Washington Center *for* Equitable Growth

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Engineering, Industrialism, and Socioeconomic Orders in the Second Industrial Revolution

What U.S. policymakers today could learn from emerging technology professions and innovation at the turn of the 20th century

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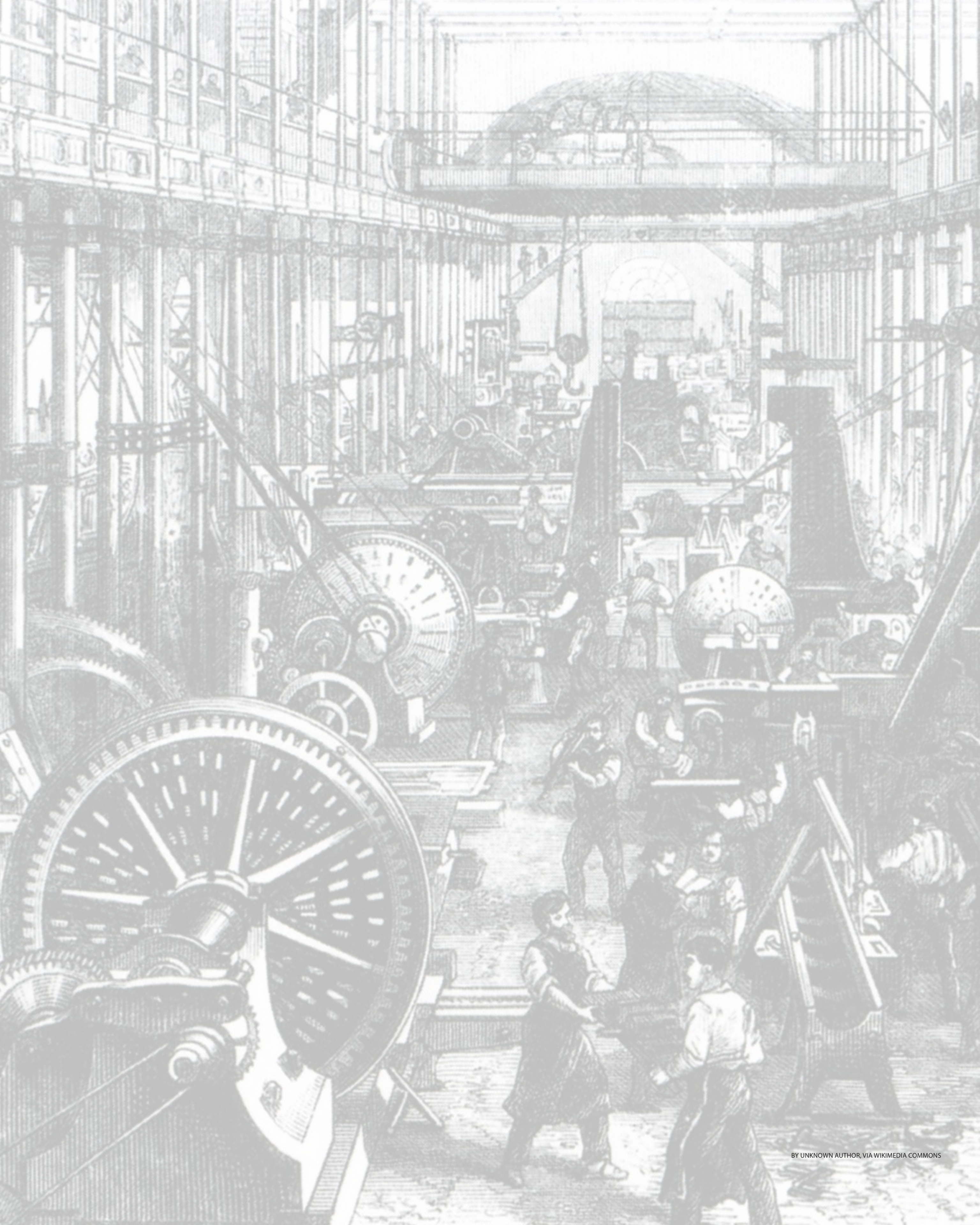

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Explaining the "History of Technology" series and equitable growth

By Jonathan D. Moreno

"Let me recite what history teaches," wrote the 20th century American novelist Gertrude Stein. "History teaches."

