the "Tech Plan," by which any industrial firm could contract with the Institute for specific research work. By paying a fee for service, the firm would receive not only the particular work specified but also access to staff, faculty in related areas, library facilities, information on the work done in Institute laboratories which might be relevant, bibliographical services, and information, both personal and academic, about all present and former MIT students and faculty who might be able to contribute to the research effort or to the general work of the firm. In the 1940s, the highly successful Division of Industrial Cooperation became the Division of Sponsored Research, its responsibilties broadened to include military and government, as well as industry sponsored research.

What the centralized division of industrial cooperation did for the fragmented efforts of departments at MIT, the National Research Council (NRC) did for the research activities of the nation's universities as a whole. Established during World War I, and funded primarily by such private agencies as the Industrial Engineering Foundation, the Chemical Foundation, the Rockefeller Foundation and the General Education Board, the NRC assumed the task of coordinating the integration of universities within the industrial structure, of promoting research in science while at the same time fostering efforts along industrially-defined lines. The most active Division of the NRC both during and after the war was the Engineering Division, headed by such industry leaders as Frank Jewett, Elmer Sperry, and, by 1930, Dugald Jackson. The NRC provided invaluable assistance to burgeoning science-based industry, sponsoring research projects, conducting extensive surveys of facilities in the government and the nation's colleges and universities, publishing bibliographies of research in progress, compiling personnel rosters of research institutes, university science and engineering faculty, graduate students, and recent Ph.D.s, and even conducting tours for businessmen of major research facilities in industry and universities. The NRC, in short, spread the message and served the ends of the science-based industrial corporations.

Industrial sponsorship and direction of university research successfully shifted the burden of the major costs of science-based industry from the private to the public sector. But this was not all. Perhaps more important, it redefined the form and content of scientific research itself. This involved more than the general shift away from natural philosophy—the search for metaphysical truth through an understanding of Nature—to utilitarian science—the quest for intervention in, and power over, Nature, through knowledge of the fundamental relationships between matter and energy, a shift already well underway by the end of the nineteenth century. Now the shift toward utility assumed particular forms, those measured by the specific, historical needs of private industry, by particular firms intent upon increasing their profit-margins and their power. The industrial transformation of science affected not only what kinds of questions would be asked but also what particular questions would be asked, which problems would be investigated, what sorts of solutions would be sought, what conclusions would be drawn. Science had, indeed, been pressed into the service of capital.

Higher Education and Industrial Research

If research was vital to science-based industry so too was technical manpower. The first industrial concerns to employ college graduates (engineers) on a large scale were the electrical manufacturing companies, GE and Westinghouse. It was thus these firms, and others like them which emerged later, which developed the form of higher education demanded by modern corporate industry. With only slight exaggeration, the in-house training programs of these companies, the so-called "corporation schools," may be seen as the pilot programs, the experimental models of higher education as a whole in the twentieth century America.

Until relatively late in the nineteenth century, the colleges were dominated by classicists and clerics, both of whom shared Platonic disdain for the practical arts and their correlate, money-making enterprise. Thus, the colleges tended to remain removed from the steadily expanding realm of industry, with its noisy shops and less noisy counting-houses, and schools of technical education were forced to take root outside of, and oftentimes in opposition to, the established colleges. If the colleges happened to turn out men who ultimately entered industry, they did so largely by chance and from a distance. Between the end of the Civil War and the turn of the century, however, owing in large part to the pressure placed upon the established colleges by wealthy industrialists and the federal support of land-grant colleges in agriculture and the mechanical arts, there was a tremendous growth in the number of engineering schools, and thus a growing pool of technically-trained men for industry.

For a number of reasons, however, industrial managers found technical graduates ill-prepared for immediate use by the company. For one thing, since the colleges could scarcely keep pace with the rapidly changing industrial state of the art, students were generally given instruction in obsolete methods with outdated equipment. At the same time, since engineering educators were preoccupied with enhancing their academic respectability, they tended to emphasize scientific theorizing and mathematics at the expense of practical training in industrially applicable engineering. Thus they turned out graduates who were neither cultured gentlemen nor effective practitioners. Perhaps most important, graduates were imbued with the aristocratic arrogance of a university elite, the entrepreneurial spirit of laissez-faire capitalism, or the scientific zeal for untrammeled inquiry — traits which hardly suited them for efficient, loyal employment as subordinates in authoritarian corporate enterprise. "The fundamental difficulty," Charles Scott of Westinghouse complained in 1907, "is lack of adaptation to new circumstances and conditions. We do not underrate knowledge and training, but we want the graduates to be of use. . . . We want men who can see the situation and fit themselves to it. The possibilities and the outcome depend upon the ability of the man for harmonizing himself with his environment, and the more complete and efficient this adjustment, the more useful the life." What is called for on the part of the graduates, another corporate educator concluded, is "self-forgetfulness."

