Firms in Conflict: Liquid Fuel Producers in the U.S. and Germany, 1910-1933

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Two events in 1913, Standard Oil of Indiana's successful introduction of the first thermal cracking process for petroleum and Friedrich Bergius's first patent on coal hydrogenation, signalled the beginning of a new era in liquid fuel manufacture. On the U.S. side of the Atlantic, many petroleum firms raced to develop and establish their own cracking processes--all using increased pressures as well as high temperatures to produce added yields of gasoline. Large, science-based firms dominated the field. In Germany another large multidivisional firm, I.G. Farben, developed the field of catalytic hydrogenation, the process of using not only high pressures and temperatures, but also hydrogen and catalysts to liquefy coal and produce motor fuel.

Although these firms' commanding lead in the liquid fuel business support the major conclusions of such masterful comparative studies by Alfred Chandler, Jr. and Thomas P. Hughes [7, 20], the continued success and significant number of mid-sized corporations in both nations suggests the need for a closer look.[1] Such firms as Standard Oil of New Jersey and I.G. Farben created and nurtured research and development laboratories, established multidivisional structures, made vital contacts with ever-widening science and technical groups, and sought supportive government relationships. Yet a range of smaller firms in both the U.S. and Germany, although adopting some of these same tactics, consciously resisted the organizational revolution of corporations in the early 20th century to retain their smaller, family-oriented business structure. Thus, although there were some significant differences in the techno-political economies of the two nations, the effort to preserve older forms of businesses on both sides of the Atlantic appears to suggest a common battle in western capitalism between older and newer forms of business staged both in the marketplace and within the halls of science and government. A closer look at these firms in conflict should provide us with a more complete picture of a developing capitalist economy.

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[1]This paper is a partial abstract of a book-length manuscript. Notes will be indicative, not exhaustive.

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Jersey Standard and I.G. Farben

Although it entered the petroleum cracking race after its sibling, Standard of Indiana, Jersey Standard quickly made up for lost time. Realizing at the end of World War I that it could not continue to make royalty payments of over one million dollars annually to Indiana for the Burton cracking process, Jersey began developing its own process. The firm enticed the leading engineer from Indiana Standard, Edgar M. Clark, to work on a new process. But more importantly its new acquisition, Frank Howard, began to establish the first research and development team in the petroleum industry. Although its initial technical contributions to the cracking field were respectable, the firm leap-frogged others when its patent lawyers acquired basic patents in the petroleum cracking field (Ellis), and eventually became a key member of the ensuing Patent Club [12, 16, 34].

Jersey's scientific and technical strategy also encompassed institutional ties, such as its help in the early 1920s in creating the Fundamental Research Project of the American Petroleum Institute [1, 38] and its joint ownership with General Motors of the Ethyl Gasoline Corporation to produce the tetra-ethyl lead additive. And although Jersey's lack of technical manufacturing expertise was evident with a disastrous lead poisoning accident in its production plant in 1924, the firm rode out the public relations storm while the Ethyl Corporation soon proved successful in marketing the lead additive [16, 25, 39].

Jersey accompanied its emerging technical position by a simultaneous reorganization of its business structure and the improvement in its relations with the government. Inheriting both a disjointed corporation resulting from the 1911 antitrust division, and an unwieldy committee organizational system, Jersey acquired production and pipeline capacity after the war and slowly began to reorganize in the mid-1920s into the first multidivisional petroleum firm. The improved lines of authority, coordination of departmental activities, and attention to long-term planning bolstered its refining and other efforts [8]. The firm also strengthened its multinational organization at this time.