Does history teach? In particular, does history teach about job destruction and creation? Can the study of history, both in case studies and in the broad strokes of trends, help us understand how structural changes in the U.S. economy have affected growth and inequality in the past? Can they give clues about what we can expect in the future?

The Washington Center for Equitable Growth set out to answer those questions by establishing a Working Group on the History of Technology. In a Washington, D.C. policy environment dominated by economists and political scientists, we wanted to see if the tools and concepts of the history of technology can be deployed in ways that complement those other disciplines. After all, historical precedents are routinely cited in policy discussions, but rarely are they subjected to the close analysis that professional historians can bring to the conversation.

Our working group of technology historians seeks to answer the question of whether there are elements of previous mass technological shifts that may aid in the management of workforce disruptions brought about by the post-high-tech revolution. The group considered this question in light of the overarching mission of Equitable Growth to investigate whether and how economic inequality affects economic growth and stability. By casting an informed look back to previous technology-driven job upheavals, we may find shifts in inequality and growth—shifts that indicate whether these phenomena are linked. If so, then perhaps answers to today's growing income and wealth gaps will lie in some combination of spontaneous forces and active interventions by government or through public-private alliances.

We did not look for technological speculation or "futurism" in our work. But any technology that is or has been in operation for the last couple of hundred years has been fair game for our group, from the steam engine and railroad to nanoengineering, synthetic biology and microchip production, as well as the workforces related to those endeavors. Otherwise, in charging our group of historians, we brought no preconceptions in this regard. Nor do we think that there will necessarily be a clear line from previous experience to the future. Some past events and concepts might be a dead end, but some might provide a foothold, however modest, on understanding what lies ahead.

Whatever the case, historical lessons are too important to be ignored in considering the future of job creation in a post-high-tech world. In the words of the 18th century Scottish philosopher David Hume—a decidedly less musical but no less nuanced writer than Gertrude Stein—the future tends to resemble the past. The challenge, we might add, is ascertaining which tendencies will turn out to matter in the years ahead.

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A map of lines and metallic circuit connections, 1891.

BY AMERICAN TELEPHONE AND TELEGRAPH COMPANY

Overview

In the longstanding historical debate over what exactly was revolutionary about the so-called Second Industrial Revolution in the late 19th and early 20th centuries, historians today are often asked to draw parallels between it and the current "Fourth" Industrial Revolution, characterized by the emergence of massive personal and private use of handheld electronic computers as well as the emerging use of "Big Data," in the early 21st century. But few historians have examined the parallels between the emergence of engineering as a profession at the dawn of the age of electricity and of massive chemical and mechanical manufacturing, a time when technology transfers and high-tech immigrants moving between the United States and Europe also reshaped U.S. manufacturing and the work of its labor force in myriad ways.

Today's technologies (often pioneered by immigrants) have their most visible impact on the U.S. economy and the global economy through rapid change and innovation. They include, for example, the big data- and computing power-driven engineering push toward driverless cars, and the massive crunching of biological and chemical data that is transforming all manner of medical technologies and treatments. At the same time, the U.S. economy and its workforce expertly maintain, and rely on, the large networks of technological systems—such as the electrical grid, the telegraph and railroad networks, and the infrastructure of civil engineering—created during the Second and Third (during the Cold War) Industrial Revolutions.[1]

Innovating and maintaining have gone hand in hand and depended on one another for the entire history of technology. This is why taking a look at the "experience" of technological and economic change that accompanied the emergence of the engineering profession in the decades straddling the turn of the last century may well give policymakers today some scope to understand how the merger of different types of engineering professions may affect innovation, economic growth, and changes in the U.S. workforce that in turn may help or hinder more equitable economic growth.