The in-house corporation schools created by GE, Westinghouse, AT&T, Kodak, DuPont, Dow, various Edison companies, and other leaders of science-based industry were designed to habituate college graduates to industrial employment, to give them additional technical training and the proper business point of view, to teach them how to follow orders. The importance of these schools in the training of generations of engineers should not be underestimated. In electrical engineering, for example, the college graduate during the first three decades of this century had of necessity to become a "testman" at Schenectady or a "special apprentice" at Pittsburgh in order to complete his professional training. Along the way he usually learned to see the world as his superiors at GE or Westinghouse saw it. In addition to their actual educational function, the corporation schools constituted an important phase in the evolution of modern personnel management, pioneering in methods of testing, rating, selecting and classifying graduates, of "scientifically" fitting the man to the job. (Thus, it ought not be surprising that the National Association of Corporation Schools (NACS), formed in 1913 to coordinate in-house educational activities nationwide, changed its name after World War I to the National Personnel Association and, again, to the American Management Association.) By the second decade of the century, however, the most pressing task the corporation educators faced, in their view, was that of putting the corporations themselves out of the education business, of gearing the colleges to do the job right the first time.

By enthusiastically promoting closer cooperation between industry and the colleges, the corporate educators sought to shift the burden of "correct" training back to the colleges, and the taxpayer. Operating through such agencies as the NACS and the Society for the Promotion of Engineering Education (SPEE), they strove to transform the universities into efficient processing plants—"factories" as they usually referred to them—for the production, selection, and distribution of the human material required by industry, according to changing industrial specifications. The SPEE played a crucial role. Organized in 1893 by engineering educators, it was the first national association of college educators devoted exclusively to educational matters. For the first decade and a half after its establishment, the SPEE members concerned themselves primarily with minor matters of pedagogy and the perennial problem of academic status. In 1907, however, the year Dugald Jackson became SPEE President, membership roles were swelled by the influx of "practicing engineers and businessmen" and the focus of discussion shifted dramatically to such questions as "adapting technical graduates to industry," "making graduates more efficient," and the like. From this point on—until the 1930'—the SPEE was the major forum for the corporate reform of higher education. "Each institution is in reality a factory turning out engineers," H. F. J. Porter of Westinghouse explained to SPEE members. The challenge is how to manufacture a "uniform product." Porter's colleague at Westinghouse, Charles Scott (soon to become head of electrical engineering at Yale) concurred, summed up the task at a joint meeting of the engineering educators and industrialists.

> If producers and users of steel rails were in conference they would discuss the uses which rails are to serve, classifying the kinds of service, considering wherein past products had failed, inquiring as to chemical analysis and metallurgical treatment. They would seek improvement in production and discrimination in use. But the more difficult problem of human material. . . has received less attention; how seldom do representatives of engineering industry and of engineering education meet together for conference. Yet they are users and

> producers of a vital product. Let us try to agree on what we want and then determine how to get it and how to use it. How many boys of differing kinds can be individually developed and fitted to varying needs?

A major step forward along these lines was the cooperative education movement, begun in the engineering school of the University of Cincinnati in 1907 and pressed ahead enthusiastically by the NACS and the SPEE. "The aim of the course," Dean Herman Schneider boasted, "is not to make a so-called pure engineer; it is frankly intended to make an engineer for commercial production. . . . This system will furnish to the manufacturer a man skilled both in theory and practice, and free from the defects concerning which so much complaint is made." The cooperative course successfully brought the school into the shop; students spent alternating periods in the factory of a cooperating firm and in the classroom of the school. In this way, students were able to get the "proper" business point of view, the necessary habits of industrial discipline and corporate subservience while still in school. The movement spread rapidly throughout the country, at the prompting of both industrialists and corporate reformers among engineering educators. At MIT, for example, cooperative programs were begun in electrical engineering by Magnus Alexander, educational director of GE's Lynn plant, and in chemical engineering by Arthur D. Little, the country's foremost industrial research consultant, while at the University of Pittsburgh a college-wide program was initiated by Dean Frederick Bishop, national Secretary of the SPEE. By the 1920s variants on the cooperative plan were introduced at such schools as Northeastern, Tufts, Drexel, Case, Union College, Marquette, New York University, Antioch and Harvard, and included liberal arts students as well as undergraduate engineers.