Finally, Jersey consciously strove to avoid dependence on the state, while correspondingly improving its relations with the government. As French sociologist Michel Callon has argued, managers of systems builders like Jersey (and I.G.) sought to construct undeniable business and technological positions to reduce their dependence on politics, which proved unreliable. Jersey faced a rocky road because of the Rockefeller legacy and the 1911 antitrust publicity. Through the efforts of its president, A.C. Bedford, the firm's service in World War I, and its participation in Herbert Hoover's Associative State of the 1920s, Jersey began to cultivate friendly relations with a periodically dangerous regulator. Despite the pervasive public perception of the "Standard Oil Trust" that was reinforced by periodic FTC and congressional investigations and other incidents, Jersey managed to nurture a grudging respect from the federal bureaucracy, Congress, and the public regarding the firm's efficiency [9, 10, 16,]. Jersey's political efforts paid off when the Federal Oil Conservation Board remained a weak body, and particularly when Jersey and other multinationals defeated a

proposed tariff on imported oil in the early 1930s [9, 28]. By this time the firm had also launched an effort to build supporters within the Army Air Corps [35].

Germany's I.G. Farben followed a similar strategy of technical excellence, corporate organization, and friendship with the government. The leading chemical firms of Germany that formed I.G. pioneered the modern research and development laboratory in the late 19th century as they explored the uncharted waters of synthetic dye manufacture. They expanded their scientific/technological networks by establishing contacts with university professors and by leading in the creation of the fundamental research-oriented Kaiser Wilhelm Society in 1912 [2, 15]. One of the major corporations later becoming a corner stone of I.G., the BASF, literally saved the German army from defeat in 1915 with its production of synthetic nitrogen for explosives manufacture. As Thomas Hughes and Helmut Tammen have shown, the firm's race into this field acquired a technological and economic momentum into methanol and gasoline production which took advantage of its scientific/technological network and experience, economies of scale, and search for new markets [19, 32].

BASF already had strengthened its position by joining in the merger and reorganization of the major German chemical firms into the I.G. Farbenindustrie. Integrating their corporations horizontally and vertically as early as 1904, the managers of Germany's major chemical corporations organized I.G. Farben into a multidivisional corporation in 1925. The master builder of this organization, Carl Duisberg of Bayer A.G., had based many of the innovations on his observations of large American corporations [2]. Duisberg also adopted many techniques of American corporate political lobbying in influencing members of the Reichstag [32]. The resulting firm was by far the largest chemical firm in Germany, its capitalization of RM 646 million elevating the company to one of Germany's largest [22]. Yet its leaders did not rest. The firm's aggressive R&D efforts, representing 13% of its sales in 1927-29, was just one indication of its commitment to growth in Germany and the world [32].

I.G.'s quick entrance into the gasoline-from-coal field brought a number of problems, however, and the firm was forced to seek state aid. Problematic catalysts and doubled production costs for the gasoline process, coupled with a drastic decline in the price of imported petroleum with which BASF had to compete, forced the firm to seek reduced transportation charges from the government-owned railroad and, particularly important, higher import tariffs on foreign petroleum. Although the I.G. had avoided reliance on the government more so than the coal community or the alcohol producers, the firm soon became an expert in influencing the government. It developed the most sophisticated lobbying apparatus, which encompassed not only substantial contributions to center/right parties and personnel within the cabinet and Reichstag, but also massive economic and political departments that created data and coordinated lobbying efforts. It sought to woo the Nazis to a more favorable economic policy [5, 6, 19, 32, 40], although it trailed heavy industry and the Junker aristocrats in this activity.

Jersey Standard's and I.G.'s efforts to build their patent webs and expand their businesses helped the companies grow more alike in several

ways. The initial Jersey purchase of I.G.'s hydrogenation rights outside Germany in 1929 for $35 million was only the beginning of an evolving relationship, including sharing of patents and know-how in hydrocarbon fields. Jersey used the catalytic hydrogenation experience and its commanding technical and economic position to organize six other international firms in what John Enos has called the greatest R&D venture before the Manhattan Project: the development of the fluid-bed catalytic cracking process of making gasoline. Not only did I.G. participate in this consortium, but it also gained valuable synthetic rubber technology from Jersey in the late 1930s. The two firms established this mutual relationship, but they also worked increasingly with their nation's military (I.G. more than Jersey) in developing fuels needed in war [12, 24, 31].