The technological and sociopolitical concerns of engineers more than 100 years ago—including how they, as an emerging profession, were trying to constitute themselves as a new cultural and expert elite, both in Europe and in North America—experienced conflicts among themselves as well as competition from existing elites whose roots went way back to pre-industrial ages, such as the nobility, senior civil servants, high-ranking military personnel, and members of the so-called "free" professions medicine and law. Engineers were more affected than other elites and experts by the immense economic ups and downs between 1870 and 1933 in the western world, as traditional elites often operated in idiosyncratic and protected labor markets (such as the civil service and the church service). Traditional elites also came more often from families that were already privileged, and were able to soften more easily the blows of the rapid changes in the economic cycles of this high industrial age.[2] (The "Third" Industrial Revolution, if this terminology is used, usually refers to the nuclear age and the massive use of electronic computers on the part of the military, government operations, and large corporations in the private sector, ca. 1940 to 1980.[3])

A close look at the voices of these engineers in this high industrial age may help us understand links that we have overlooked so far between the experience of technological change and artifacts (and machine culture) on the one hand, and the experience of class, income, technological expertise, employment stability, and social and cultural status on the other. The first sustained debates about the "consequences" of technology in society (including, but not limited to, the question of economics) occurred right at this time, and were advanced by engineers themselves. Engineers asked about the impact of rapid technological change and, at a more fundamental level, whether humans and societies had become more and more "like machines." Such concerns were debated among both traditional and new elites, often against the background of the First World War and its aftermath. Related issues have remained pressing to this day and have come to include questions about post-industrial digital technologies and their effect on human relations and politics.[4]

The two leading nations of the Second Industrial Revolution were Germany and the United States, and their technological and socioeconomic change happened against the background of distinct histories in the two countries of industrialization, nation-state building, and the experience of growing and shrinking economies. Both German and American engineers began to consolidate as professional classes in the late 19th century by being trained at newly founded institutions of technical education, developing highly gendered group identities, seeking places within archaic social orders, establishing professional associations and periodicals, and creating bonds with political scientists, economics, philosophers, and politicians.[5]

These newly emerging professional engineers, like everyone else, experienced the second wave of the machine age around 1900 as something new and often threatening, as cultural but also as workforce interruptions (for example in civil engineering and architecture).[6] Germany and the United States, apart from their leading roles in the Second Industrial Revolution, also nurtured vigorous and highly visible intellectual, economic, and cultural lives more generally, and had, since the early 1870s, established stable conduits across the Atlantic for an ever-increasing exchange of people, commodities, and ideas. There was also significant temporary and permanent migration of engineers between German-speaking central Europe (including areas in Austria, East Prussia, Switzerland, Silesia, and Hungary) and North America.[7]

There were key agents in the social and economic emancipation of engineers: prominent figures who were at the same time engineers, political thinkers, and cross-Atlantic migrants (such as General Electric's chief engineer and Schenectady socialist councilman Charles Steinmetz, whose life and work I explore in the second half of this paper, and the automobile engineer and political refugee Nathan Stern) as well as lesser-known immigrant engineers from German-speaking Europe who were also interested in philosophy and political theory of technology. Such lesser-known engineers were organized in societies, including the National Association of German-American Technologists, for example. NAGAT's periodicals demonstrate engineers' interest in philosophy, social upward mobility, and negotiations of their identities as immigrants from Europe. These writings reveal engineers' invocations of pre-industrial social orders and industrial economic orders such as mercantilism, capitalism, and socialism.[8]

Migration and exchange happened as part of the vibrant "technology transfer" of the time—especially in mechanical, chemical, and electrical engineering—which mobilized knowledge, artifacts, and people.[9] Questions about the new industrialism and its relationship to traditional social institutions (including democracy) also traveled across the Atlantic in both directions. The production of philosophical ideas on the part of German-American engineers happened in specific social spaces in which matters of social status, philosophy of technology, and pre-industrial social institutions were discussed right next to matters of technological artifacts and industrial production.

To assess these many profound changes faced by engineers and driven by engineers, in this paper I look at two distinct episodes at the time. The first involves the newly emerging group of chemical engineers in the United States. The second presents the distinguished electrical engineer Charles Steinmetz. Both episodes and personalities illustrate the social and economic dynamics of engineering and engineers' self-images at the time.

