MINING HISTORY IN TWO DIMENSIONS: ENGINEERING DRAWINGS OF MILWAUKEE'S NORDBERG MANUFACTURING COMPANY

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The Nordberg Manufacturing Company produced heavy equipment from production facilities in Milwaukee, Wis., and St. Louis, Mo., for nearly a century, developing its name in the mining industry with steam-powered ore-crushing stamps, air compressors, pumps, and hoisting engines. Nordberg expanded into the internal combustion field, building some of the first (and largest) American diesel engines. The company became a significant producer of diesel engines in the utility power generation and marine propulsion markets.

Although the company ceased independent corporate status following a 1970 merger, hundreds of pieces of Nordberg equipment survive, many maintained in operating condition. In addition, portions of the company's business records are preserved in a variety of archival repositories, including large collections of engineering blueprints. The materials include project proposals, order books, photographs, advertising literature, and more than 1,200 sets of blueprint drawings.

The history of the Nordberg Manufacturing Company and the disposition of its archival records provide a useful case study of the value of such companies and collections to mining heritage. These collections, particularly the voluminous sets of dimensioned blueprint drawings, provide distinct curation challenges to collecting institutions and present mixed experiences in the actual and potential use by historians, restoration specialists, and other researchers.

A Brief History of the Nordberg Manufacturing Company

Bruno Nordberg was born in 1858 in Finland. At age 21, he received a degree in Technology from the Univ. of Helsinki. He immigrated to the United States, taking up a position with the Erie Railroad in Buffalo. In 1880, Nordberg moved to Milwaukee, accepting a position of draftsman with the E.P. Allis Company. He had an abiding interest in steam power and worked closely with the Allis line of Corliss steam engines. Nordberg was particularly interested in improving the efficiency of engines and steam-powered devices such as pumps and compressors. During his time with the Allis Company, he worked his way up to the position of designer and assistant chief engineer.

Nordberg developed a concept for a poppet valve steam engine with a unique cut-off governor. He was able to secure a patent for the governor and in 1886, with the support and capital of several colleagues, formed what was initially called the Bruno V. Nordberg Company. The enterprise rented space in a former Pabst Brewing Company

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warehouse, but quickly grew in size producing Corliss engines and other special purpose steam engines.[2]

By 1901, the company had constructed a new facility along Chase Avenue on the outskirts of Milwaukee. The plant would grow to be one of the largest heavy machinery manufacturing facilities in the United States, with machine and carpenter shops, a foundry for large castings, a pattern shop, and erecting rooms for pre-assembly of all machinery orders. The machine shop claimed to be the first in the world to have a separate direct current motor drive on each machine tool instead of line and belt shafting.

Initially, the company primarily filled orders for prime movers, pumps, and compressors, but Bruno Nordberg continued to seek new markets and customers. He made his first trip to Michigan's Keweenaw copper mining district in 1897. By this date, the mines were working at increasing depths and encountering problems finding hoist and pumping engines powerful enough to work to these levels. Company lore recounts Bruno Nordberg's visit with William Parnall, manager at the Tamarack mine, sketching on the back of an envelope the design for a cylindro-conical hoisting drum able to hold 6,000 feet of cable. The envelope is gone, but the original typescript proposal dated April 14, 1897 survives.[3]

The company soon expanded from hoisting engines to the construction of compound steeple steam stamps, pumping engines, and air compressors. Nordberg also entered into a license agreement with the Symons Company to produce cone crushers, later purchasing Symons in 1928 and expanding to produce gyratory crushers, ball mills, and rod mills. Today, the cone crusher is the only equipment to continue trading under the Nordberg brand name.

In 1914, the Nordberg Company completed a license agreement to develop oil-powered internal combustion engines using patents developed by Rudolph Diesel. These were mammoth stationary engines, designed as prime movers for large industrial plants. The first of these engines, a 1250 h.p., was delivered to the Phelps-Dodge mining company for their operations in Arizona. Phelps-Dodge was so pleased with these engines that they ordered another 12 the following year – and additional orders for a total of 27 engines by 1922, the last of which were rated at 2400 h.p. with 600 h.p. per cylinder. The company also began building large diesel engines for municipal power and water utilities. Many of these large Nordberg diesels still operate in communities across the United States.

The company found a market for large-bore triple-expansion steam engines in maritime applications. Even before the United States entered World War I, Nordberg was building steam engines for the Merchant Marine. Upon the declaration of war, Washington placed an order for 100 engines of 1500 h.p. each. Steam continued to have value as

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[2] Corporate history is taken from Nordberg Manufacturing Company, 1958, and Nordberg Manufacturing Company, 1961.
[3] The story is recounted in both Nordberg Manufacturing Company, 1958, p. 4, and Nordberg Manufacturing Company, 1961, pp. 16-17. The typescript order is in box 12, folder 1, Collection 957, Nordberg Manufacturing Collection, Archives Center, National Museum of American History, Smithsonian Institution.

an efficient technology – during World War II, Nordberg built 100 five cylinder uniflow steam engines which were used to power 50 “baby flat top” aircraft carriers.