The Successful Independents

Several medium-sized firms in the liquid fuels industry adopted some of the new techniques of doing business, but steadfastly avoided multidivisional--and in many cases corporate--organization. These companies were partly or entirely under the direction of founding or family members. The U.S. firms managed this feat principally by adroit use of science, technology, and business methods, and they had the advantage of a booming commercial gasoline market. German firms followed similar strategies, but in their fragile liquid fuels market they capitalized on their political connections to garner government benefits as well.

Sun Oil Company under the Pew family is perhaps the ideal example of an independent oil company that astutely employed most of the successful tactics of American businessmen in the 1920s, save one: relinquishing family control of the firm. Although Gus Giebelhaus calculates that Sun Oil could have grown even more in this boom decade had it expanded its capital through public sale of stock, the Pews--including the sons of the founder--steadfastly refused to do so. The father had successfully dodged the Standard Oil Company in the late 19th century, and his sons continued to emphasize the values he taught them of hard work, independence, the family business structure, exploration and use of the best technology, and as little contact as possible with the government [17]. The second generation did adopt new tactics, notably in technology and science, but their entrepreneurialism affected even these new methods.

The Pews remained in control of Sun Oil well through World War II. The patriarch, J.N. Pew, Sr., constructed his business in Pennsylvania and Ohio using nephews and sons, and the second generation continued to control the firm. They took advantage of opportunities in World War I and the 1920s and 1930s while following a conservative financing program. But because of wise business and technical decisions, and a growing industry, Sun Oil prospered. After the firm entered the gasoline market, Sun's refining capacity zoomed from about 3,200 barrels per day in 1920 to 44,000 bpd in 1928 and 56,000 bpd by 1937.

The entrepreneurial spirit and family firm mentality influenced directly Sun's technology and scientific research. The Pews were so independent that they always strove to develop, own, and operate their own

technologies. Having some technical training among their number, they were astute in choosing the Cross cracking process in 1922--a technically superior process because of its high pressures [18]. Yet the Pews chafed at paying royalties on this process that soon became part of the Patent Club, of which the old nemesis, Jersey Standard, was a member. By 1928 Sun had experimented with high temperatures and pressures, constructed its own processes, and escaped the technological clutches of the other firms. Hoping that an in-house scientific research and development laboratory would aid them in their technological race, the Pews began to construct one in 1928. Although their chief scientist explored some promising avenues, the firm's limited resources, small organization, and lack of coordination restricted the lab's contribution to improved cracking and technology in general. The family compromised its independence only slightly by joining forces with a scientific entrepreneur, Eugene Houdry, whose fixed-bed catalytic cracking process offered the technological breakthrough that Sun, along with Socony-Vacuum, could refine and develop [12, 17, 18]. Despite this great achievement, however, Sun's small organization and the ad hoc research and development arrangement with Houdry and Socony-Vacuum delayed further improvements. Only the multinational corporations marshalled the resources, talent, and organization to move to the more complex and efficient fluid bed process. Characteristically, Sun Oil refused to join this cooperative venture in 1938.

Sun Oil also challenged its competitors by using innovative marketing strategies for its gasoline, and in so doing helped spur the Ethyl Gasoline Corporation and the other majors to redefine gasoline in the minds of the public by inventing the octane rating in 1928-1931. Sun's aggressive marketing of its gasoline, by emphasizing its anti-knock capacity and using a blue dye along with similar tactics by other marketers to identify their gasoline in relation to leaded gasoline (which by law was tinted red), challenged the Ethyl Corporation to design another measure of anti-knock gasoline [16, 25, 29]. Ethyl's scientists spearheaded the creation of the octane rating in 1926 and cooperated with auto and oil associations and the Bureau of Standards in refining the scientific measure. Ethyl and General Motors increasingly raised the rating in top quality cars and thus forced Sun to seek out and develop the catalytic Houdry process to boost its antiknock rating [11, 25, 36]. Companies employing strategies with science, technology, and marketing thus pushed and pulled each other along the path of production in a consumer society.

