

Samuel Wetherill, Joseph Wharton, and the Founding of the American Zinc Industry

THE TWO people most closely associated with the founding of the zinc industry in the United States were the Philadelphians Samuel Wetherill (1821–1890) and Joseph Wharton (1826–1909). From 1853 to about 1860 they variously cooperated and competed with each other in setting up commercially successful plants for making zinc oxide and metallic zinc for the Pennsylvania and Lehigh Zinc Company at South Bethlehem, Pennsylvania.

Both did their work in the face of an established and successful zinc industry in Europe. Accordingly, they looked to Europe for standards governing efficiency of production, quality of product, and the arts of management and marketing. They had to surpass at least some of these standards in order to establish the domestic industry on a firm basis.

Zinc is a blue to grey metal found in deposits throughout the world. It is used for thousands of products, for example, in the fields of medicine, cosmetics, die casting alloys, galvanizing of iron, paint, rubber, ceramics, plastics, chemicals, and heavy metals. It ranks “only behind aluminum and copper in order of consumption among the nonferrous metals.”¹ In short, it has from an early stage in the Industrial Revolution been essential to the maintenance and progress of a technological society.

The industry has two main branches. One is the manufacture of zinc oxide. The other is the making of metallic zinc or spelter, as it is called in the trade. These industries are relatively new in the western world. Portuguese and Dutch traders brought spelter to Europe from the Orient about the seventeenth century. In all

¹ *Metal Statistics*, 65th ed. (New York, 1972), 301.

likelihood the techniques used for making zinc in Europe also came from the East. The refinement of the metal in the West began in the eighteenth century; and about a century later the manufacture of zinc oxide was started.

These industries in spelter and oxide are closely related to another which is ancient. This is the manufacture of brass, an alloy of approximately seventy per cent copper and thirty per cent zinc. The brass industry existed long before anyone knew of zinc in its pure form. Someone—or more likely various people at different times and in different places—discovered that copper, heated in a bed of a certain sort of earth, took on a lustre similar to that of gold. It was not necessary to know that this special earth was an ore of zinc today called calamine. One needed only to identify the special earth as that which produced a metal in the same general class as bronze, an alloy of copper and tin. Brass was probably known to some civilizations of the Middle East several thousand years before the Christian era. The Romans used it for coins and other objects at least by the first century A.D.²

In both Europe and the United States the industries in spelter and zinc oxide developed independently of the manufacture of brass. As an example of this, a copper and brass shop, later made into a foundry, existed in Bethlehem, Pennsylvania, from 1832. Its operation had nothing to do with the establishment near there of the zinc industry; nor did it originally use the ores located in nearby Upper Saucon township.³

In reviewing the European beginnings of the manufacture of zinc and zinc oxide, it is desirable to distinguish between the science of zinc, the process of making the metal, the techniques used in the process, and the industry. These four fields of endeavor—science, process, technology, and industry—developed pretty much together in the case of zinc. One can meaningfully contrast the situation with the establishment of the anthracite iron industry in the United States, in which the process for making anthracite iron preceded by several years the development of a viable technology, and both

² Walter R. Ingalls, *The Metallurgy of Zinc and Cadmium* (New York, 1903), 1–2; John Percy, *Metallurgy* (London, 1861), 518–528; R. J. Forbes, *Metallurgy in Antiquity* (Leiden, Netherlands, 1950), 272–289.

³ Joseph M. Levering, *A History of Bethlehem, Pennsylvania* (Bethlehem, 1903), 717.

were well in advance of an understanding of the chemical reactions involved.⁴ That is, in the anthracite iron industry the pioneering engineers operated mostly on the basis of experience and hunch, whereas Wetherill and Wharton, and their predecessors in Europe, heavily depended on a knowledge of chemistry.

A clue as to why the chemistry, process, techniques, and industry in zinc developed in concert is to be found in several peculiar properties of the element. At ordinary temperatures zinc is relatively inert, a quality which in the early nineteenth century led to using it as a roofing material and somewhat later as a means for galvanizing iron to prevent rust. But as the temperature rises to about 434° C., the melting point, zinc becomes active. In the presence of oxygen it catches fire and burns brightly, forming the dense white smoke known as zinc oxide. If the heating of the metal is continued in the absence of oxygen, then about 940° C. the zinc is volatilized. Now, this temperature is still below that needed to release zinc from its ore.

That, basically, is why zinc in its pure form remained unknown for so many millenia. When early manufacturers calcined ore to the temperature at which the zinc could be released, it either oxidized and escaped with the smoke or, if a strong reducing agent such as carbon or iron were present to take up the oxygen, it escaped as pure zinc vapor.⁵

These properties also help to explain why some zinc ores were for many years incorrectly identified, although their existence as a "strange mineral" was known. The ore in Sussex county, New Jersey, now known as red oxide of zinc was before the American Revolution thought to be red oxide of copper. When the mine failed to yield the anticipated copper, its owner, Lord Stirling, abandoned it.⁶ Similarly, the ores of Upper Saucon were known long before they were correctly identified. These ores were primarily calamine, a carbonate of zinc, and electric calamine, a hydrosilicate of zinc. About 1830 a wagonload of the unknown mineral was hauled to

⁴ W. Ross Yates, "Discovery of the Process for Making Anthracite Iron," *Pennsylvania Magazine of History and Biography* [hereinafter *PMHB*], XCVIII (1974), 206-223.

⁵ Forbes, 275. A discussion of the properties of zinc can be found near the beginning of most of the standard texts on the metallurgy of zinc, for example, Percy, 531-548.

⁶ C. T. Jackson, "On the Manufacture of Zinc and Zinc White," *Proceedings of the American Association for the Advancement of Science* (Washington, D. C., 1850), IV, 335.

the Mary Ann iron furnace in Berks County, Pennsylvania, for testing. In the high heat of the blast furnace all the zinc escaped.⁷

This effect would also result from attempting to refine a fourth commonly found ore of zinc, namely, blende or black-jack, which is a sulphide of zinc. When blende is roasted the sulphur is driven off and replaced by oxygen, so that at the higher temperatures the manufacturer is also dealing with oxide of zinc.

Additionally, the tendency of heated zinc to combine with oxygen, or to lose its oxygen to some strong reducing agent, and the tendency to cement with copper and some other metals, indicates a need to refine zinc ore in chambers which are chemically inert and highly resistant to cracking in intense heat. Some clays have these desired qualities.

Put together, these properties suggest that a usable process for refining the ores of zinc would involve reducing them and distilling the volatilized spelter in clay vessels. As soon as the early European manufacturers understood these chemical properties of the metal they were able to articulate the process and the techniques for putting it into service.

By the time Wetherill and Wharton developed the zinc industry of the United States a considerable literature in English, French, and German on the science and metallurgy of zinc existed.⁸ Yet, one of the most lucid descriptions of the process came from Joseph Wharton in a statement he prepared in 1860 to support a request for a high tariff on spelter. As he explained it, the process consisted of three stages, namely, the preparation of the ore, its reduction in a furnace, and the distillation of the vapor thus released. No matter what techniques were used, the process was the same:

The ore is first calcined, finely pulverized, and mixed with pulverized coal. This mixture is then placed in air tight retorts . . . set in furnaces,

⁷ Benjamin L. Miller, *Lehigh County, Pennsylvania: Geology and Geography* (Harrisburg, 1941), 327.

⁸ For example, both Frederick Overman, *A Treatise on Metallurgy; Comprising Mining, and General and Particular Metallurgical Operations* (New York & London, 1852) and John A. Phillips, *A Manual of Metallurgy* (London, 1852), describe the process and techniques of making spelter and zinc oxide. Another useful source concerning this and the establishment of the industry is to be found in the article, "Zinc" in *New American Cyclopaedia* [hereinafter *NAC*] (New York, 1863), XVI, 635-647. A perusal of the footnotes in Percy, 518-605, will give an idea of the extent of the literature on zinc before 1861.

each furnace containing as many retorts as can be properly heated, and tended; the furnaces must be strongly built, and yet so formed as to allow full access to all the numerous retorts for the purposes of charging, cleaning, and replacing them; the retorts must be air-tight, strong, and capable of enduring the fieriest heat. . . . The furnaces are so strongly heated as to bring the retorts with their contents to a full white heat, which causes the carbon of the coal to take oxygen from the zinc ore, thus liberating the metallic zinc . . . this zinc vapor escapes into condensers attached to the retorts where it cools sufficiently to assume the liquid form and whence it continually trickles, or is drawn at certain intervals according to the construction of the apparatus. This operation combines the processes of reduction and distillation, and does not succeed without great care, since a bad material for the retorts, a variation in the heat of the furnace, a wrong proportion of the ingredients of the charge, a want of skill or punctuality in the workmen, or an accident to a furnace may cause considerable loss almost imperceptibly; in fact a difference of one third of the entire yield may readily occur between the quantities produced by two sets of workmen unequal in skill, but consuming the same quantities of materials and having in all other respects equal advantages.⁹

No matter what techniques were used, the ore first had to be properly prepared. A stream of water strong enough to knock loose the clay, etc., was used to wash it. Then a group of boys or women picked the ore over, removing useless rock and other impurities. The concentrated ore was ground and put into a calcining furnace specially built for the purpose. Different sorts of ore needed different types of furnace. For example, blende had to be ground more finely and burned for a longer period of time than did calamine. When the ore had been calcined, it was ready for the reduction furnace.

By 1850 three types of reduction furnace were being used, known respectively as the English, the Silesian, and the Belgian. A fourth, called the Carinthian, had already been discarded. All were strongly built brick structures consisting of two chambers, one on top of the other. The upper chamber was the oven containing clay retorts. The lower had the fire.

The English furnace was octagonal in shape. It contained relatively large retorts or pots, about eight to a furnace. The distilled zinc was collected *per descensum*, that is, through a system of nozzles and condensers attached to the bottom of the pot. The

⁹ Box 10, Wharton Papers [hereinafter WP], Friends Library, Swarthmore College.

English system consumed large quantities of coal and produced less zinc in a given period of time than did the Silesian or the Belgian furnaces. It was the least used of the three at the time of the establishment of the industry in the United States. About 1860 it was abandoned altogether.¹⁰

The Silesian and Belgian furnaces were rectangular and adapted to distillation *per ascensum*. The most obvious differences between the Silesian and the Belgian furnaces involved the size, shape, number, and arrangement of the retorts or muffles, as small retorts were often called. Those in the Silesian furnace were the larger. Wharton described them as being "shaped like a thick book set on its flat edge."¹¹ The oven of the Silesian furnace contained six equal and similar arched recesses on each side. A recess had two muffles laid flat. A system of nozzles and condensers attached to the top of one end of the muffle conveyed the distilled zinc out of the furnace.

The muffles of the Belgian furnace were small and cylindrical and were arranged in parallel rows one above another. Each was tilted slightly downward toward the end to which the nozzle was attached. These muffles contained a maximum charge of about fifteen pounds, as compared with the approximately fifty pounds that a Silesian muffle could hold.

The Belgian system used less coal and produced more zinc in a given period of time than did the Silesian. On the other hand, the Belgian method used more labor, and the men worked harder and suffered more from the heat than did the workmen employed in the other two systems.

In Europe the commercial production of spelter preceded that of zinc oxide by a good many decades. The reasons for this are to be found in the nature of the markets and the belated development of a technique for making the oxide. By 1805 ways had been found to make pure zinc malleable, so that it could be rolled in sheets. With this breakthrough the use of zinc for roofing and packaging quickly developed.¹² In the 1840s manufacturers began to employ zinc for galvanizing iron; and there was the trade in brass—although the makers of brass were somewhat reluctant to change their ways,

¹⁰ Percy, 550-595; Phillips, 418-427.

¹¹ "Statement on Manufacturing Zinc and Spelter in the United States," Box 10, WP.

¹² A. Lodin, *Métallurgie du Zinc* (Paris, 1905), 8.

arguing that calamine produced a better quality of brass than did pure zinc.

By mid-century the European spelter industry was well established. Plants existed in England, Sweden, Silesia, Prussia, Poland, Belgium, Hungary, France, Spain, and probably in other countries. Most of the works were small, capable of producing only a few tons of spelter a day. The largest and most renowned was at Moresnet, near Aix-la-Chapelle. This factory used the deposits of calamine and other ores at nearby La Vieille Montagne. In 1837 the operation was incorporated as the *Société de la Vieille-Montagne*.