Chemical Engineering

Students at a industrial chemistry laboratory at the Massachusetts Institute of Technology, 1893.

BY UNKOWN AUTHOR, VIA WIKIMEDIA COMMONS

Chemical engineering in the late 19th century faced unique problems in demarcating itself from its neighboring science, chemistry. Today, chemical engineering is one of the "big four," along with civil, mechanical, and electrical engineering, but the other engineering disciplines are older and were always larger.[10] Contested issues revolved around engineering methods and techniques, but also around social status and class. Mechanical and civil engineers had their roots in craft and artisan traditions, and there were struggles in these fields between practically trained and academically trained engineers about the emphasis on scientific training. Civil and mechanical engineers in the end were much better able to use science to distinguish their emerging professional fields from lower-status craft groups such as surveyors, carpenters, building contractors, or mechanics and machinists. And electrical engineering, which emerged more directly from the academic science of physics, also faced less resistance on the part of physicists compared with the resistance that chemists displayed toward chemical engineers.[11]

By 1900, chemistry was a well-established science in the United States, and many chemists did not believe that establishing a new engineering discipline that was derived from their science was a good thing.[12] In a meeting in 1908 to discuss the need for a separate society for chemical engineers, a leading chemist declared:

'Chemist' is a good enough term for me, and if the chemists stand up for their names and their interest as well as the engineers do, you do not need any society to speak for you. Stick to what you have. I do not think we have any need to form any other organization.[13]

Terry Reynolds, Professor Emeritus in the Department of Social Sciences at Michigan Technological University, explains how chemical engineers scaled up chemical processes originally performed in the laboratory to the industrial level, leading to large-scale chemical production, which made them so desirable at the time. But in the minds of leading chemists, this "did not require a separate discipline."[14] Yet a specific model for this "scaling-up process" (and the expertise it required) already existed—in Germany. There, research chemists who developed new processes in the laboratory were themselves in charge of scaling them up to an industrial level. Mechanical or civil engineers and other technical personnel were in charge of handling the engineering parts. This model retained traditional disciplinary boundaries and divisions of labor between chemist and engineer. It did not require, for the time being, the creation of a new profession.[15]

Helping along the professionalization of chemical engineering was the fact that a large number of American chemists were educated in Germany in the late 19th century. University of Pennsylvania professor of the history and sociology of science Arnold Thackray's work, among others, tells us that in the period between 1876 and 1905, more than half of the presidents of the American Chemical Society had been trained in Germany, most at Göttingen or Leipzig.[16] Establishing a distinct professional identity for chemical engineers in America was difficult, but it was not an inevitable consequence of the growth of large-scale chemical production. One result of that was an uncertain status and anxieties of American industrial chemists.

In periodicals of societies of chemical engineers, the engineers themselves talked about their situation. In 1905, for example, a new periodical was founded with the name *The Chemical Engineer*. In the first issue, it was introduced as a "new monthly journal devoted exclusively to practical chemistry." The editorial said that the journal interfered "in no way with the other excellent chemical journals now published in this country." And the editorial also emphasized that the journal would "publish no papers on theoretical chemistry."[17] About the name, the editorial said that they called the publication *The Chemical Engineer* because the vast majority of the technical chemists at the time in the United States were "not only workers in the laboratory" but had active supervision in operations of the "great" American chemical industry.[18]

The new journal, said the editorial, would therefore provide a meeting place where chemistry and engineering might join hands. Special attention would be paid to the testing of materials such as cement, asphalt, steel, and paint. And abstracts of the leading articles on chemical technology from the French and German magazines would appear, along with a correspondence column in which subscribers could trade ideas, and a job exchange.[19] At the end of the first editorial, we find evidence of some status problems, in the last sentence, which comes across almost biblical in its rhetoric:

> *We want the only American journal on technical chemistry to be the best of its kind. Give us your help and encouragement and we will make this journal one of use to practical chemists, of whom so much has been asked and to whom so little has been given.*[20]

Another example of a very early periodical for chemical engineers is *The Journal of Industrial and Engineering Chemistry*. Editorials in this journal, between 1909 and 1910, dealt with topics such as the necessity of a separate discipline of chemical engineers, ethics, the constitution of engineering societies, and the contributions that chemical engineers could make to the efficiency of industry in the United States, which was a major political topic at the time, and one of the intellectual roots of technocratic thinking, of which I discuss aspects in the second part of this paper.