While the cooperative education movement established closer industry-education interaction, other corporate reform innovations had the purpose of rationalizing the "processing plants" themselves. The corporate educators were ardent promoters of testing programs and efficient selection, rating and classifying processes much like those developed in the corporation schools and other areas of personnel management. Charles Mann, author of the first national study of engineering education in the U.S. (sponsored by the SPEE and funded by the Carnegie Foundation for the Advancement of Teaching) explained the primary purpose of introducing testing into the schools, in an address to the NACS in 1914. "The one point that I want to bring out clearly to you," Mann stressed, "is that definite objective tests which define the type of ability which you wish to have developed are the most valuable, not only to yourselves as employers in selecting your help, but also as your most powerful means of controlling what is done in the school." The development of testing procedures for evaluating the aptitude of students, advanced considerably by the corporation schools, was paralleled by the creation of mechanisms for selecting and distributing the educational products. The first placement bureau in an American university, for example, was established at Kansas State College by GE engineer Andrey A. Potter, who served as both dean of engineering and president of the local chamber of commerce. Later dean at Purdue, president of the SPEE, and a major force in engineering education, Potter had also developed the personality rating scales for evaluating students according to standards of "character," as well as more traditional academic measures, scales which were widely adopted both by educators and corporate managers.

The biggest push toward the rationalization of higher education came during the First World War, which also saw the unprecedented advance of intelligence testing and educational psychology. During the war, the nation's colleges came under the authority of the War Department Committee on Education and Special Training, designers and directors of the Student Army Training Corps. This committee, surprisingly enough, was composed of corporate educators from Westinghouse, Western Electric, and other firms as well as leaders from the SPEE, all of whom had donned uniforms for the duration. With the authority of the War Department behind them, these people were able to introduce many of their educational innovations with relative ease while conditioning a good many educators to produce according to specifications, industrial as well as military.

After the war, the corporate reform of higher education was continued under other auspices: the National Research Council, the SPEE, and, perhaps most importantly, the new American Council on Education (ACE). The latter, dominated from the outset by War Department Committee members Samuel Capen and Charles Mann, both prime movers in corporate educational reform, quickly became the chief sponsor of the new "science of education" and promoter of testing in the schools (ACE testing programs coalesced eventually into the

Educational Testing Service). It was through the ACE that the educational reform movement begun in the corporation schools of science-based industry and developed in the engineering schools entered the body and soul of higher education as a whole. In 1924, ACE Chairman Henry Suzzalo aptly summed up its mission.

> The American system of schools has a sanction in public efficiency as well as in equality of personal opportunity. [University educators] have an immediate responsibility to make the prospect more effective.... Soon we must become as wise in pedagogical method as we have long been in scientific method. The processing of human beings through intellectual experiences is far more important socially than the processing of material things. Yet physical technology holds a place of respectability among us which human technology has not yet won.

During the first half of the twentieth century, and at the initiative of reformers from science-based industry, colleges and universities were retooled to fit the contours of a corporate, technological society; institutions of higher education were transformed into processing plants, integral parts of the industrial structure charged with the production of manpower and the habituation of students to the disciplines of loyal, efficient corporate service. Perhaps no single individual better embodied this transformation than William Wickenden. An electrical engineer, Wickenden taught in the cooperative program at MIT with Dugald Jackson before leaving the academy to become first personnel director of the Bell Labs and then vice president for technical personnel for AT&T. Leaving AT&T in 1923, Wickenden became director of the most comprehensive study of engineering education in history (The SPEE Wickenden Report) and thereafter president at Case Institute. A giant in his profession and probably the foremost figure in twentieth century engineering education, Wickenden summed up the meaning of his life's work a year before his death, in 1946.