In general the manufacturers of spelter operated their own mines and clay pits and with the exception of heavy machinery made most of their own utensils and equipment. The workmen were few and highly skilled, possessing a number of trade secrets which they carefully concealed from competitors. The superintendent adopted a paternalistic attitude toward his employees. Like an early iron-master he was expected to know all phases of his operations, from the prospecting for ore to the marketing of the finished product.¹³

By modern standards the quantities of spelter produced in the pioneer days of the industry were small, although the rate of increase in production was great (e.g., 340% from 1830 to 1840).¹⁴ Wharton estimated that by 1854 the world production of spelter had grown to 30,930 long tons, distributed as follows:¹⁵

Country	pounds	long tons (2240 lbs.)
Silesia	44,000,000	19,600
Belgium	13,200,000	5,890
Germany, Poland, Spain, etc.	9,900,000	3,970
England	3,300,000	1,470
	<hr/> 70,400,000	<hr/> 30,930

¹³ *Ibid.*, 8-9; Ernest A. Smith, *The Zinc Industry* (London, 1918), 10-18. For a description of zinc mining operations in Europe see J. D. Whitney, *The Metallic Wealth of the United States Described and Compared with That of Other Countries* (Philadelphia, 1854), 340-346.

¹⁴ "In 1830, the total production of spelter in Europe was less than 5,000 tons, and in 1840, ten years later, the total output had only reached a little more than 17,000 tons." Smith, 14. By contrast, in 1971 the consumption of slab zinc in the United States was 1,187,000 tons, of which 43,800 tons were used for making oxide. An additional 200,000 tons of oxide were also consumed. *Metal Statistics*, 65th ed., 301.

¹⁵ "Statement on Manufacturing Zinc and Spelter in the United States," Box 10, WP.

The industry in zinc oxide began about 1845. Although the use of zinc oxide as a pigment for making white paint had been demonstrated as early as 1780, a successful commercial operation did not begin until the Vieille-Montagne company found a simplified way of making it—the company burned spelter, collecting and condensing the smoke as it was formed. As Wharton once wrote to his agents in London, “The whole trade in zinc oxide is very recent. I remember the first casks of French which were introduced into this city [Philadelphia]; they were sent by the workers to my brother and myself, who were then [*circa* 1847] White Lead Manufacturers, to sell on commission. . . . Even the few sample casks could not be sold without much trouble.”¹⁶

In the United States several rich deposits of zinc ores were discovered and correctly identified a number of years before anyone attempted to exploit them commercially.¹⁷ The deposits at Franklin and Sterling Hill in Sussex County, New Jersey, in addition to once being incorrectly thought to contain much copper, were later wrongly considered to include magnetite, a variety of iron ore prevalent in northern New Jersey. In fact, they contained no substantial amount of copper, although they did have much iron mixed with zinc in a peculiar ore found nowhere else, to which the name Franklinitite was given. They also contained a red oxide of zinc called zincite. The red color came from the presence of manganese. This ore, too, at the time of its discovery was found nowhere else.¹⁸ A third ore in the deposits was willemite, a silicate of zinc. These ores were correctly identified by 1824. The combination of these ores with a large variety of other minerals and trace elements made the deposits at Franklin and Sterling Hill two of the most complex bodies of zinc ore found anywhere.¹⁹

The deposits in Upper Saucon Township were identified somewhat later. A strange mineral on the farm of Jacob Ueberroth had for years been known to exist, but early attempts to find out what it contained had failed. Finally, in 1845 Ueberroth took samples to

¹⁶ Wharton to Coates & Co., Dec. 18, 1857, Box 10, WP.

¹⁷ Whitney, 347–353, describes the various deposits of zinc known by 1854 to exist in the United States.

¹⁸ Phillips, 411.

¹⁹ Kemble Widmer, *The Geology and Geography of New Jersey* (Princeton, 1964), 34–36; Lodin, 23–24.

William Roepper, an administrator for the estates of the Moravian church in the nearby Borough of Bethlehem. Roepper was also a chemist, geologist, and metallurgist of considerable talent. When in 1865 Lehigh University was founded he joined the faculty as Professor of Geology and Mineralogy. Roepper tested the ore in the local brass foundry of Lehman & Brothers and pronounced it to be calamine of excellent quality.²⁰

Still, the development of the industry lagged. At the request of the United States government, the Swiss Consul John Hitz in 1838 made some spelter from the zincite of New Jersey which was used at the United States arsenal in Washington, D. C., to manufacture brass for a set of standard weights and measures. Not until 1850 was the first serious commercial operation attempted.²¹

Why was the zinc industry so late in getting started? Markets for zinc oxide and spelter existed; the deposits in New Jersey and Pennsylvania were located close to canals which could provide the necessary transportation to nearby port cities. Fuel and water power were available. No great amounts of capital or labor were needed. Americans were psychologically ready to exploit the mineral wealth of these areas, as the previous development of the coal and iron industries showed.

Yet early tries at founding a zinc industry ended in failure. In Pennsylvania Roepper interested Robert Earp, a Philadelphia merchant, in leasing the Ueberroth property. Earp sent nine tons of the ore to England in one of his ships. It was tested in English furnaces, which were not hot enough. Word came back that the Saucon ores could not be used.²² In New Jersey the Sussex Zinc and Copper Mining and Manufacturing Company was formed in 1848, and the New Jersey Exploring and Mining Company a year later, to work the deposits at Franklin and Sterling Hill respectively.²³

²⁰ Richmond E. Myers, "The Story of the Zinc Industry in the Saucon Valley, I" *Rocks and Minerals* (February, 1935), 18.

²¹ Joseph Wharton, "Memoranda concerning the introduction of the Manufacture of Spelter into the United States," *The American Journal of Science* (New Haven, Conn., July-December, 1871), 168; Walter R. Ingalls, *Production and Properties of Zinc* (New York & London, 1902), 13.

²² Myers, I, 18; Miller, 327.

²³ The New Jersey Zinc Company, *The First Hundred Years of the New Jersey Zinc Company* (New York, 1948), 11.

Richard Jones, working for the Sussex company, attempted to make spelter by using Belgian retorts. "The experiment proved a failure owing to excessive breakage of the retorts due to the high tenor of the ore in iron and manganese."²⁴

As Frederick Overman put it in 1852, "the low price of the European article renders it unnecessary to use our rich deposits of this ore."²⁵ That was a polite way of saying that the Americans were as yet unable to compete successfully with the Europeans in making spelter and zinc oxide.

The reasons were to be found in the complexity of some of the ores, the failure of manufacturers to understand the requirements of the process for making spelter, and in general the lack of technical knowledge and the necessary mechanical skills. Yet, while manufacturers were seeking to overcome these obstacles, they found a cheaper way of making zinc oxide than the method used in Europe. In large part this was because in anthracite they had a better fuel. Anthracite could provide a white heat relatively free of unwanted gases. Zinc ore burned with anthracite could produce an oxide which could be fairly easily separated from impurities, collected, and condensed to marketable form.²⁶

Men of the Sussex company shortly devised a furnace for making zinc white. The furnace did not manufacture the oxide directly from the ore. Zincite was first separated from the Franklinite and was then reduced in retorts similar to those used for making spelter. The vaporized zinc was burned to form oxide of zinc as it escaped from the retorts. The company reported its findings to the American Association for the Advancement of Science. Samples of the finished product were produced at a meeting in 1850 and the process was duly described in the *Proceedings* of that society, together with the statement, "Not only is the zinc ore used for making zinc white, or metallic zinc, as may be required, but the ground ore itself is made into an orange colored paint of value. And the Franklinite is ground

²⁴ Ingalls, 13.

²⁵ Overman, 456.

²⁶ Abram S. Hewitt, "A Century of Mining and Metallurgy in the United States," *Transactions of the American Institute of Mining Engineers* (May, 1876-February, 1877), 174, writes that the manufacture of zinc oxide directly from the ore would have been impossible without anthracite. However, at the time he wrote most metallurgists would probably not have taken this extreme view.

and used for a brown paint, and also for desulphurizing sulphurous cast iron in the puddling furnaces."²⁷

Members of the Franklin Institute of Philadelphia also discussed the product. The presentation emphasized the nonpoisonous nature of paint made with zinc white and went on to comment, "It is a purer white, covers as well as the first quality white lead, and does not require a greater number of coats. . . . The price, at present, is double that of lead, but, on account of its lightness, it will cover a much larger surface. The New Jersey specimen was as white as the French, and sold at a less price, they having improved very much in its manufacture since last March. . . ." ²⁸ Patents for various aspects of this process were granted in 1854 to Richard Jones of Burlington County, New Jersey, and to Jonathan G. Trotter and James Renton of Newark.²⁹

The invention of this process was a step toward establishing the zinc oxide industry in the United States, although by itself it did not do the trick. It did, however, lead to a combination of the two New Jersey companies into one, known as the New Jersey Zinc Company.³⁰ A few years of experience with zinc white made in this way from the Sterling Hill and Franklin mines showed that it was distinctly inferior to the French oxide. Paint manufacturers continued to use mostly white lead; and if they wished to improve the quality of their product by using zinc oxide, they generally bought the French article. In sum, the New Jersey ores proved intractable. In order to remain in business the New Jersey Zinc Company began to make its own paint and to market it.

This marked a significant development of the ready-mix paint industry of the United States. As Joseph Wharton explained the situation in 1857 to his London agents, "The course of the paint trade in this country is generally for one class of manufacturers to make the dry paint bodies while others grind them in oil for painters' use. Some concerns however unite the two operations, and the writer feels little doubt that the paint which was offered to you

²⁷ C. T. Jackson, "On the Manufacture of Zinc and Zinc White," *Proceedings of the American Association for the Advancement of Science* (Washington, D. C., 1851), 337. A description of the furnace appears in *ibid.*, 336-337.

²⁸ *Journal of the Franklin Institute* [hereinafter *JFI*] (January, 1851), LI, 67. See also "Zinc Paint," *The Mining Magazine* (New York, July, 1853), 87.

²⁹ *JFI* (1854), LVII, 316, 319, 253.

was that of the New Jersey Zinc Co. . . . who grind much of their dry oxide into paint, on account of its inferior reputation with paint grinders."³¹

The New Jersey Zinc Company spent much of its time in the early years of its existence in mining zinc ore for the manufacture of paint. In an advertisement in the *New York Tribune*, 1854, the company offered for sale white zinc paint "dry or ground in oil" as well as brown and stone-colored zinc paints, and declared that "A method of preparation has recently been discovered which enables the Company to warrant their Paints to keep fresh and soft in the kegs for any reasonable time."³²

The New Jersey Zinc Company continued to hunt for a better process of making zinc oxide. It employed at that time as superintendent a young man named Samuel Wetherill, who succeeded—but not to the immediate advantage of the New Jersey Zinc Company.

Samuel Wetherill belonged to a Quaker family of chemical manufacturers and merchants. His grandfather, also named Samuel and the most famous of the line, had played a leading role in 1775 in founding the United Company of Philadelphia for Promoting American Manufactures.³³ Early in the Revolutionary War Samuel had been read out of Meeting for contracting for the sale of cloth to the Continental Army for making uniforms. He and others had thereupon founded the Society of Free Quakers. In 1789 he had started the family chemical firm, whose principal item of manufacture and sale was white lead for paint. The firm succeeded in spite of the opposition of English manufacturers.³⁴ When Samuel died the firm passed to his sons. The business continued to prosper, even in times of economic depression, and by 1849 had difficulty in supplying the demand for white lead.³⁵

³⁰ New Jersey Zinc Co., *First Hundred Years*, 11.

³¹ Wharton to Coates & Co., Oct. 5, 1857, Box 10, WP.

³² New Jersey Zinc Co., *First Hundred Years*, 12, 14-15. Also, on the early operations of the Company see "New Jersey Zinc Company," *The Mining Magazine* (New York, August, 1853), 203; and "New Jersey Zinc Company" and "New Jersey Franklinite Company," *The Mining Magazine* (New York, June, 1854), 700-702.

³³ Arthur C. Bining, *The Rise of American Economic Life* (New York, 1955), 229.