Throughout the period Sun avoided most attempts to cooperate with government authorities, a tactic that backfired in World War II. The two sons of the founder, J. Howard and J. N. Jr., were particularly adamant in their free enterprise stance. Only with the prodding of a cousin in the Southwest oil fields did the family finally support government aid in controlling crude oil production in the mid-1930s. An internal Sun Oil review found in 1943 that Sun's lack of goodwill with the military retarded the wartime use of its catalytic cracking process, which was the only one available in the late 1930s and very early 1940s [12, 18].

Yet another U.S. firm that blended entrepreneurial strategies with techniques of the 20th century was the Universal Oil Products Company.

Its success offered numerous independent refiners a reasonably priced cracking process, and thus a good chance to retain their family-oriented structure while adopting an advanced technology. Far from being a corporation, UOP had been bankrolled by J. Ogden Armour; only a few engineer/managers led the process design firm. Yet it was highly innovative in the construction of patent webs and advertising campaigns to appeal to many independent oil refiners. The UOP leadership carefully constructed a formidable patent foundation in thermal cracking, but they also added practices such as clean circulation, which was particularly valuable in cracking heavy charging stocks. Other successful tactics included its aggressive intimidation of all other major cracking processes and the defense of its licensees from possible lawsuit. It thus provided small and mid-sized refiners (with as little daily capacity as 2,000 barrels), as well as large, integrated firms like Shell and Socal, an opportunity to use a cracking process at a moderate royalty and thus survive or prosper [12].

The UOP also used innovative advertising to appeal to many independent refiners unused to modern concepts of science-based technology. Employing the symbols and metaphors of independent businessmen and farmers, the UOP appealed to the smaller refiner who was many times baffled in the early 20th century by the new and sometimes conflicting measures, tests, and terms of the oil industry. These were the yeoman of the oil industry, who threw up skimming plants to heat and distill oil in the 19th century style. The UOP capitalized on their confusion and appealed to them with common sense or bucolic terminology [27].

Also picking and choosing from newer strategies in the liquid fuels business were German coal industrialists, who dominated smaller companies and yet innovated in science, technology, and government influence. These coal barons included such names as Stinnes, Krupp, Thyssen, and Kirdorf. They still retained considerable power within their firms--even if the firm had been incorporated. Sizes of companies ranged from the smallest mines to medium/large firms, the latter with capitalizations of RM 50 to 200 million by 1925. Some consolidation by firms like the Gelsenkirchener Bergwerks A.G., and particularly the Vereinigte Stahlwerke A.G., had occurred in the mid-1920s, which facilitated rationalization of mines and coke plants [22]. Still, the pattern for the Ruhr firms since the late 19th century was to join in cartels to market coal and then to coordinate the fuel's by-product lines, such as nitrogen, benzene, and tar. The Benzene Association originated before World War I and prospered thereafter, particularly because of the fluid's effectiveness in high compression German motors [30].

The coal industrialists linked their strategies of joint business efforts with research and development plans in the post-1912 period. Valuing science, the coal barons all had relatively small testing laboratories. But they realized that there were many other potential products that could originate with coal and coal-related chemistry and that the I.G. Farben companies presented a rising competitive threat in hydrocarbon chemistry. They thus formed another combination in 1912 to promote fundamental research in coal, the Kaiser Wilhelm Institute for Coal Research. The head of the Institute, the talented chemist Franz Fischer, discovered the valuable

Fischer-Tropsch process of liquefying coal using a discarded I.G. Farben experiment. He and his staff then researched proper catalysts and production techniques to begin commercialization in the mid-1930s [13, 23].