An editorial from 1909 from this journal was entitled "The Industrial Chemist and his Journal."[21] It stated that a journal published in the interests of the American chemical engineer was necessary, and as a justification the text says that "the Technical Chemist loves his science no less than his brother," by which the author means the researcher or teacher. The editorial also emphasizes the crucial role of the chemical engineer in the upscaling of laboratory chemistry for industry, and it closes by saying that we often hear of the success of a laboratory method, and its failure when applied on a manufacturing scale. The editorial concludes that, in many cases, failure is due to lack of engineering knowledge.[22]

In regard to ethics, another editorial in this periodical spoke about recent battles against fraud with medical drugs, and how that gave rise to the National Food and Drug Act in 1907.[23] The editorial states that chemical engineers should use their influence to teach consumers about mixtures of worthless and dangerous medicines that are for sale for general domestic use, and that chemical engineers should put pressure on agencies to provide correct labeling. The editorial then says that "the chemical fake assumes many guises" and suggests that "finding educational and legislative ways for eliminating them is worth the effort of chemists interested in building the profession and extending its usefulness."[24]

This focus on food safety is a good example for how the virtuous functions of chemists and chemical engineers is attached to an interest in building up and extending influence as a professional group. Yet another editorial dealt with the founding of an "American Institute of Chemistry." It says that there was a real need for such a thing because in any given trade or profession, it was necessary to evaluate the ability of particular members, and the only person to do this was an experienced member of that same trade or profession. This was supposed to be the principle of the proposed Institute of Chemistry, on the model of other professions such as medicine, law, and dentistry.[25] In such editorials, these latter professions served time and again as role models for professionalization of engineers, and for increasing their visibility and credibility.[26]

One last editorial to be mentioned dealt with the problem of making industrial production and use of resources more efficient. This editorial tapped into a discussion at the time that was about science and economics, but also about politics and international diplomacy. The editorial said that mass production in the United States was often run badly, and that other nations had developed much better methods, notably Germany. The editorial said that the prosperity of the nation and the people was determined by the efficiency with which resources were used, but it also said "we don't know enough about efficiency to run our manufacturing well." Evidence for this were the losses in nearly every step of the production, and the editorial claimed that "our industrial salvation" must be found in a closer cooperation between production and science. The editorial said that "such co-operation" existed, namely in Germany, and that the results were evident throughout the world in the tremendous expansion of German industry. The editorial, finally, saw the applied chemist as a key figure in this: It said that no agency was more directly relevant to increasing efficiency than chemistry applied to industry.[27]

Charles Steinmetz

Charles Steinmetz photographed with Albert Einstien and other scientists and engineers during a tour at Marconi RCA radio station, Brunswick, New Jersey.

BY UNKNOWN AUTHOR , VIA WIKIMEDIA COMMONS

Charles Steinmetz, an immigrant from Germany and an electrical engineer, ended up becoming a key theorist of technology, efficiency, and technocratic society. A great deal of what we know about him is owed to the groundbreaking biography by Ron Kline, a Cornell University professor of the history and ethics of engineering.[28] Steinmetz was a well-known figure in the 1910s and 1920s in the United States who died suddenly at the height of his fame in 1923. Newspapers quoted his views on religion, politics, on science, and on future technologies. He was a hunchbacked immigrant who rose to fame as the chief engineer of General Electric and as a symbol of a new breed of engineers in the succession of Thomas Edison.