³⁴ M. I. Wilbert, "Early Chemical Manufactures—A Contribution to the History of the Rise and Development of Chemical Industries in America," reprinted from *JFI* (May, 1904), CLVII, 7-8, 12.

³⁵ Miriam Hussey, *From Merchants to "Colour Men"—Five Generations of Samuel Wetherill's White Lead Business* (Philadelphia, 1956), 34.

The Samuel Wetherill who went to work for the New Jersey Zinc Company was a son of John Price Wetherill. During his youth young Samuel worked for the family firm and began experimenting with zinc ores with the idea of using them to find a substitute for white lead in the manufacture of paint. In 1850 he joined the New Jersey Zinc Company and within two years had invented a commercially profitable process for making zinc oxide directly from the ore.³⁶

Although this accomplishment was a major advance, little is known of its inventor. Samuel apparently left no collection of papers, and he is seldom mentioned in the writings of other people. Clearly, however, he was imaginative and adventurous, an originator rather than a manager. *The National Cyclopaedia of American Biography* lists his occupation as that of "Inventor."³⁷ Although by breeding a Quaker, he loved horse racing and apparently tolerated gambling.³⁸ He occasionally dabbled in politics.³⁹ With the outbreak of the Civil War he organized a company of cavalry of which he became commanding officer.⁴⁰ Later, in 1865, he was elected a vestryman of the newly founded Episcopal Church of the Nativity in South Bethlehem.⁴¹ His social acquaintances and employees probably found him genial and approachable, although somewhat unpredictable.⁴²

Samuel developed his process in the laboratory by means of chemical experiments and not by trial and error using industrial furnaces.⁴³ Several decades later Charles P. Williams described the Wetherill process thus:

³⁶ Myers, I, 18-20.

³⁷ *The National Cyclopaedia* (New York, 1897), VII, 506.

³⁸ Myers (I, 21) calls both Wetherill and Gilbert "ardent sportsmen and lovers of horses. During the summer hardly a noon hour passed that did not see one or both of these gentlemen willing to contend their favorite horse with any that might be offered."

³⁹ Thus on Aug. 9, 1856, he participated in a large rally at Easton favoring the election of James Buchanan for President and was made chairman of one of its meetings. *Easton Daily Express*, Aug. 10, 1856. In 1861 Wetherill was one of the local representatives to the state convention of the Democratic Party. *Lehigh Valley Times*, Feb. 9, 1861.

⁴⁰ Levering, 743-744.

⁴¹ John P. Chamberlain, et al., *One Hundred Years of Nativity* (Bethlehem, Pa., 1966), 23.

⁴² Myers (I, 21) reports that Wetherill was loved by his employees at the zinc works and gave them a yearly dinner.

⁴³ An article by W. P. Blake of the New Jersey Zinc Company in the May, 1852, issue of *American Journal of Science and Arts*, 417n., refers to Wetherill's experiments.

The furnace is operated by spreading over the grate-bars a layer of anthracite coal (commonly of the size of either "pea" or "nut" coal), which, after thorough ignition, is covered with a stratum of mixed crushed ore and anthracite dust, in the proportion of the two parts by weight of the former to one of the latter. The usual charge is about 600 pounds of the mixture indicated; the weight of the bedding coal is from 250 to 300 pounds. The charge is elaborated in about six hours' time.

In this furnace, under the conditions indicated, there is a rapid reduction of the zinc oxide of the ore to vapor, and an almost simultaneous reconversion of the metallic vapor into oxide. This reduction and oxidation of the zinc, taking place *pari passu*, as it were, in the same furnace chamber, constitutes one of the interesting features of the method, which Wetherill notes, in describing his furnace, as "a compound reducing and oxidizing furnace."⁴⁴

About the time that Wetherill invented his method for making zinc oxide, another employee of the New Jersey Zinc Company, Samuel T. Jones, invented a means of capturing the oxidized zinc. This became known as the "tower" or "bag" process. It became a standard companion of the Wetherill process. A fan blew the oxidized zinc upwards into a tower, where it passed into muslin bags. The oxide condensed out and adhered to the inside of the bags, while the other vapors passed through the mesh into the smoke stack.⁴⁵

Jones received his patent February 24, 1852.⁴⁶ Wetherill applied for a patent in that year and received it in November, 1855.⁴⁷ He also patented an improvement on the tower process⁴⁸ and, later, several improvements on his own invention.⁴⁹

Before the New Jersey company made a decision about using Wetherill's process, he received a visit from Earp, who wanted to know if the New Jersey company would take over his lease on the Ueberroth farm. Wetherill investigated the Saucon deposits and immediately acquired the lease on his own behalf. He then went to the president of the New Jersey company and offered to sell his

⁴⁴ *Transactions, American Institute of Mining Engineers* (May, 1876-February, 1877), 45.

⁴⁵ W. J. Taylor, "Manufacture of the Oxide of Zinc near Lancaster, Pennsylvania," *JFI* (1859), LXVII, 279-280.

⁴⁶ *JFI* (1852), LIII, 252.

⁴⁷ *JFI* (1855), LX, 385.

⁴⁸ *JFI* (1855), LIX, 247.

⁴⁹ *JFI* (1856), LXII, 315; *JFI* (1857), LXIII, 110.

patent to the company, together with the lease. Richmond E. Myers, following an unpublished manuscript by a son of Samuel, written much later, gives the sequel: the directors of the company "refused to meet his figure, even threatening to sue him for his process, which they claimed was theirs inasmuch as he had perfected it in their laboratories. They did offer him five thousand dollars for it, a figure far below his purchase price. When Mr. Wetherill was informed of this action, he sat down at his desk, wrote out his resignation from his position, 'took his hat from the rack, and walked out of the office.'"⁵⁰

Wetherill sought out a friend, Charles T. Gilbert. Together they laid plans for opening a mine on the Ueberroth property and for building a plant to make zinc oxide at a newly laid out town across the Lehigh river from the borough of Bethlehem.

Bethlehem was then an almost solidly Moravian community of about two thousand souls on the north bank of the Lehigh River. Only eight years had elapsed since the authorities of the Church had relaxed their rules concerning sales of land to permit non-Moravians to settle permanently in the community. In the process of doing this the Moravians had sold four large farms on the southern bank of the Lehigh opposite Bethlehem. Several persons bought three of these farms. The fourth and largest was retained by the person in charge of the transaction, Charles Augustus Luckenbach, first Burgess of Bethlehem. A few years later a railroad company, soon to be known as the Lehigh Valley Railroad, was formed and began making plans to connect the anthracite fields north of Mauch Chunk (now Jim Thorpe) with New York and Philadelphia, passing near Bethlehem and Allentown. Luckenbach laid out a plan of a town on his farm, which he called "Augusta."⁵¹ A local lawyer named Charles Brodhead purchased part of the farm adjoining the planned town. Since the iron industry of the Lehigh valley was already booming, Brodhead anticipated the possibility that the United States government might establish an iron foundry at this "Southern Addition to the Borough of Bethlehem," as the new community was being called. His uncle, Senator Richard Brodhead, had married a niece of Jefferson Davis, then Secretary of War, who

⁵⁰ Myers, I, 19.

⁵¹ Levering, 718-722.

had recommended to Congress the establishment of the foundry there. But Congress did not accept the recommendation; the foundry was not built, and Charles Brodhead had the property on his hands.⁵²

Accordingly, Brodhead entertained the prospect of a zinc works on the southern bank of the Lehigh. The deposit of ore was located about four miles south of Bethlehem, a few hundred yards west of the Bethlehem-Philadelphia pike. Wagons could easily haul the ore over South Mountain to the river. The finished product could travel over the Lehigh, the Morris, and the Delaware Division canals and within a few years could go by railroad to either Philadelphia or New York.

Brodhead enlarged the plan of Augusta and in 1853 renamed it "Wetherill" in honor of Samuel's father, who had died the year before. Samuel Wetherill and Gilbert entered into partnership and bought land of Brodhead in the new town. They induced some entrepreneurs to sponsor a company for mining the Saucon ores and for manufacturing zinc paint. In the spring of 1853 a charter for this company was obtained from the State of Maryland, under the name of the National Mining Company. Within a few months the sponsors had the company rechartered under the laws of New York as the Pennsylvania and Lehigh Zinc Company, by which name it thereafter became known. The capital stock was fixed at one hundred thousand shares with a par value of ten dollars. Most of the subscriptions to the stock came from New York City. The first president, Thomas Andrews, was from there.⁵³

The Pennsylvania and Lehigh Zinc Company took over the

⁵² J. Davis Brodhead, *Historical Sketch of South Bethlehem* (South Bethlehem, Pa., 1885), 7n.

⁵³ The most reliable and useful sources concerning the founding and first few years of the Pennsylvania and Lehigh Zinc Company are: Peter Fritts, *History of Northampton County, Pennsylvania* (Philadelphia, 1877), 211-212; Matthew S. Henry, *History of the Lehigh Valley* (Easton, Pa., 1860), 237; *Laws of the Commonwealth of Pennsylvania, Session of 1855*, 603-605; "George Thompson Lewis," *Encyclopaedia of Contemporary Biography of Pennsylvania* (New York, 1889), I, 158-160; "Joseph Wharton," in Herman L. Collins and Wilfred Jordan, *Philadelphia: A Story of Progress* (New York, Philadelphia, & Chicago, 1941), IV, 83; William C. Reichel, *The Crown Inn Near Bethlehem, Penna.* (1872), 143-144; Levering, 720-721; Brodhead, 6-8; Myers, I, 18-21; "Zinc," *NAC*, XVI, 635-647; Whitney, 351; *The Mining Magazine*, (November, 1853), 544-546; (January, 1854), 55, 57, 99-100; (February, 1854), 172, 175; (March, 1854), 289, 292; (April, 1854), 410, 411; (May, 1854), 527, 528; (June, 1854), 643-645.

Ueberroth lease and other properties and assumed overall financial responsibility for the undertaking. It contracted with the firm of Gilbert and Wetherill for mining and manufacturing operations and with James T. Lewis and Company of Philadelphia for marketing the zinc oxide. Gilbert and Wetherill immediately employed Captain John M. H. Kennan, a graduate of the Royal College of Engineers, Sappers, and Miners at Woolwich, England, to take charge of the mines. They personally undertook the task of constructing the oxide works. These were completed October 13, 1853, at a cost of \$85,000. The following year the works burned down—but were quickly rebuilt. The partners opened a barrel works and a paint mill across the river in Bethlehem, using water power from the Lehigh canal.

At that time the market for zinc oxide was good. Production at the new plant went ahead relatively smoothly and economically. According to their contract, Gilbert and Wetherill were to manage the oxide works for a period of twelve years, producing four tons per day, for which the company would pay them a standard price, *i.e.*, fifty dollars a ton, the company furnishing the ore at the works. Gilbert and Wetherill easily fulfilled the terms of their contract. A new trade journal, *The Mining Magazine*, advertised their success, praised the quality of their oxide, and acclaimed the inventiveness of Samuel Wetherill.

Thus, at the time of its inception the zinc works in South Bethlehem was a cooperative undertaking between the Pennsylvania and Lehigh Zinc Company on the one hand and the firm of Gilbert and Wetherill on the other. Each had something the other needed. The company supplied the money and management in coordinating the various activities of mining the ore and of making and selling oxide and paint. Gilbert and Wetherill supplied the process and, of equal importance, the expertise. As Wharton later emphasized, in making zinc oxide and spelter, money, patents, textbook knowledge, and labor were not enough. In addition the manufacturer needed an expertise that could be obtained only from experience in the art of making the product, and of observing others making it and learning their “secrets.”⁵⁴ For this reason alone Gilbert and Wetherill

⁵⁴ “Statement on Manufacturing Zinc and Spelter in the United States,” Box 10, WP.

would be indispensable to the company until such time as others learned the techniques or until other experts could be obtained.

In the spring of 1854 Gilbert and Wetherill were in fairly complete control of the operations of the Pennsylvania and Lehigh Zinc Company and were enjoying their triumph. They planned an enlargement of the oxide works and anticipated a revision of their contract to increase daily production substantially. Even then, however, some other people were engaging in activities which would soon result in shifting control of the company away from the partnership and would eventually eliminate Gilbert and Wetherill from the enterprise altogether.