> The very word university comes from the Latin word for corporation and the college dormitory is simply a continuation of the plan of the guilds by which the master workmen not only trained their apprentices but took them into the households to live. That is where our circle began, but as it swung out on its wide arc, the world of education drew

> further and further away from the world of industry. . . . The Sorbonne and Oxford scarcely knew of the world of science and for the world of industry they had only disdain. But the two circles went swinging on, bringing industry and education ever closer and closer, until tonight they are closing back once more at the point of origin where industry and education are one, where corporation and university again mean the same thing.

Archival Sources and Industrial America

The foregoing discussion of the incorporation of American universities as functioning units within the industrial system has provided but the barest outline of an important, neglected, part of American history, one which has only just begun to be reconstructed. Here the purpose has been merely to suggest in broad strokes a general perspective, a coherent conceptual structure, for utilizing the archival materials of individual universities as to so illuminate the larger story they contain. No one would dispute the fact that university archives constitute a vast, largely untapped resource for the American historian. The real challenge, however, remains in asking the right questions of this assembled material, questions which bring as much of the information as possible together in a meaningful, illuminating way. Here the questions are: how did America become a science-based corporate society; how did a revolution in production, wherein science became wedded to the useful arts, give rise to the technological society which we now call home? University archives contain some of the more important answers.

The intelligent use of university archival materials—often of the most mundane nature—goes far beyond the simple cataloguing of names, the who's who analyses of boards of trustees, which are often offered in answer to such questions. Viewed through the correct lens, such materials allow researchers carefully to reconstruct a social transformation of major proportions. For the story just told, university archives were used extensively, in addition to published materials and the archival resources of such national agencies as the National Research Council, the American Council on Education, the Society for the Promotion of Engineering Education, and the National Archives. However, the archives of the Engineering Foundation, the Chemical Foundation, the General Education Board of the Rockefeller Foundation, the Carnegie Foundation for the Advancement of Teaching, the American Management Association, the National Bureau of Standards, and other national organizations remain to be critically examined. The most valuable information, and insight, was gleaned from university archives.

The personal papers of important individuals proved invaluable. Since many of the key reformers within the universities were former industrial officials, their correspondence offers an inside view of corporate reform efforts, the perspective shared by industrial executives and their collegiate counterparts. The particular collections which offered the most insight included:

William Wickenden, president of Case Institute of Cleveland, former director of personnel recruitment at AT&T and head of the national SPEE investigation of engineering education. His presidential and personal files offer a vivid account of the transformation of technical education in this country, the development of industrial technical institutes, the expansion of management training for engineers, the close ties between Case and local chemical and machine tool industries, the growth of research and laboratory facilities at the Institute, and the intimate, continuous relationship between university presidents and top corporate leaders throughout the nation.

Charles F. Scott of Yale, head of electrical engineering department and prominant consulting engineer for Westinghouse in Pittsburgh. Scott served as president of the SPEE at the time of the Wickenden investigations and was a key figure in the development of in-house training activities at Westinghouse and throughout the country.

Frederick Bishop, dean of engineering at the University of Pittsburgh and for thirty years national secretary of the SPEE and editor of the influential *Journal* of the society. Bishop's papers provide much information on the early development of cooperative education schemes, especially with nearby Westinghouse, industrial research at universities, and the role of the colleges during the war.

Andrey A. Potter, dean of engineering at Purdue. Potter's papers provide extensive material on technical education, testing, guidance, and, most importantly, professional placement; in addition, there is much important information about engineering experiment stations.

Henry Suzzalo, president of the University of Washington in Seattle.

Suzzalo was a major figure in the formulation of a "science of education," which centered at Columbia Teachers College in New York, served as U.S. Commissioner of Education and president of the ACE. In Seattle, Suzzalo enjoyed very close ties with that region's lumber, fishing, and nascent aircraft industries and played a major role in the control of the Seattle general strike of 1919. His papers shed light on the workings of the ACE, on the rationalization of education at the university and the growth of scientific research and industrial cooperation. In addition, because Suzzalo served as a member of the Council of National Defense (CND), which played the key role during the preparedness campaign, his papers offer a glimpse of how universities and regions geared up for war. The importance of papers such as these is pointed up by the fact that Suzzalo's collection contained a complete set of minutes of the CND's Committee on Education, the agency which first mobilized the colleges for wartime service. Suzzalo was a member of the committee but, being three thousand miles from Washington, D.C., had the minutes mailed to him. The National Archives' CND collection lacks these minutes, indicating simply that they have been lost; thus, Suzzalo's papers more than likely contain the only set of minutes extant.