Steinmetz was born in 1865 in Breslau (now in Poland, and was then part of Prussia) and studied mathematics and physics as a young man. When he was 23, he was forced to escape from Germany—he was an active socialist in youth organizations and had written a paper that criticized the Prussian government. He eventually immigrated via Switzerland to the United States and arrived there in 1893. He soon found work with an electrical firm in Yonkers, New York. General Electric purchased the company in 1894, and Steinmetz eventually rose to the position of GE's chief consulting engineer. He also advanced during the 1890s to the top of his entire profession, electrical engineering, in the United States.[29]

Steinmetz's chief accomplishments were his mathematical theories of alternating current. They provided for the first time tools for engineers to design alternating current circuits. This was crucial at the time for the transmission of electrical power over large distances, which happens with great losses when direct-current circuits are used. Alternating current solved this problem, but it created another: Its variation in direction and intensity makes it much more difficult to analyze mathematically. Steinmetz's training and skills were unusual among American engineers at the time, and he translated the complicated mathematics of electrodynamics into a language that could be used by engineers.[30]

The number of college-trained electrical engineers was generally rising from the early 1880s onward. But compared with mining, civil, and mechanical engineering, electrical engineers did not have a long professional tradition and were lacking a field, shop, or mining culture.[31] That was their version of trouble finding a professional identity, in parallel to the case of the chemical engineers. The trouble specifically of these two groups of engineers makes sense when one remembers that the two big technologies of the Second Industrial Revolution were chemistry and electricity, and that the technologies were just coming into being and were much less rooted in the First Industrial Revolution, or in earlier industrialization, than the technologies used by mining, mechanical, and civil engineers.

Steinmetz wrote down his mathematical techniques in textbooks, and they had tremendous influence on generations of electrical engineers across the United States. Among his works are "Theory and Calculation of Alternating Current Phenomena" from 1897 (with a second edition in 1898 and a third edition in 1900); "Theoretical Elements of Electrical Engineering" from 1901 (with a third edition in 1909 and a fourth edition in 1915); "General Lectures on Electrical Engineering" from 1908 (with a fifth edition from 1918), and "Engineering Mathematics; a Series of Lectures Delivered at Union College," 1911 (with a third edition in 1917). Two of his works stand out. One is entitled "America and the New Epoch" and is from 1916; the other one, from 1922, is entitled "The Place of Religion in Modern Scientific Civilization."

Steinmetz's immigration to the United States coincided in time with rapid industrial advancement, increasingly larger factories of production, and the incorporation of smaller firms into larger ones. New groups of people were running and managing these larger units, and the emergence of Taylorism (the theory of management that stresses the efficiency of engineering, manufacturing, and labor productivity presented by the late mechanical engineer Frederick Taylor in 1911) and Fordism (so named, of course, after Henry Ford and his pay and assembly line innovations first used at his car factories in Detroit in 1913) around the same time is also no coincidence. There were new groups of people, but also new conflicts of interest between them and groups that existed before.[32] Steinmetz's political interest was directed among other things toward those conflicts. His distinguished position at General Electric also became a platform for him to step onto the wider stage of public affairs. He became a leading figure in the American Institute of Electrical Engineers, a socialist councilman in Schenectady, and a part-time professor of political economy at Union College in the city.

During the Progressive Era in the United States, ideas of "engineering society" were widespread. They consisted of applying methods and principles of science and technology to reform education, the professions, business, and government. Many reformers at the time came from a "new middle class" that was made up of doctors, lawyers, social workers, journalists, and other professions emerging at the turn of the century, as Steinmetz's biographer Kline explains. Some of these new professionals wanted to impose a bureaucratic order, run by experts, on a national culture that was rapidly changing through urbanization and industrialization.[33] They also wanted to raise their social status (as we saw) by making more rigorous the standards of their professions. Engineers were part of this new middle class, and they shared the belief that a "professional" was a person who was formally trained in a systematic body of knowledge, had a sense of social responsibility, and belonged to a group that was self-regulating. Steinmetz himself, as a leader of the American Institute of Electrical Engineers, campaigned for a code of ethics, for technical standards, and for professional autonomy.[34]