In 1853 a young man named Joseph Wharton and several friends took a horseback trip through eastern Pennsylvania, visiting the zinc deposits at Friedensville on the way. Shortly thereafter *The Mining Magazine* began reporting very active trading in Pennsylvania and Lehigh Zinc Company shares on the New York Stock Exchange. In the six-months period following December, 1853, 77,400 shares exchanged hands. The reports for February 20 and March 20, 1854, noted large purchases of shares in Philadelphia. The May 20 report announced a complete reorganization of the company.

One may surmise what happened. Several members of the Wharton and Lewis families of Philadelphia, plus a few other Philadelphians, had become convinced of the basic soundness of the new enterprise on the banks of the Lehigh and proceeded to buy up enough stock to gain a controlling interest. They then replaced Thomas Andrews as president with Samuel F. Fisher; and six of them applied to the legislature of Pennsylvania for a new charter. These were Joseph Wharton; his elder brother by about two and one-half years, Charles; George T. Lewis; Charles Lennig; Samuel F. Fisher; and Henry B. Tatham. The charter passed the legislature at its next session and was signed by Governor James Pollock May 2, 1855. The purpose of the reorganized company was that "of mining zinc ore, and other ores found in connection therewith; and of manufacturing zinc paint, metallic zinc and other articles from said ores in the counties of Lehigh and Northampton, and of vending the same or any of them, under the name and style of 'The Pennsylvania and Lehigh Zinc company.'" The capital stock was in-

creased to two hundred thousand shares with a par value of five dollars. Provision was made for exchanging the old for the new stock. Also, as a condition for being granted the charter, the reorganized company was to take over the existing contracts with James T. Lewis and Company and with Gilbert and Wetherill. The charter was to remain in force for twenty years.⁵⁵

In 1855 Joseph Wharton became general manager for the company's operations. From this time the control of Samuel Wetherill over the company began to decline.

Joseph Wharton was the fifth of ten children born to William and Deborah (Rowland) Wharton.⁵⁶ Like Wetherill, he was the son of a Quaker family of merchants and had experience in the manufacture and sale of white lead for paint, but there the likeness ends. By contrast to the colorful and somewhat easygoing Wetherill, Joseph Wharton was disciplined and businesslike. He loved order and possessed a driving ambition which frequently put his Quaker principles to a severe test. Although he had considerable talent in the fields of chemistry and engineering, his greatest genius lay in management and finance. "His keen eye seemed to see physically just what events would flow from given causes. He could apparently look through an entanglement of existing affairs and coordinate their results with unerring foresight. . . . His command of the methods of finance was perfect. He was by instinct a banker. . . ."⁵⁷ Hard work, a preference for simplicity, and a hatred of slavery⁵⁸ were among the qualities which influenced his professional life. He was devoted to his religion and to his family. His letters to Charles and to Elida John, a friend who managed one of Joseph's farms, were couched in a friendly style. The letters to Charles especially were often quite long and contrast in almost every way with the unemotional and brief epistles which Joseph sent to President Fisher.

Wharton was educated for Harvard but did not immediately enroll there. Instead, in 1847 he went to work on a farm for several

⁵⁵ *Laws of the Commonwealth of Pennsylvania, Session of 1855*, 603-605.

⁵⁶ Anne H. Wharton, "The Wharton Family," *PMHB* (1878), II, 214.

⁵⁷ Harrison S. Morris, "Obituary of Joseph Wharton," *Proceedings, American Philosophical Society* (1909), XLVIII, lxxi-lxxii.

⁵⁸ Once he gave as a reason for not accepting an offer to help exploit the rich zinc deposits of eastern Tennessee that he would have to use slave labor, to which he was opposed. Wharton to Stephen Hills, Feb. 13, 1857, Box 10, WP.

years and then joined with another older brother, Rodman, and with Robert Haydock of New York in forming a white lead manufactory, "R. Wharton & Brother," with an office at 101 South Front street, Philadelphia. The manufactory was called the Aramingo Works. After several years of this, the brothers sold the firm to John T. Lewis and Brothers—the brothers here being Saunders and George T., who later became one of the sponsors of the reorganized Pennsylvania and Lehigh Zinc Company. During the early 1850s various of the Wharton and Lewis brothers apparently cooperated on several business ventures. For example, Joseph and Rodman Wharton and George T. Lewis demonstrated that cottonseed cake, far from being a worthless by-product of the manufacture of cottonseed oil, was, properly processed, an excellent fodder for cattle.⁵⁹

As general manager of the Pennsylvania and Lehigh Zinc Company Joseph Wharton was naturally expected to promote and protect its interests. Thus he supervised an agreement between the company and Charles Brodhead for a right of way for a road extending over the latter's property from the main pike to the zinc works.⁶⁰ He arranged for the transfer of property from the New York to the Pennsylvania corporation⁶¹ and negotiated for the purchase of the Ueberroth farm.⁶² But his major task was that of keeping a check on Gilbert and Wetherill, on whose work the profits of the company ultimately depended.

This led to much correspondence. Gilbert and Wetherill, being in actual management of the oxide works, lived in Bethlehem. Wharton continued to reside in Philadelphia and traveled to South Bethlehem only when he felt that his presence there was needed. After completion of the North Pennsylvania Railroad in January, 1856, connecting Philadelphia with the Lehigh Valley road (which had been opened the year before), the trip took only a few hours.

⁵⁹ Dorothy B. Campbell, typed mss., "Joseph Wharton" (1940), Box 7, WP; printed notice, "R. Wharton & Brother," Box 24, WP; Articles of Agreement between Joseph Wharton, Rodman Wharton, and Robert Haydock, dated Sept. 1, 1847, Box 24, WP; "George Thompson Lewis," *Encyclopaedia of Contemporary Biography of Pennsylvania*, I, 158-160.

⁶⁰ Agreement between Charles Brodhead and the Pennsylvania and Lehigh Zinc Company, Lehigh Zinc Co. papers, folder D, Moravian Archives.

⁶¹ Wharton to Charles Illins, Sept. 11, 1855, Box 10, WP.

⁶² Wharton to Illins, Nov. 27, 1855, *ibid.*

Wharton employed a general superintendent in South Bethlehem named Richard W. Leibert. Many of the letters which passed between Wharton and Leibert have survived, as well as some of those between Wharton and Gilbert and Wetherill. It is from these and from letters which Wharton sent to other persons connected with the company's business that the criss-crossing and by no means harmonious paths of Wetherill, the company, and Wharton can be principally traced.

One letter reflects a decision necessitated by the completion of the North Penn Railroad. In order to use the railroad effectively in shipping oxide to Philadelphia, a siding had to be put in the company's yards. Who was to pay for this? Wharton wrote to Gilbert and Wetherill: "I hear from Mr. Leibert that it is difficult to ship oxide by RR until the track is laid into the yard of the zinc works—also that you are now engaged in grading for that track and expect me to send up RR iron for it, on the supposition that our Co. and your firm shall each pay one half of the total cost." Wharton declared that the company would probably not object to this.⁶³

But the tone of the letter suggests that Wharton disapproved of Wetherill's procedure, that is, taking an initiative and then expecting the company to back him up. Certainly Wharton had good reason for disliking such conduct. Almost from the first the interests of Gilbert and Wetherill and those of the company, as these were defined by Wharton, clashed. "Mr. Fisher has returned Gilbert and Wetherill's draft for oxide at $2\frac{1}{2}$ c and will not pay over $2\frac{1}{4}$," wrote Wharton on one occasion;⁶⁴ and two weeks later he advised an associate, "We have favorable advice also as to other points in our contract with G & W for instance that $2\frac{1}{4}$ c is very clearly all that they can ask, that the standard of excellence in the oxide is the best known commonly in the market made by dry process (all the French is made so which gives us French as the standard) and that 40% ore means ore which contains by strict analysis 40% and not such as will yield by G & W's process 40%."⁶⁵

A constant point of disagreement involved quantity vs. quality.

⁶³ Nov. 30, 1855, *ibid.*

⁶⁴ Wharton to Leibert, Sept. 11, 1855, *ibid.* Two and one-quarter cents a pound would be \$50.40 for a ton of 2,240 pounds. The contracted price was \$50 a ton.

⁶⁵ Wharton to Illins, Oct. 4, 1855, *ibid.*

Although Gilbert and Wetherill had contracted to produce four tons of oxide daily, the works theoretically could produce ten tons a day.⁶⁶ Gilbert and Wetherill wanted to increase production. They asked for additional ore from the company's mines. Wharton was more concerned with improving the quality of the oxide. Although the Saucon Valley zinc ores were among the purest in the world,⁶⁷ the oxide which Gilbert and Wetherill made varied considerably in quality. In all likelihood this resulted in part from the fact that such impurities as existed in the Saucon ores were unevenly distributed—a common feature of zinc ores. Thus, oxide made from some ore might be exceptionally pure, whereas oxide made in exactly the same way from other ore from the same vein might be inferior. Wharton believed that the reputation of the company would depend on its reliability in supplying on demand oxide of a high and uniform quality. For this reason, Wharton desired to restrict production to the contracted amount.

He tried various ways to force his policy on Gilbert and Wetherill. He insisted that the phrase "first quality" in the contract should be interpreted to mean "equal to the best French oxide." On one occasion he wrote to an agent in England requesting samples of the two best brands of European zinc oxide, that called "Blanc de Neige" and the number one grade of the Vielle-Montagne company.⁶⁸ He also sought to limit the amount of ore sent to Gilbert and Wetherill. This is the import of his insistence that "40% ore" meant ore containing 40% zinc by analysis, and not such as would produce 40% zinc—for a small amount of the zinc was lost in the process. He wrote to the superintendent of the mines, "I do not wish Gilbert and Wetherill to have *any* ore beyond the quantity necessary to make 4 tons oxide per day—16 tons of ore daily is plenty and you must try to give the mule teams some work about the mines to employ their leisure."⁶⁹ He urged Wetherill and Gilbert to make repairs and renovations with the aim of improving the

⁶⁶ Whitney, 352.

⁶⁷ Wharton to Illins, Sept. 25, 1855 and Apr. 25, 1856, Box 10, WP; Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 176; Charles W. Eliot and Frank H. Storer, "Arsenic as an Impurity of Metallic Zinc," *The American Journal of Science and Arts* (New Haven, July–November, 1861), 388–389.

⁶⁸ Wharton to Latham, June 4, 1856, Box 10, WP.

⁶⁹ Wharton to Richard Panoe, Oct. 26, 1855, *ibid.*

product. Once, having received from them assurance that the factory would be shut down for repairs, he wrote to Leibert, "If they do start on Monday you will please notify them that as it is contrary to the understanding I had with them, our Company will decline receiving the product; and you will, if they still go on, decline to certify the Invoice on Saturday or to receive it from them."⁷⁰ Several months later Wharton severely criticized Wetherill for the way in which he had supervised some alterations:

In contracting with our Company you bound yourselves to furnish to us oxide of zinc of a certain quality to be made by you in our works, then in your occupancy; which quality you have failed to furnish us.

You represented to us that certain alterations in our works would probably enable you to produce a better quality of oxide of zinc, and we thereupon consented to have these alterations made, at the expense of this Company.

In order that you might be unable to find fault with the alterations when completed, we entrusted them entirely to you agreeing to refund your expenses therein.

The job being thus undertaken and committed to you, you for your own gain and benefit in order that your profits derived from your manufacture for us, might be interrupted as short a time as possible employed a larger number of men on it than could work to the best advantage thereby making the job cost several hundred dollars more than it need have cost if done with ordinary economy of wages and without extraordinary dispatch.

After lecturing Wetherill still further, Wharton concluded by reminding him "that for a period of several months you have been appropriating this company's premises, steam power and zinc ore in experimenting for your own private purposes, without so much as asking consent."⁷¹

In July, 1856, Wharton was granted a patent for an improvement in the apparatus for purifying white oxide of zinc, "separating it from impurities, by causing the products of the furnaces to impinge successively upon a surface of water."⁷² By now he wanted to break the company's contract with Gilbert and Wetherill. One can surmise that he was confident of being able to replace their

⁷⁰ Dec. 29, 1855, Box 10, WP.

⁷¹ Feb. 22, 1856, Box 10, WP.