Although the coal industrialists sought the advantages of large-scale operations in business and science-based technology, their refusal to operate integrated research and development laboratories resulted in complicated chains of command, lack of responsibility and coordination, remnants of competitive misgivings of partners, and a paucity of funds for the long-term project. Post-war economic crises exacerbated already complicated and uncertain financing arrangements. And taking the Fischer-Tropsch process into production required not only the organization of a development consortium, but also cooperation with the commonly-owned Ruhrchemie A.G. [3, 13]. Like Houdry and Sun Oil, they managed to discover a commercially viable process, but they lacked the economic and technical resources to expand upon their discoveries in the same manner as the multidivisional corporation, I.G. Farben.

The greatest difference between the successful entrepreneurs in each nation was their relationship with the state. As the Pews and many independent U.S. firms desired only a limited, policeman-like government, Germany's depressed economy, its need for domestic liquid fuels, and the political disposition of its smaller and mid-sized firms encouraged their search for state aid. Compared with I.G. Farben, which sought help from the government as a last resort, the Ruhr industrialists--and particularly the nobility-dominated alcohol producers--more readily initiated pleas for state subsidies [5, 6]. The German tradition of cooperation with and regulation of agriculture and industry remained more important for these older forms of business than for the chemical corporations. The Coal Barons relied on more traditional forms of political influence, such as personal ties or campaign contributions, rather than the more innovative I.G. with its political department and economic think tank.

German alcohol producers provide yet another example of businesses which retained older strategies while adopting new concepts. While they relied on cartels and governmental patronage, they innovated in science and technology to achieve success. Dominated by East-Elbian landholders and aristocrats, this group had strong ties with the bureaucracy and considerable pull with conservative parties. Without the Weimar government's ample subsidies, German alcohol for motor vehicles would not have been commercially viable. But with aid throughout the Weimar era, continued under the Nazis, alcohol constituted about 10% of the German motor fuel supply by the 1930s [4, 33, 37].

Similar to the coal barons in organization and research, the alcohol producers retained individual control over their small distilleries through a cartel organization and yet explored scientific and technological avenues, often with government's help. Before the end of the 19th century they formed an alcohol cartel to establish higher prices and seek new markets. The alcohol-from-potatoes distillers numbered 6,000 in 1913 and produced 80% of the nation's alcohol. In response to the declining consumption of alcoholic spirits, this cartel (Verein des Spiritusfabrikanten) promoted alcohol's use in automobile engines. Aided directly by the national

government, the alcohol cartel evolved into a monopoly and established a Power Alcohol Company to increase alcohol's use as a motor fuel. Having seen the value of research and development in agriculture, these producers were successful in garnering state aid for an Institute for Commercial Fermentation in Berlin, along with regional research. Engineers and scientists explored the development of more efficient production processes and new methods of mixing alcohol with other motor fuel constituents [21].

Failed Innovators

Mention needs to be made of another group of businessmen who were anxious to innovate, but whose decisions led to failure. These ranged from independent U.S. oil men, whose unscientific efforts at technical innovation were doomed from the outset [26, 27], to Friedrich Bergius of Germany, who acquired basic patents in synthetic fuel manufacture before I. G. Farben. Only after Bergius failed in leading both the scientific investigation and the business organization of his process did he sell his rights to I.G. Farben in 1925 [14, 37].

Conclusion

With this brief look at the liquid fuels industries of the U.S. and Germany during a period of growth and turmoil, we find a bevy of firms in conflict, all inventing and adopting new approaches to business, technology and science, and government representation. There were clear leaders, such as Jersey Standard and I.G. Farben, and there were a number of major oil firms that adopted similar strategies. But even in an industry prone to economies of scale and scope, many medium and smaller sized businesses deliberately chose not to change their business organization, while at the same time they sought innovative approaches to technology and science, and sometimes tested the mettle of the industry's best. This testament to the strength of business individualism existed in both nations despite their varied resource bases, cartel laws, and political traditions. Thus in these two western capitalist nations, a "modern" business organization did not necessarily have to accompany a "modern" view toward technology and science. The nature of government relationships in both nations also appears to have been quite complex. All firms tried to avoid it, and those seeking it were motivated by a number of factors: necessity, national traditions, changes in the fuel market, the health of the economy, and former relationships.

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