Kline emphasizes in particular how it was Steinmetz's work on committees for standardizing electrical tools that was a breeding ground for his later theory of technocratic socialism of which he proposed outlines in 1916 in "America and the New Epoch." The American Institute of Electrical Engineers standardized electrical performance requirements, voltages, and frequencies—and Steinmetz encouraged this in order to increase manufacturing efficiencies. Engineering societies developed influence in general in the field of standardization (they do so to this day) and often in rivalry with business interests.[35] Some believed at the time that the Institute would compromise its integrity if manufacturing engineers were involved in setting standards, but the Institute also needed their cooperation in order to enact realistic standards—and that is also a dilemma that engineering societies continue to face.[36]

The efficiency movement in the United States at the time (and in other industrial nations such as Great Britain) aimed to eliminate waste in all areas of economy, society, and natural resources (such as water, lumber, petroleum), and to broadly implement procedures for doing so. Leading people in the movement wanted to improve government performance by training experts in public and civil service, and they explicitly stated once again that the German and Austrian states and civil services were their models.[37] For Steinmetz, ideas of efficiency and waste (in engineering design and elsewhere) resulted in his embracing ideas of a technocratic political system.

The first time that we see Steinmetz experience his technocratic ideal is, as Kline points out, when he cooperated with a group of engineers from competing companies (Westinghouse Electric and General Electric) on a committee on standardizing electrical tools at the American Institute of Electrical Engineers. The committee met in 1912 and 1913 to revise standards, and there was reportedly an unprecedented spirit of cooperation on this committee to develop the new rules. On the committee with Steinmetz was, among others, Benjamin Lamme, the Chief Engineer of Westinghouse Electric. He was the one who built the giant generators at Niagara Falls and the power plant of the Manhattan Elevated Railway.[38]

The two top electrical engineers of the American industry at the time enjoyed their cooperation on this committee and became friends.[39] Lamme wrote in a letter to Steinmetz about the growing friendship between rival engineering organizations and how it was a great step forward, and Steinmetz wrote to Lamme that "engineers of the corporation should impress upon the world, and upon the men in the organization, the solidarity of the engineering interests, even if the commercial interests are competitors."[40] Out of experiences like this—of engineering, rather than worker, solidarity, as Ron Kline says—grew Steinmetz's theory of technocratic, corporate socialism.[41]

Benjamin Garver Lamme circa 1915.

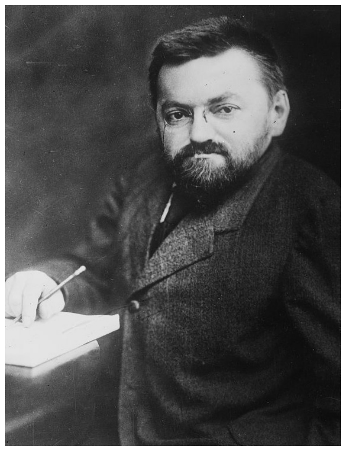
LIBRARY OF CONGRESS, VIA WIKI COMMONS

Steinmetz's work "America and the New Epoch" was published in the middle of the First World War, in 1916. In it, he first engages in some American history, explaining that it was in the early colonial communities in North America that the current government system originated, with its fundamental democratic principles and fundamental inefficiency, as he says, as evident in the "rotation in office." In the simple colonial society, he says, it was natural that any intelligent citizen was considered eligible to any office, and that the office-holder changed at every term. But, Steinmetz says, this has become a serious handicap in our present, highly complex civilization: "When in rapid succession a theater-director, a physician, a minister, and a lawyer are placed in administrative charge, then the absence of knowledge and experience must lead to the incompetence and inefficiency that we see now in all our political life."[42]

Steinmetz then says more about the history of industrialization in the United States. He points to the beginnings of industrial development in the early 19th century in New England and then laments that in the early 20th century, the corporate development of industry has been arrested by the interference of the government. He blames this increasing interference, and the unjustified public demand for it, and the resulting inefficiency and waste on the uneven industrial development in the country, arguing that industrial development was fairly uniform in other nations whereas, in the United States, the development of industries along the Eastern Seaboard was about a generation ahead of that in the Midwest and the West. In the East, he said, there emerged corporate organizations while there was still a large class of small, individual producers in the West who were ready to fight the corporation and its higher efficiency of production.[43]