⁷² *JFI* (1856), LXII, 234.

expertise. In a letter to P. Latham in England he explained the situation:

Our Company is now bound by a contract with Gilbert and Wetherill to have made by them in our works a certain daily quantity of oxide of zinc, and on account of the unsatisfactory quality of their make and for other reasons we wish to erect new works and make a further quantity for ourselves. Gilbert and Wetherill claim that we cannot do this (on the plan we wish) without violating a patent taken out by Mr. Wetherill for the process of making oxide of zinc by burning a mixture of coal and zinc ore.

Wharton wanted Latham to investigate the possibility that a Mr. De Gee of De Gee, Gernant and Company of Ougrée, Belgium, had patented a process similar to that of Wetherill and prior to the time that Wetherill's patent had been granted. He also asked Latham to get from De Gee information on the manufacture of zinc oxide, apparently with the intention of attempting to find an alternate to the Wetherill process.⁷³

The relations between Wharton and Gilbert and Wetherill worsened. In September, 1856, the company closed down the partners' operation. Wetherill retaliated by taking advantage of a clause in the contract which permitted the partners under the circumstances to attach the property of the company and make zinc oxide on their own account.⁷⁴ Sometime within the next year the company bought out the interest of Gilbert and Wetherill, giving them a mortgage on the company in exchange.⁷⁵ That ended the dispute over the manufacture of zinc oxide, although it did not immediately end the partners' connection with the zinc industry. But before the next forward step in production could be taken, trouble struck the company in the form of the Panic of 1857.

On August 24 the New York office of the Ohio Life Insurance and Trust Company closed its doors. Other banks almost immediately halted payment in specie. Money became scarce; many businesses failed; unemployment rose.⁷⁶

Wharton described the situation to his agent in London as a

⁷³ Feb. 7, 1856, Box 10, WP.

⁷⁴ Articles in *Easton Daily Express*, Sept. 22, 26, and 30, 1856.

⁷⁵ Wharton to Leibert, Oct. 30, 1857, Box 19, WP.

⁷⁶ Margaret G. Myers, *A Financial History of the United States* (New York & London, 1970), 126-128.

temporary setback: "This country is not in an exhausted impoverished condition but is rich in all the elements of productive process and in the precious metals; it had to be sure spent too much for foreign goods and in building railroads, but I believe that the present crisis though severe might have been safely ridden through without suspension of specie payments by any of the Atlantic cities except for the rotten condition of the Bank of Pennsylvania, the unavoidable downfall of which in the midst of the panic excited such distrust among the populace as to force the other banks of this City."⁷⁷

Nevertheless, the Pennsylvania and Lehigh Zinc Company faced the possibility of bankruptcy. The market for zinc oxide shrank, and the price fell. The company could not meet all of its current obligations and had a large debt. About four months after the Panic set in, Wharton summarized the debt as follows:

Notes carried by Directors and others, falling due within a few months and covered by the Co.'s Bonds @ 20%	87,250.00	
arrears of Interest	4,151.79	91,401.79
James R. Whitney's claim against Ueberroth Mine, with interest		91,250.00
Notes given to Wetherill Zinc Co.		37,467.50
Other Promissory notes due soon		2,141.58
Divers small bills overdue		2,290.48
Arrears of interest on mortgages, taxes and water rent overdue, say		2,800.00
Arrears of Salaries to Presdt. & Sec'y		750.00
Principals of Mortgages to Ueberroth, Stadiger and Goepf		25,075.00
Total debt as cash this day about		<u>\$253,176.35⁷⁸</u>

Wharton himself was for a time a creditor for part of his salary. On July 13, 1857, he had written to President Fisher offering to accept 3,500 pounds of number one oxide and the use of the company's paint mill in Bethlehem for the rest of the year in return for arrears in his salary.⁷⁹

⁷⁷ Wharton to Coates & Co., Nov. 2, 1857, Box 10, WP.

⁷⁸ Wharton to the President and Directors of the Pennsylvania and Lehigh Zinc Company, Jan. 12, 1858, *ibid.*

⁷⁹ Wharton to Fisher, July 13, 1857, Box 10, WP.

Wharton's offer is of interest because, in the context of later events, it shows a desire to increase his control over the company's activities. Probably the directors did not agree to his proposal. In any event, it was soon overshadowed by a much larger transaction. Wharton offered to lease all the properties of the company, thereby assuming financial control over the entire enterprise, in exchange for exclusive control over foreign sales during the life of the contract. The directors agreed, and the contract was signed. It was to run for six months, ending April 13, 1858. Wharton was to pay the company eighty tons of oxide monthly as rent, which he would dispose of on the domestic market. The profit on oxide above that amount which he might make and sell abroad was to be his.⁸⁰

Wharton was supremely confident in his own business ability by comparison with that of other principals associated with the company. The Panic, which so gravely embarrassed the company, was for him an opportunity. By superior business ability he would save the company; in so doing he might conceivably succeed in controlling the zinc industry of the United States. He wrote to James T. Lewis, "Except for the arrangements which I made with the Zinc Co. I feel sure that it would have produced nothing this winter and might probably enough have become bankrupt. As it is, my only chance of coming out whole from the heavy burden of rent and expenses which I have assumed is in making a large amount of product, (more than the American market can take) and in disposing of the surplus abroad in the cheapest possible manner. So long as my arrangement lasts you are sure of having the sale of as much zinc oxide as you can with all diligence dispose of in America; when it terminates no one can possibly predict what changes will take place."⁸¹

Wharton set to work vigorously to develop a foreign market. Reasonably good quality at a price lower than the French oxide were the points he chiefly relied on. He already had made a contact in London with the firm of Messrs. Coates and Company, 13

⁸⁰ Although no copy of this contract has been located, the essentials can be found in the correspondence of Wharton between September, 1857, and April, 1858, cited in this article.

⁸¹ Wharton to James T. Lewis, Dec. 22, 1857, Box 10, WP. Lewis and Co. still had the contract with the Pennsylvania and Lehigh Zinc Company for marketing the oxide and were clearly angry at being bypassed by Joseph for the foreign market. This letter was an attempt to mollify Lewis & Company.

Bread street, Cheapside. This company became his principal agent for marketing oxide in England. He also sent his brother Charles to England to help develop markets and to send back information for improving the business. In December Joseph himself tried unsuccessfully to open a trade in zinc oxide with Cuba.⁸²

The prospect of finding a European market for American zinc oxide was uncertain. On December 20 Joseph wrote to Charles that the expenses under the lease with the company had so far been \$16,000, "that is to say I owe as much more than when I started it, and my share of the product should be worth \$21,000 which if well sold will leave something after paying thy expenses and say \$3,000; but alas the expenses are certain and the sales are not." In the same letter he commented, "The Zinc Co. gets along but is very short—has not yet paid Sept. bills nor interest on mortgages. I do not think however that it will break this winter."⁸³

The contact with Coates and Company worked out well, in part perhaps because Charles was there to expedite deliveries and to iron out other difficulties. In his account book for 1857–1858 Joseph noted a total of 616,000 pounds of number one oxide consigned to Coates and Company, to be sold by them on commission at 3¼c per pound, plus smaller amounts of the lesser grades.⁸⁴ Some zinc ore was also sold. Charles traveled to other cities in England and then went to the continent. He reported good prospects in England for a market in the best spelter. Joseph encouraged him in his continental travels but with doubts (justified, as they were later proved) about any great success:

As for the French market for zinc oxide I don't have any faith in it because the folks there are accustomed to the best article and we have a heavy duty to contend against. Russia may do better; Germany may possibly do, or Belgium but neither very likely. The Southern European states however would be very likely to take zinc oxide if they can grind it there. . . . Constantinople is likely to resemble these latin markets. Still try all and sell where you can.⁸⁵

⁸² Wharton to (indecipherable), Dec., 1857, Box 10, WP; J. Wharton to C. Wharton, Mar. 5, 1858, *ibid.*

⁸³ J. Wharton to C. Wharton, Dec. 20, 1857, *ibid.*

⁸⁴ Box 25, WP.

⁸⁵ J. Wharton to C. Wharton, Mar. 5, 1858, Box 10, WP.

Wharton tried to have his lease of the company's works extended beyond the original time of six months. On November 11, 1857, he wrote Charles of an idea concerning how this might be done: "I am not sanguine about keeping the lease after April 13; but it may possibly work—the scheme is this; for me to buy from G & W their mortgage notes against the Co. for \$38,500—paying them therefore in oxide; for me then to give the Co. one year's extension on that debt; and for the Co. to give me in return the option of continuing the lease to Oct. 1, 1859." He added that President Fisher did not much approve of the idea, and there was also doubt that Gilbert and Wetherill would approve it.⁸⁶ In the event, the idea was stillborn. Early in March he wrote his brother, "my lease may run for years";⁸⁷ but in fact, Fisher and the directors were anxious to resume control over the works.

In a sense, Wharton's success was his undoing. By his energy as lessee he had demonstrated the enormous profitability of the enterprise. On February 20 part of the square tower in which the oxide was collected fell down, and the works had to be closed for a few days for repairs. Until then he had produced oxide at the rate of two hundred tons a month, of which only eighty per month had gone to the company. Basically he was doing what he had earlier prevented Gilbert and Wetherill from doing, namely, emphasizing quantity at the expense of quality. Eventually this produced a formal, strong remonstrance from President Fisher: "There never has been since my connection with the Company so much general complaint of our oxide since the date of your lease last fall, not from any one house but from several."⁸⁸ Nevertheless, Wharton made a profit for the company and an additional thirty thousand dollars for himself.⁸⁹ In addition, he had established a foreign market. Under the circumstances, the desire of the directors to end the lease and thereby receive the profits for distribution among the stockholders is understandable.

The promise of profit was so great that refinancing of the company's debt became possible. The company advertised for a loan of

⁸⁶ J. Wharton to C. Wharton, Nov. 11, 1857, *ibid.*

⁸⁷ J. Wharton to C. Wharton, Mar. 5, 1858, *ibid.*

⁸⁸ Fisher to Wharton, July 31, 1858, Box 19, WP.

⁸⁹ Campbell, Box 7, WP; Wharton to Fisher, Mar. 16, 1858, Box 10, WP.

\$300,000 for five years at six per cent. Stockholders were to have the first chance to subscribe to this loan at sixty per cent of the value of their stock. The circular issued by the company informed the stockholders,

Confirmation of the security of this proposed Loan and of the probably favorable prospects for the future of the Stockholders is had in the fact, that an amply responsible party has offered to extricate the Company from its debts, in consideration of leasing to him the Mines and Works of the Company, for a period of three and a half years, with privilege of taking from the Mines during that time, 60,000 Tons of Ore, which offer would probably have to be accepted, this present proposition failing.

The circular noted that profits from sixty thousand tons of ore, converted into oxide, would amount to at least three hundred thousand dollars.⁹⁰

The end being in sight, on March 13 Wharton wrote to Fisher giving notice that he would "withdraw from the lease" on April 21, 1858, "that being the day to which the six months lease was extended on account of the time lost by me from the accident to the square tower."⁹¹

Thus the Pennsylvania and Lehigh Zinc Company survived the depression as a major supplier of oxide. Wharton again became general manager. Coates and Company remained as agents in London. The firm of Gilbert and Wetherill broke up. Gilbert went to New York, where later he entered the rubber industry.⁹²

The new national industry in zinc oxide continued to prosper, in large part as a result of the Wetherill process. In a letter concerning the tariff written in 1860 Wharton acknowledged the prosperity by minimizing the need for a protective tariff for it: "Zinc Oxide might also with propriety pay an import duty of 1 cent per pound, though its manufacture is not likely to be eradicated from this country by any competition which can now be brought against it from Europe."⁹³

In the past Wharton had had another motive for watching Wetherill besides that of improving the quality of the company's

⁹⁰ Circular, Mar. 2, 1858, *ibid.*

⁹¹ Wharton to Fisher, Mar. 13, 1858, Box 10, WP.

⁹² Richmond Myers, "The Story of the Zinc Industry in the Saucon Valley, II," *Rocks and Minerals* (March, 1935), 33.

⁹³ Wharton to (indecipherable), June 15, 1860, Box 10, WP.

oxide. The two men were independently of each other attempting to develop a commercially successful furnace for making spelter. As Wharton saw it, this made Wetherill a competitor.