Samuel P. Capen, chancellor of the University of Buffalo, first specialist in higher education for the U.S. Bureau of Education, principle figure in the War Department's Committee on Education and Special Training, and founder, and long-time chairman of the ACE. Capen's papers are a goldmine for the historian of higher education in America during the twentieth century; of particular interest is the extensive and extraordinary collection of letters written to his wife during his extensive travels throughout his career. These letters provide an unequalled glimpse of the internal development of educational reform on the national level, the central role played by technical men in that reform, the reform strategies adopted during the war period, and the psychological make-up of principle reformers. Rarely is an historian offered such an intimate portrait of institutional change, or, for that matter, of the relationship between husband and wife in the upper circles of society (Capen's wife was the daughter of Carroll D. Wright, first U.S. Commissioner of Labor and president of Clark University).

Dugald C. Jackson, long-time head of MIT's Electrical Engineering

Department, leading power engineering consultant, spokesman for private ownership of utilities, president and key figure in the SPEE, initiator of cooperative education programs with some of the nation's largest corporations, and mentor of a generation of scientists, engineers, industrial executives, and government science administrators. His correspondence reflects the growth of technical education, the evolution of scientific research, the development of science-based industry and, most clearly, the integration of universities within the industrial structure.

Personal papers of individuals like these men who straddled the worlds of education and industry serve as convenient and valuable entrées into the realm of corporate, scientific reform. But this is just the beginning. Presidential papers, such as those of the MIT Corporation provide access to corporate boardrooms of industry as well as universities, containing as they do extensive correspondence between college officials and corporate leaders. Departmental records, such as those of the electrical and chemical engineering departments of MIT, allow the historian to trace the growth and direction of scientific research, technical education, and document the two-way flow of industrial and college personnel—faculty and students—back and forth between the schools and the factories. Course and school records, such as those of the course on Engineering Administration and the School of Management at MIT, and conference records, such as those of the National Employment Managers Conference at the University of Rochester, provide detailed information of the growth and content of management training. Finally, laboratory reports, such as those of the famous Servomechanisms and Radiation Labs at MIT, offer insight into the development of major scientific discoveries and inventions—radar, digital computers, automation—which can be gained in no other way, and provide extensive documentation of the intimate links between universities, industry, the government, and the military.

Finally, the records of even the seemingly most routine matters with which a university concerns itself provide a tremendous resource for the historian of modern America. For the study of the development of science, science-based industry, and patterns of public investment, the record of university research is invaluable. Consulting done by faculty, career patterns of students and faculty, departmental records of curriculum evolution, laboratory notebooks all contain valuable information. Even more important are records indicating sponsorship, sources of funds, ties with local and national industry, military and other governmental agencies, research "spin-offs," — private consulting, research, and manufacturing firms set up by project engineers—library facilities including theses and dissertations, and extension programs offered by universities to local industry and agriculture. Educational records are also extremely valuable. Course syllabi and lectures; the records of admissions and testing offices and guidance, counseling and, most importantly, placement offices; departmental records of all kinds; teacher evaluations; and the records of cooperative courses (especially in engineering schools but also in business and policy-oriented departments) allow the historian to trace the changing form, content, and meaning of education as it was transformed and incorporated within the corporate, technologically advanced industrial system. This material sheds light on the processes whereby the young are habituated to accept, and trained to work efficiently within, the institutions which have come to dominate American society. Last but certainly not least, the records of administrators—presidents, deans, department heads—provide documentation of endowments, funding, budgets (changing allocation of resources) and the ideological predispositions of the directors of one of America's largest and most important industries, higher education.

To conclude, university archives contain a wealth of information for the historian of modern industry, the historian of science and technology, the historian of education, the historian of the arts and countless other specialists. Most importantly, however, they contain material that demonstrates convincingly that these varied strands of the nation's past are actually of a piece, reflecting the scientific and corporate transformation of American society in the twentieth century; they show, moreover, that universities have played a central role in this dual transformation. In providing documentation of the evolution of these universities, university archives at the same time shed considerable light on a social transformation of major proportions, one perhaps unmatched in this nation's history.