An equally serious enemy to progress toward cooperation, according to Steinmetz, is the strong individualistic temperament of a large part of American citizens. His solution to that is a better understanding between industrial corporations and the general public. He sees an obligation on the part of corporations to establish harmonious social relations and "industrial and social peace," as he says, but he states that corporations still fail to recognize this need.[44] Looking once more back to Europe, Steinmetz observes that the old world has gone to pieces (he writes this in 1916), and that a new one would need to rise from its ruins in an era of cooperation. Germany, he says, already has organized its industries cooperatively, has encouraged and enforced by government acts corporations, which we have outlawed, he says. And he sees an industrial efficiency resulting in Europe that he calls a "menace" to the individualistic nations. Our government as now constituted, he says, is not adapted for efficient constructive work.[45]

It is in this context that he formulates his political and economic visions: We have to find new ways and means to accomplish a thing which has never been accomplished before—"co-operative organization of a democratic nation."[46] He presents two more major lines of argument here: an idea of a strong civil service (coinciding with technocratic structures) and some elements of a utopia that he presents to his reader as resulting from his ideas. He says that constructive work in the American political system is accomplished where the office is held more continuously, namely either under civil-service rules or because the office is not sufficiently important to be included in the rotation principle (he calls that principle the "distribution of spoils").[47] And he insists that there can be no efficiency without continuity of the administration. When Americans consider political offices, he said, they generally disregard the principle of expertise and competency and place a man who has failed in every business he undertook in administrative charge of the community.[48]



Charles Proteus Steinmetz circa 1910-1915.

BY RICHARD ARTHUR NORTON, VIA WIKIMEDIA COMMONS

Steinmetz then outlines a utopia by asking: "What, then, are the structural elements in our American nation from which a continuous, competent, and responsible government could develop—a government such as is required for the efficient industrial co-operation of all citizens in the interest of all, under democratic principles?"[49] The elements that he lists are those normally considered elements of socialist economies and societies. There would be no industrial competition, for example, because in the cooperation of all producers, duplication of work and waste would be eliminated. The production of goods and services also would be controlled to correspond with the legitimate demands for the product, and all production for mere profit, without regard to the demand for the product, would cease. And because competition between industries also would cease, the country's transportation infrastructure (waterways and railroads) would be used to the fullest extent, and no interest would deflect to one mode of transportation what could more economically be carried by the other. Consequently, there would be competition between the kinds of energy sources and plants to be used (gas-engine, electric motor, local steam-turbine, or long-distance transmission system), and the decision would be made on the basis of the relative economy of the various propositions, uninfluenced by commercial or financial considerations. Finally, he speculated that there would have to be active cooperation between all producers, from the unskilled laborer to the mastermind who directs a huge industrial organization.

Conclusion

The immigrant Steinmetz had a perspective on principles such as individualism or the rotating office of democratic voting that was different from that of other important figures in the United States. And his utopian vision of a technocratic socialist society obviously never came to pass. But in his writings, and that of the American technocratic movement in general, we find many questions about whether and how this new, industrial type of society could be governed with political ideas that were first developed and tried out in pre-industrial societies—and often idealized when the idea of the "modern" in this era had not yet been "industrialized." It was not least the engineers as newly emerging technical experts with a need and desire for a place in a rapidly changing order that took on questions in the metaphysics and the political theory of technology to participate in debates about the most pressing questions of the Second Industrial Revolution. They had both intellectual concerns and concerns in socioeconomic status as they were asking about the interrelations between technology and society.

Engineers have engaged in reflections on the larger connection between technology and society ever since they became a profession, and they have done so for philosophical, social, economic, and technological reasons. In the Second Industrial Revolution (when the United States was first experiencing a "machine age"), engineers laid the foundations not only for networks and technological systems that provided the foundation for sustained industrial economic growth, but also for sustained conversation about the place of technology and technological expertise in the social order of a rapidly industrializing nation state.

About the author

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