From the beginning of his connection with the Pennsylvania and Lehigh Zinc Company Wharton was thinking about the possibility of manufacturing spelter. He wrote to John Hitz, who had made the first spelter in the United States, "As the manufacture is not understood in this country except so far as can be learned from books and experiments it is of course very desirable for a Company owning such abundance of zinc ore as ours, to have the experience of a person practically acquainted with the business and I should be much gratified to converse with you on the subject."⁹⁴ A little over a week later he again wrote to Hitz saying that he would not enter the business of making spelter without the prospect of sufficient profit and stated a need for "reliable estimates of the cost of producing the article."⁹⁵ Apparently the two met and Hitz gave his opinion, for about a month later Wharton wrote to Charles Illins, "I have today the estimate of Mr. Hitz Swiss Consul of the cost of making spelter in Bethlehem—he gives details adding up to \$74 a ton meaning I suppose 2240 lbs."⁹⁶ Now, that would be approximately $3\frac{1}{3}$ cents per pound for spelter which might sell on the market from between $4\frac{1}{2}$ c and 6c per pound. From this time on Wharton was constantly experimenting with ways of making spelter.

The aims of Wetherill and Wharton in wanting to make spelter, such as can be induced from their subsequent activities, were somewhat different. Wetherill, the inventor, wanted to duplicate his success in the manufacture of zinc oxide by developing a new process which he could patent. He would then make money principally from the patent rights. Wharton, on the other hand, wanted any process which would produce marketable spelter on a favorable competitive basis. Wharton aimed to make money principally from the manufacture.

Under other circumstances these aims might have been complementary. The inventor and the businessman might have aided each other. But the difficulties which Wharton and Wetherill encountered

⁹⁴ Wharton to Hitz, Aug. 16, 1855, *ibid.*

⁹⁵ Wharton to Hitz, Aug. 24, 1855, *ibid.*

⁹⁶ Wharton to Illins, Sept. 25, 1855, *ibid.*

in working together in the production of zinc oxide precluded any possibility of cooperation in as controversial an undertaking as that of making spelter commercially and profitably. Wharton especially viewed control over the manufacture of zinc metal to the exclusion (if possible) of persons such as Wetherill as being highly desirable.

Wetherill variously conducted his experiments at the mines, in the factory of the company in South Bethlehem, and at works erected on a four-acre lot which he owned adjoining the grounds of the company's property.⁹⁷ A serious shortcoming was lack of a steady supply of ore. This led Wetherill to prospect for deposits on farm land adjacent to the Ueberroth tract in Upper Saucon township.

Wharton worked to prevent Wetherill from using the company's facilities. Wharton's insistence on limiting the ore sent to Gilbert and Wetherill for their operation in zinc oxide was in part influenced by a desire that Wetherill should not have sufficient ore to engage in the manufacture of spelter. In October, 1855, Wharton wrote to Illins, "Gilbert and Wetherill have got Dr. Baxter at Friedensville to open their zinc land. The first plan was to go into the Hartman Farm but they afterwards gave up that and decided to try the Correll lot. They talk as if they were in earnest about spelter making but as yet have no ore demonstrated in sufficient quantity to warrant any expensive buildings."⁹⁸ The next month he again wrote Illins, "Gilbert and Wetherill are still making fruitless endeavors to develop a grand zinc mine on their property, and our mine still looks exhaustless. . . ."⁹⁹

Wharton arranged for the Pennsylvania and Lehigh Zinc Company to buy as much of the ore-bearing land near Friedensville as it could get. However, he found no immediate way to deprive Gilbert and Wetherill of their holdings, on which some ore was found.¹⁰⁰ Early in 1856 he wrote Leibert to keep a record of the length of time Wetherill had used the company's engine and other facilities

⁹⁷ Reichel, 143.

⁹⁸ Wharton to Illins, Oct. 4, 1855, Box 10, WP.

⁹⁹ Wharton to Illins, Nov. 27, 1855, *ibid.*

¹⁰⁰ The January 15, 1856 issue of the *Easton Daily Express* carried the news that "A very extensive Zinc mine has just been discovered, on lands of Gilbert and Wetherill, at Friedensville." This announcement was false, as the subsequent investigations of Wharton revealed. However, several years later, excellent mines were opened on the Hartman and Correll farms, both of which Gilbert and Wetherill had been prospecting.

in experimenting with a spelter furnace and to get particulars "about the situation of the ore G & W have found."¹⁰¹ In the spring of the same year he wrote Illins that Gilbert and Wetherill were still trying to start a metal furnace, but had not yet found anyone with sufficient skill to build one, and that they did not yet have a sure supply of ore. They had been working at a spelter works for six months, he said, and had spent about five thousand dollars.¹⁰²

On November 26, 1856, Wetherill received a charter of incorporation for the Wetherill Zinc Company. In this way his activity in trying to make spelter was legally separated from his work with Gilbert in manufacturing oxide. Probably during the depression months of 1857-1858 Wetherill's experimenting was temporarily halted, for on March 1, 1858, Leibert wrote to Wharton, "Wetherill informed me today that he intended to commence experimenting in the manufacture of spelter tomorrow at the Wetherill Zinc Co.'s works but on his own account altogether and that he expected to purchase his zinc ore from the Penna. & L. Zinc Company should he find it impossible to procure a sufficient supply from their own mines."¹⁰³ Six weeks later Leibert wrote, "Wetherill's metal experiment has proved to be a total failure, and the metal works are now shut up again."¹⁰⁴ Yet the attempts to make spelter continued. On October 26 Leibert wrote to Wharton, "Wetherill received three car loads of roadbridge clay yesterday morning and I have been told expects several retort makers from Phila. to make his retorts and muffles."¹⁰⁵

Wetherill produced his first ingot of pure spelter in 1858. According to Wharton, "The first sheet zinc made in America was rolled by Alan Wood & Sons of Philadelphia, from an ingot of Mr. Wetherill's spelter."¹⁰⁶ In 1859 Wetherill was granted a patent for a spelter furnace containing vertical retorts.¹⁰⁷ Thus he succeeded in developing a new technique for making excellent spelter from the Saucon Valley ores.

¹⁰¹ Wharton to Leibert, Jan. 10, 1856, Box 10, WP.

¹⁰² Wharton to Illins, Apr. 25, 1856, *ibid.*

¹⁰³ Leibert to Wharton, Mar. 1, 1858, Box 19, WP.

¹⁰⁴ Leibert to Wharton, Apr. 20, 1858, *ibid.*

¹⁰⁵ Leibert to Wharton, Oct. 26, 1858, *ibid.*

¹⁰⁶ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 168.

¹⁰⁷ *JFI* (1859), LXVII, 252.

Only, Wetherill's technique for making spelter was not commercially feasible. As Wharton explained it later, "Mr. Samuel Wetherill . . . experimented in a spirited manner upon the production of metallic zinc, and actually produced some at South Bethlehem, Pa., as early as 1858, but though he persevered for about two years, and made a considerable quantity of excellent spelter—in all I think about 50 tons—the cost price was too high, and his enterprise was finally abandoned."¹⁰⁸

In the same article Wharton summarized his own approach:

Having acquired some practical knowledge of the properties of zinc, by several years experience as general manager of the Lehigh Zinc Co.'s mines and zinc oxide works, and having also gathered such information as was possible from books and other sources, I made various trials during 1857 and 1858, to invent some form of furnace which should effect the evolution and condensation of zinc vapor in a larger and more continuous way than was practised in Europe, and which should thus fulfill in a simpler and more scientific manner, what seemed to be the easy theoretical conditions of the problem. Some of these attempts were not devoid of ingenuity; they cost me much toil and money, but they all failed utterly, by reason of my having overlooked one or another of what may be called the conditions of secondary importance. They served very little purpose but to instruct me in the real difficulties of the manufacture, and I revert to them now mainly to point out to my younger or more sanguine readers that it is usually very bad economy to labor over the rudiments of an art which is to be transplanted, repeating perhaps, many futile unpublished experiments of its founders, when it is at all practicable for them to adopt the processes successfully used elsewhere.¹⁰⁹

Almost from the time of beginning his experiments Wharton was sensitive to the need for obtaining the expertise and experience to be found only in Europe. In 1856 he wrote to Roepper, who was planning a trip to Europe, "We desire to get fuller information than we now possess relative to the best European processes of making spelter, and also to import a few workmen skilled in the different

¹⁰⁸ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 168. A supplement to the charter of the Wetherill Zinc Company signed by Governor A. G. Curtin May 1, 1861, summed up its failure. *Laws of the Commonwealth of Pennsylvania, Session of 1861*, 609-610. A notice of intent to dissolve the Wetherill Zinc Company appeared in the Feb. 23, 1865, issue of *The Moravian*, the only newspaper then being published in Bethlehem.

¹⁰⁹ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 168-169.

branches of that business."¹¹⁰ In 1857 a man named Stephen Hills wrote asking whether Wharton would be interested in helping to develop some calamine deposits in east Tennessee.¹¹¹ Wharton declined the offer, giving as one reason the distance of the site from sources of skilled labor.¹¹²

In the years 1856-1857 Wharton encouraged several men to build a spelter furnace for the company. The first was Charles Hoofstetten, who built a Silesian furnace near the mines. Hoofstetten failed, being "unable to make or to procure any suitable muffles."¹¹³ The following year either Wharton or Wetherill gave permission to two young men named Matthiessen and Hegeler to experiment with Hoofstetten's abandoned plant. Matthiessen and Hegeler had just come to the United States from the school of mines at Freiberg, Saxony. They proved that anthracite and New Jersey clay could be used. They, too, had trouble making suitable muffles. The Panic of 1857 ended their experiment. They went to Wisconsin and later developed zinc works there.¹¹⁴

During the period that he was leasing the oxide works, Wharton asked a man named Nathan Bartlett to continue experiments in making spelter. On January 18, 1858, Leibert wrote to Wharton, "Tomorrow some of the Wetherill Zinc Co. are expected but Nathan and myself will take good care not to admit any of them inside the works."¹¹⁵ Bartlett supervised the building of a spelter furnace which at least for a time operated successfully. "The metal furnace still continues to work successfully. Nathan took about 100 pounds from the retorts this morning," wrote Leibert in November. "Nathan has charged ore of the retorts in a peculiar manner and expects an unusual quantity of metal from it."¹¹⁶ "The spelter which Nathan

¹¹⁰ Wharton to Roepper, Apr. 18, 1856, Box 10, WP.

¹¹¹ Hills to Wharton, Feb. 11, 1857, Box 19, WP.

¹¹² Wharton to Hills, Feb. 13, 1857, Box 10, WP.

¹¹³ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 168.

¹¹⁴ Ingalls, *Production and Properties of Zinc*, 14; E. J. Gerrard to Wharton, Apr. 20, 1857 and Apr. 24, 1857, Box 19, WP.

¹¹⁵ Leibert to Wharton, Jan. 18, 1858, Box 19, WP. Bartlett also helped to make improvements in the process for manufacturing zinc oxide. A patent for a new sort of furnace for making zinc oxide was granted to Joseph Wharton and Nathan Bartlett in July, 1858. *JFI* (1858), LXVI, 252.

¹¹⁶ Leibert to Wharton, Nov. 22, 1858, Box 19, WP.

has melted over looks so inviting that he thought you would like to have it all melted over again into heavier ingots before sending it to the Co.'s office."¹¹⁷

Bartlett's experiments occurred during the period which Wharton later referred to as a time of failure as a result of neglecting European experience. Also during this time Wharton experimented with a new sort of spelter furnace in Philadelphia.¹¹⁸ Then in late 1858 or early 1859 he formed the idea of constructing a Belgian furnace using skilled workmen imported from Belgium and, if possible, imported managerial talent. For the latter he again sought out Louis De Gee, who was then apparently traveling in North America. Probably the two met, for there is no correspondence on record until a letter from De Gee to Wharton, dated February 20, 1859, indicating that Wharton has explained the situation and asked De Gee to serve as a consultant. "Plus j'étudie votre affaire et plus je vois que vous avez encore grand besoin de moi." De Gee then offered to remain in America and advise Wharton from February 28 to March 28 for a sum of 340 pounds.¹¹⁹

Wharton was not yet ready to take advantage of such an offer. He first had to persuade the directors of the company to underwrite the cost of a furnace. He prepared estimates, showing that six hundred pounds of spelter could be produced per day at a cost of \$24.55, or a little more than four cents a pound.¹²⁰ He wrote to Fisher, asking permission and saying that he had invented a spelter furnace which he refused to patent in order to avoid any appearance of antagonism to the company. He added that if the company would not agree, he would build the furnace anyway.¹²¹

Fisher replied that the directors considered Wharton's figures incomplete and would not make a contract with him for the manufacture of spelter at any price, "nor do I believe that a contract on the basis of your letter will ever be sanctioned by the directors, and possibly none on any terms."¹²² Wharton expressed disappointment "at the summary rejection of any sort of contract between

¹¹⁷ Leibert to Wharton, Dec. 14, 1858, *ibid.*

¹¹⁸ "Zinc," *NAC*, XVI, 644.

¹¹⁹ De Gee to Wharton, Feb. 20, 1859, Box 24, WP.

¹²⁰ "Estimate of cost of manufacturing spelter at Bethlehem," Mar. 1, 1859, Box 10, WP.

¹²¹ Wharton to Fisher, Mar. 15, 1859, *ibid.*

¹²² Fisher to Wharton, Mar. 22, 1859, Box 20, WP.

the Co. and myself for erecting a spelter works, after the encouragement at first given by some of the Directors to such a scheme." He declared that he had already bought land "adjoining our oxide works" and had managed "to obtain access to European spelter works."¹²³

Nevertheless, the directors finally agreed to the experiment.¹²⁴ Wharton built his furnace with the help of three Belgians whom he procured through the services of De Gee.¹²⁵ These were André Woot Detrixhe, J. Duport, and Jean Henrard. By midsummer the furnace was successfully making spelter.

In retrospect it is easy to understand why the directors finally gave their assent to this experiment. Although the industry in zinc oxide was profitable, it was small. Metallic zinc could be used to make oxide and had many other uses, and more were being found all the time.¹²⁶ Moreover, Wharton had proved that the Saucon ores were capable of producing spelter of a very high quality, which would always have a market.

Still, the directors delayed in giving consent to a full-fledged spelter works. As Wharton later put it, "Both funds and courage were in fact rather lacking."¹²⁷ On September 19 Wharton wrote to François Lemal, another Belgian workman, saying that since the company had not yet made up its mind as to the appropriate size of a spelter works, Lemal should say nothing to De Gee as yet about coming to the United States and not to engage anyone else to come to Bethlehem "with you now."¹²⁸ On October 15 Wharton wrote De Gee asking him to come "to advise me as to the . . . management of a spelter works of a certain size, and as to the manner of keeping the accounts of such a factory as practiced in

¹²³ Wharton to Fisher, May 2, 1859, Box 10, WP.

¹²⁴ Consent can be inferred from a statement in the contract between Wharton and the company dated Dec. 13, 1859. Lehigh Zinc Co. Papers, Moravian Archives, Bethlehem.

¹²⁵ Wharton to De Gee, Oct. 15, 1859, Box 10, WP.

¹²⁶ For example, see report on "The Veille Montaigne [*sic*] Zinc Company," *The Mining Magazine* (October, 1853), 439, and short articles by George Henwood showing the increasing use of zinc products and the rise in price paid for zinc by manufacturers, *The Mining Journal* (London, Mar. 5 and 26, 1859), XXIX, 162, 207.

¹²⁷ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 170.

¹²⁸ Wharton to Lemal, Sept. 19, 1859, Box 10, WP. On Nov. 14, 1859, Wharton wrote De Gee that Lemal and his family had safely arrived in Bethlehem. *Ibid.*

Europe." Wharton added that the directors had not yet given their consent to the project, but that he expected this to be forthcoming in a few weeks. "In this country companies often move very slowly and cannot act as resolutely or efficiently as individuals who possess adequate means."¹²⁹

In September Wharton had given the directors another report showing that the cost of producing one thousand pounds of spelter in the experimental furnace had been \$40.71, or a little over four cents a pound. A month later the directors agreed to a plan proposed by Wharton. A contract was signed December 13, 1859. The terms as summarized in part by Wharton were as follows:

I engaged for the sum of \$30,000, to convey to them a suitable piece of ground in South Bethlehem, Penn., and to erect thereupon by July 1, 1860, a complete Spelter Works, of sixteen Belgian furnaces, each containing fifty-four working retorts; the furnaces to be enclosed in a suitable stone or brick building with slate roof, 155 feet long and 40 feet wide; the establishment to be provided with steam engine and boilers, steam pump drawing water from the Lehigh river, blowers, ore-crushing mill and store room—all these latter to be enclosed in a suitable stone building with slate roof—also to be provided with pottery fully equipped with clay mills and apparatus to make all fire bricks, retorts, condensers, etc., needed in the business, ore-roasting furnaces, air flues and water pipes, railroad into yard, coal bins, etc., and to be in all respects capable of making from the Lehigh Zinc Co.'s selected or lump ores 3,000,000 lbs. of spelter annually. I also bought from the Company 15,000 tons (of 2,352 lbs. each, moist weight) of their selected ore at \$7 per ton for the first 5,000 tons, \$7.50 per ton for the second 5,000 tons, and \$8 per ton, for the third 5,000 tons; the average price which had been theretofore received for several considerable lots of similar ore, sent by the Company to England. I also agreed to rent the factory to be built as above mentioned, from July 1, 1860 until Jan. 1, 1863 at \$3,000 per annum, and at the end of that period to hand it over to the Lehigh Zinc Co., in complete running order for producing the stipulated 3,000,000 lbs. of spelter annually.¹³⁰

In addition, the contract stipulated that the \$30,000 was to be paid to Wharton in six installments of \$5,000 each, the last to be paid on completion of the works; he was to engage at his own expense "the workmen brought to this Country from Europe"; and

¹²⁹ Wharton to De Gee, Oct. 15, 1859, *ibid.*

¹³⁰ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 170-171.

if he patented any improvements, he would grant a free license to the company to use them. Finally, the contract provided for a system of arbitration by "two disinterested persons who shall be chosen by the parties" as a means of resolving disputes.¹³¹

Six weeks before the contract was actually signed Wharton wrote to De Gee of his success, adding that the company had also agreed to bring De Gee over as a consultant. The letter included a sketch of the ground plan of the proposed spelter works and was accompanied by 25 pounds to pay traveling expenses of another potter, the wife of Duport, and the mother of Detrixhe.¹³²

During the next several months the two men bargained back and forth concerning the terms on which De Gee might come to Bethlehem. Wharton wanted De Gee for a fairly long period of time—at least three months, and possibly for several years beyond that as foreman of the spelter works. On the other hand, Wharton was reluctant to pay much until De Gee should prove his worth. Wharton's basic offer was two hundred pounds plus expenses and an additional two hundred pounds if, after De Gee arrived, Wharton thought he was worth it. De Gee wanted to spend no more than fifteen days in Bethlehem for a flat fee of four hundred pounds plus expenses; and he made no commitment concerning a longer stay as foreman, although he left the possibility open. On December 20 De Gee informed Wharton that he planned to leave Belgium on the steamer *City of Baltimore* on January 1.¹³³

De Gee spent several weeks in South Bethlehem in early March, 1860. It is impossible to assess the extent of his help to Wharton. At the time Wharton was sufficiently impressed with him to ask that he stay and manage the spelter works for three years. On March 11 De Gee agreed to remain if Wharton would pay him a fixed salary of \$6,000, give him half the difference between the cost of production and $3\frac{1}{2}c$ per pound or $\frac{1}{4}c$ a pound bonus on all zinc made, whichever he preferred, and allow him the free use of a house, a servant, a horse, heat and, light.¹³⁴ Wharton indicated that

¹³¹ *Articles of Agreement between Joseph Wharton & Penna. & Lehigh Zinc Co.*, Dec. 13, 1859, Zinc Co. Papers, Moravian Archives.

¹³² Wharton to De Gee, Oct. 31, 1859, Box 10, WP.

¹³³ De Gee to Wharton, Dec. 20, 1859, Box 24, WP; Wharton to De Gee, Dec. 20, 1859, Box 10, WP.

¹³⁴ De Gee to Wharton, Mar. 11, 1860, Box 24, WP.

he would pay De Gee the \$6,000 fixed salary for the period from July 1, 1860, to December 31, 1862, provided De Gee could make spelter for $3\frac{1}{2}$ c a pound; and that he would split any additional saving with De Gee if he could reduce the cost below $3\frac{1}{2}$ c a pound.¹³⁵

No agreement was reached. Relations between the two men ended in mutual charges of bad faith. The substance of their disagreement is unclear. Leibert witnessed the occasion on which De Gee's attitude toward Wharton changed and wrote of it to Wharton. The company had been negotiating with De Gee for the use of some of his patents. The papers had been drafted and were presented to him on the day before he was to leave Bethlehem for New York, where he was to deliver them to President Fisher for execution. De Gee could not read the papers, which were in English, so Roepper was called in to translate them. As he began doing so, according to Leibert, De Gee "snatched them out of his hands and threw them on the floor, and became much excited and quite angry, and said that there was ample time to have had all these matters arranged before this, and now at the last moment the Zinc Co. wanted to take advantage of him that he never said or agreed to grant a license for more than sixteen furnaces, that his contract was with him and you, and not the Penna. & Lehigh Zinc Co. that he was no fool and not to be trifled with." Leibert advised him to settle the matter with Fisher, and De Gee left, still angry. "There is something wrong somewhere, and some foul play is going on."¹³⁶ De Gee immediately wrote to Wharton asking that "my offer of 11 March 1860" be considered null and without effect, and that he had no other offer to make.¹³⁷ De Gee also sent a bill for \$390, claiming that Wharton had not paid all that had been promised. In reply Wharton claimed that De Gee had been overpaid and that he had not fulfilled the terms of his agreement. Wharton sent De Gee a bill for \$141.73.¹³⁸

Later Wharton wrote out a statement of his relations with De Gee, possibly at the request of the directors. Wharton claimed not to know why De Gee had become angry, that in fact De Gee

¹³⁵ Wharton to De Gee, Mar. 17, 1860, Box 10, WP.

¹³⁶ Leibert to Wharton, Mar. 26, 1860, Box 24, WP.

¹³⁷ De Gee to Wharton, Mar. 25, 1860, *ibid.*

¹³⁸ Wharton to De Gee, Apr. 10, 1860, Box 10, WP.

had been treated well, and that his conduct represented some hidden instability of character.¹³⁹ Wharton hinted that when De Gee had arrived in New York, Fisher had given him some encouragement of future employment with the company. Now Wharton wanted nothing more to do with the man, insisting that De Gee had been of no appreciable help, and that some of the arrangements he had ordered made in the spelter works had to be altered.¹⁴⁰ Later Wharton was informed that "(1) the *Vieille Montaigne* [*sic*] works are a dead ringer for ours; and that (2) De Gee is considered in Belgium, a charlatan."¹⁴¹

Wharton's tiff with De Gee had no visible effect on the progress of the spelter works. He continued negotiations for additional Belgian workmen to help him.¹⁴² He inquired again of Coates and Company concerning the market conditions for spelter in Europe, writing in part, "I am now making but a trifling quantity of spelter with 2 furnaces, and do not expect to get the new works into full operation for some months; in the meantime my spelter is eagerly taken at 6¼ cts. per lb. while the best Silesian sells at 5 to 5¼, and something like this difference is expected to continue even after I turn out larger quantities."¹⁴³ In late spring he imported a foreman from England, whom he soon fired for incompetence, replacing him with Detrixhe.¹⁴⁴ Wharton summarized in retrospect some of his difficulties in the spring and summer of 1860:

A severe winter prevented much progress in building until the spring of 1860, though one block of furnaces was actually put up under cover of a tight temporary wooden building; a freshet in the spring destroyed the foundations of some of the furnaces; the thick middle wall separating the backs of the several pairs of furnaces, and supporting the covering arches, was at first made of a semi-refractory red brick of the neighborhood, covered on each side toward the furnaces by about 12 inches of fire bricks; those middle walls melted out, and had to be replaced by solid fire brick masonry. In spite, however, of these and similar difficulties, everything

¹³⁹ Statement Concerning Louis De Gee, Box 24, WP.

¹⁴⁰ Wharton to "Dear George," Apr. 25, 1860, Box 10, WP.

¹⁴¹ Wharton to Fisher, Nov. 7, 1860, *ibid.*

¹⁴² Wharton to Ludwig Koch, Apr. 10, 1860, and Apr. 16, 1860, Box 10, WP.

¹⁴³ Wharton to Coates & Co., May 14, 1860, *ibid.*

¹⁴⁴ Wharton to (indecipherable), May 21, 1860; Wharton to (indecipherable), Nov. 21, 1860, *ibid.*; Reichel, 143.

was completed so nearly according to programme, that 1,100,580 lbs. of spelter was made in the new factory before the end of the year 1860; a feat which would have been impossible, but for the precaution which I had taken of importing a number of trained Belgian workmen, who arrived in August, 1860, about the time the works were completed.¹⁴⁵

Wharton reported that he had received an order of spelter for the United States Mint, "to be used I believe in California."¹⁴⁶ The Franklin Institute duly noted his achievement.¹⁴⁷

Thus Wharton succeeded in establishing a commercially successful spelter works. Although he did not meet the target date of July 1, 1860, he came close. His own account would lead one to believe that the plant was finished in August.¹⁴⁸ His account book shows that the zinc company paid him the final \$5,000—which was to be paid on completion of the works—on October 9, 1860. He had spent the \$30,000 he received from the company to help finance the undertaking, and, in addition, he had borrowed \$2,500 from James T. Borhek, a businessman of South Bethlehem, in order to buy the lot on which the spelter works stood; \$8,000 for one year from April 1, 1860, at six per cent interest from Joseph Diehl, who managed the mines; and he had received advances on spelter consigned to L. Trotter & Company, the firm in charge of marketing the product.¹⁴⁹

Having started the spelter works, Wharton now had to establish the business in the terms of his contract with the company. In operating the works during the approximately two and one half years he leased them from the company, he met and overcame several additional obstacles.

One involved labor troubles. He set about instructing Americans in the art of the Belgians. But American labor was more highly paid than its European counterpart. As the American trainees achieved their skills, they began demanding higher wages. The result was that Wharton modified the plan for training American

¹⁴⁵ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 171.

¹⁴⁶ Wharton to James C. Booth, Nov. 20, 1860, Box 10, WP.

¹⁴⁷ *JFI* (1860), LXX, 422.

¹⁴⁸ *Ibid.*, 171.

¹⁴⁹ Account Book, 1859-1860, Box 26, WP.

workmen to permit some reliance on imported labor. As he put the matter,

a force of furnace men taken from such laborers as were accessible here, and instructed in the industry, became unruly before they were half trained, and presuming upon their supposed monopoly of the art and my supposed necessities, began to demand extravagant wages and privileges tantamount to control of the works, and were only brought into subordination by the unexpected arrival, in June, 1861, of a second colony of Belgians, whom I had quietly sent for betimes.¹⁵⁰

This reliance on foreign workmen continued for several years after Wharton left the zinc industry, additional groups of Belgians being imported by the company in 1863 and 1864.¹⁵¹

A second obstacle arose in the form of anticipated foreign competition. Now, one can argue in retrospect that the quality of Wharton's product was such that he had no need to fear competition from other countries. However, his judgment on the matter was otherwise: "those dykes against the inundation of foreign spelter, which I had expected from a tariff upon it approaching the average of that upon other imported goods, were prevented by the importers, aided by some American spelter buyers, who disregarded the fact that their interest demanded a home production."¹⁵² In June, 1860, he wrote to Congressman E. J. Morris of Philadelphia: "Spelter is now imported into this country to the extent of about 10,000,000 to 12,000,000 lbs. (say \$600,000 worth) annually, paying a duty of 4 per cent; about an equal value of sheet zinc is imported, which pays 12 per cent duty. . . . I think there should be a specific duty of 1 cent per lb. or an ad valorem duty of 20 to 25% on spelter."¹⁵³ About a year later he again wrote Congressman Morris, "Chase's scheme for a Tariff raises the duty on Spelter, zinc in Pigs or Blocks . . . to \$1.50 per 100 lbs. The present Tariff (Morrill's) sets it at \$1.00 per 100 lbs. which will do well enough, though the higher rate will probably do no harm."¹⁵⁴

¹⁵⁰ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 172.

¹⁵¹ Myers, II, 34; Reichel, 144n. contains the names of all Belgians who came to South Bethlehem to work in the zinc factory.

¹⁵² Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 172.

¹⁵³ Wharton to Morris, June 6, 1860, Box 10, WP.

¹⁵⁴ Wharton to Morris, July 9, 1861, *ibid.*

A third major obstacle arose out of the depression which hit the nation's business in the months immediately preceding the outbreak of the Civil War. "Early in 1861, the demand for all goods had become very light in view of the threatening political aspect, and my spelter, though of the choicest quality and a few months before eagerly taken, could not be disposed of except in small quantities and at extremely low prices. A large stock accumulated in my hands, while money with which to continue the manufacture became very scarce."¹⁵⁵ In the spring of 1861 he wrote George T. Lewis that he had \$50,000 worth of spelter on hand and was constantly adding to the stock and requested some relief from the company.¹⁵⁶ For a time he paid his men in orders on the store in South Bethlehem,¹⁵⁷ and he gave up the idea of immediately establishing a rolling mill, which was essential to meet the demand for zinc roofing and sheathing.¹⁵⁸

The outbreak of hostilities between North and South eased this financial stringency. Zinc has many wartime uses, and the demand for the metal suddenly increased. Wharton disposed of his surplus and easily sold all the spelter he could make. As late as August, 1866, *The Moravian* reported that all the zinc works in the country could not meet the domestic demand for spelter.¹⁵⁹

The company had extended Wharton's lease of the spelter works from January 1 to April 1, 1863, "in order to compensate for certain deficient deliveries of ore." By this latter date the business was successfully established. Wharton summarized his production of spelter thus:¹⁶⁰

during the year 1860	1,100,580 lbs.
" " " 1861	3,158,630 "
" " " 1862	3,704,676 "
" 3 mos. of 1863	986,080 "
Total	<hr/> 8,949,966 lbs.

¹⁵⁵ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 172.

¹⁵⁶ Wharton to G. T. Lewis, Apr. 23, 1861, Box 10, WP.

¹⁵⁷ Letter from "Mechanic" to J. D. Laciari, Editor, *Lehigh Valley Times*, Mar. 2, 1861, 2.

¹⁵⁸ Wharton to A. George, June 20, 1861, Box 10, WP.

¹⁵⁹ *The Moravian*, Aug. 9, 1866, 4.

¹⁶⁰ Wharton, "Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States," 173-174.

Wharton listed the value of his spelter works as follows:¹⁶¹

*Value as of
Dec. 31*

1859	\$ 1,789.25
1860	11,164.85 plus \$10,000 spelter loan from P & L Zinc co.
1861	25,920.23 plus \$12,250 spelter loan from P & L Zinc co.
1862	72,768.25

When in April, 1863, Wharton turned the spelter works back to the company, he retired entirely from the zinc business. Relations between him and the company had been strained since the time he had leased it in 1857-1858. Partly, he disagreed with the company's policy of distributing large dividends to the stockholders; he would rather have diverted most of the profits into industrial expansion. During much of the period he was with the company a large part of his own assets was mortgaged, and there is no reason to expect that, given a free hand, he would have treated the assets of the company any differently. Also, and perhaps more importantly, he failed to gain control over the company. He could not get an extension on his lease of the oxide works; and the company strictly held him to the terms of his agreement in starting the spelter works, so that he had to return it to the company as soon as it was operating profitably. Possibly Wharton might have stayed on as general manager. But he was not of a temperament to work long under the direction of cautious, pedestrian persons such as Fisher.

Indications that Wharton was planning to leave the zinc company appear from about the time of the De Gee affair. In the spring of that year the company shortened its name to Lehigh Zinc Company, reduced the number of shares from two hundred thousand to twenty thousand, and increased the par value of each share from five to fifty dollars.¹⁶² It is doubtful, however, that these changes had any real effect on Wharton's decision to leave. But on April 24, 1860, he wrote to Fisher declining to be a candidate for re-election as a director.¹⁶³ The following August, in a confidential letter to George T. Lewis, Wharton listed the terms on which he would sell his assets

¹⁶¹ Account Books, 1859-1862, Box 26, WP.

¹⁶² *Laws of the Commonwealth of Pennsylvania, Session of 1860, 153-154.*

¹⁶³ Wharton to Fisher, Apr. 24, 1860, Box 10, WP.

in the company.¹⁶⁴ A month later he wrote to his uncle, Thomas J. Hollingsworth, that he disliked the new rules of the company and intended to resign as general manager, but not before May 1, 1861.¹⁶⁵ The following October 15 he sent a one sentence letter to Fisher: "I desire to resign the position of General Manager of the Lehigh Zinc Company as soon as a suitable person can be found to take the place."¹⁶⁶

Several times disputes between Wharton and the company went to arbitration. On one of these occasions Fisher privately visited Wharton's referee, Professor James C. Booth, and asked him to withdraw from the case. Wharton was angry about this and wrote to Booth, "The Lehigh Zinc Co. has as its head a half-bred lawyer with some knowledge of lawyer's dodges and very little knowledge of business. That Co. made a bargain with me hard enough for the prosperous times on which it was predicated, held me strictly to the full performance of it in these times, sent me ore for several months notoriously below contract quality, and refused to allow me any deduction in price unless my claim is absolutely proved."¹⁶⁷

Wharton made a fortune in establishing the zinc oxide and spelter businesses for the Pennsylvania and Lehigh Zinc Company. His account books give estimates of his net worth as of December 31 of each year from 1855 to 1862 and later. Some of these figures can be used to show the increase in his private estate:¹⁶⁸

<i>Year</i>	<i>Value of Total Estate</i>	<i>Value of Estate Free From Debt</i>
1855	\$ 34,608.64	\$ 3,258.64
1859	49,338.18	27,805.16
1860	65,174.41	37,395.91
1861	81,778.26	68,493.50
1862	204,764.51	128,424.92

¹⁶⁴ The assets and the terms on which he would sell them to the company were: (1) 7,145 shares of stock, not including convertible bonds and shares held by friends (an additional 5,000 shares), at \$2 per share; (2) the spelter business at \$25,000; (3) four dwellings housing workmen and two more being built, the rent being \$520 per year deducted from their wages, for \$3,000. Wharton to George L. Lewis, Aug. 8, 1860, *ibid.*

¹⁶⁵ Wharton to Hollingsworth, Sept. 25, 1860, *ibid.*

¹⁶⁶ Wharton to Fisher, Oct. 15, 1860, *ibid.*

¹⁶⁷ Wharton to Booth, July 17, 1861, *ibid.*

¹⁶⁸ Account Books, 1855-1862, Boxes 25 & 26, WP.

Naturally, he had business interests during this period other than those in zinc. A breakdown of his assets for 1862 reveals the following:¹⁶⁹

\$ 15,000	Bethlehem Iron company stock
26,250	Lehigh Zinc company stock
7,500	Reading Railroad stock
1,430	Thomas Iron company stock
72,768.25	Spelter business
15,000	Treasury notes
10,053.17	Cash

\$148,001.42 Total. The remainder, \$56,763.09, being in real estate and other securities.

Probably most of the money invested in treasury notes, the Bethlehem Iron company, and the Thomas Iron Company came from his profits from leasing the oxide business in 1857-1858.

Money was insufficient in itself to attract Wharton as long as opportunities existed for organizing and directing the use of the nation's resources. Moreover, as he concluded his work with zinc he felt a need to improve his formal education in the skills related to management. Accordingly, about the time that Wetherill rode off to war at the head of his troops, Wharton returned to Philadelphia, and from there went to Harvard for study in mathematics. He had religious scruples against bearing arms, but he found other ways to aid the cause against slavery. Within a few years, also, he would purchase the deposits of nickel ore at Lancaster, Pennsylvania, and would begin to develop the nickel industry of the United States.¹⁷⁰

Lehigh University

W. ROSS YATES

¹⁶⁹ Account Book, 1862-1863, Box 26, WP.

¹⁷⁰ Morris, lxxiii; Collins and Jordan, 82-85.