Nordberg also adapted its stationary diesel to marine applications. During the Second World War, Nordberg built more than 400 maritime diesels (including some as large as 6,000 h.p.) for use in victory ships, ocean-going tugs and smaller cargo ships being built in Milwaukee, Manitowoc, Sturgeon Bay and Superior, Wis.

Nordberg had a long association – and competition – for large diesel manufacture with the Busch-Sulzer Bros. Diesel Engine Company of St. Louis, Missouri. Following World War II, Busch was acquired by Nordberg and became a second facility for the company’s growing product lines.

Over its many decades of business, the Nordberg Manufacturing Company extended its product line in many directions, including large-bore two-cycle engines, the first uniflow diesel engines, one of the earliest turbocharged four-cycle diesel engines, and a variety of heavy duty industrial radial engines. Its radial diesel and gasoline engines were used for electric power production, including an installation of 242 engines at an Aluminum Company of America (ALCOA) facility in Texas. In addition to steam and oil-burning engines, the company explored electrical equipment such as electric mine hoists and pumping equipment.

Nordberg operated a large railway division, developed through the acquisition of the Lake Superior Loader Co. and patents to the Peterson track shifter. The company eventually produced 27 machines trademarked in their “Mechanical Muscles” railway product line, as well as small gas and diesel engines under the “Power Chief” brand for use in oil fields and along pipelines.

The company also did custom work as a machine tool builder. Products included specialized lathes, milling machines and boring tools, as well as cloth felting machines for textile manufacturers and hydraulic extrusion presses for automotive and aerospace industries.

In 1970, Rex Chainbelt, a Milwaukee company which produced machine tools, purchased the Nordberg Company and formed a new corporation called Rexnord. Although the name continued in use with several product lines, the subsequent sale of the Milwaukee plant and the sale and absorption of parts of Rexnord by several multinational ventures all but eliminated the storied Nordberg name from the industrial landscape.

Disposition of Nordberg Corporate Records

Also in the 1970s, discussion began concerning the preservation of the company's historical records, still held in the main office in Milwaukee. These discussions included Robert Johnson[4], a steam enthusiast, collector, and museum consultant.

Although the specific chain of events is unclear, the discussions drew the interest of Robert Vogel, the curator of the division of mechanical and civil engineering for the Smithsonian Institution's Museum of History and Technology (now the National Museum of American History). A decision was brokered with Rexnord in August 1979 to move a core selection of Nordberg records to Washington, D.C., including business records, advertising material, photographs, and a selection of blueprint drawings.[5]

Addition selections of blueprint engineering drawings were distributed to new industrial archives developing at three other institutions: the Western Museum of Mining in Colorado Springs, Colorado, the University of Tennessee at Chattanooga (UTC), and in the Michigan Tech Archives at Michigan Technological University in Houghton, Michigan.

None of the collections have seen extensive processing or description since 1979. The author has been unable to confirm the status of Nordberg drawings sent to Colorado Springs, and little has done with the collection in Tennessee. In fact, the current storage at UTC provides insight to how the drawings were historically stored at the Nordberg factory in Milwaukee. Following completion of an order, blueprints for a project were gathered together with larger pieces folded down to a standard dimension. Holes were pierced through the stack and pieces of wood, nuts and bolts, and a metal S-hook hanger were attached. These "bunches" of drawings were hung on an iron pipe attached to the wall. According to Neil Honerkamp, the university "recognizes the potential research value of the collection and the necessity of curating it, but currently have no immediate plans to either use the collection in their department's research schedule, nor does the university have funds to upgrade curation."[6]

At the Michigan Tech Archives, until only recently Nordberg drawings were held on metal shelving in a back storage area, still bound with wooden slats and nuts & bolts. In 2004, in preparation for moving to new space, archives' staff disbound the drawing sets and foldered them in acid free map folders. They currently reside in archival quality flatfile map drawers. Although there is an initial index to the collection, it is only available in-house and not yet discoverable or usable to distant users.[7]

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[4] Johnson was influential in developing and coordinating many historical sites in Chattanooga and the Southeast. He restored the locomotive at the Chattanooga Choo-Choo, acquired and restored two locomotives for Silver Dollar City/Dollywood, and completed extensive design and documentation for the locomotive museum in Kennesaw, Georgia. He designed the 1876 Bicentennial exhibit at the Smithsonian in Washington, D.C., as well as other regional projects such as the Tannehill State Park in Alabama and the Florewood Plantation State Park in Mississippi. Johnson owned and operated Whistles in the Woods Museum Services, was a consultant for the historic collection of TVA, and was a founding member of the Society of Industrial Archaeology.

[5] Folder labeled "Nordberg Collection," box 13, Record Unit 397, Division of Engineering and Industry Records, Smithsonian Institution Archives.

[6] Personal correspondence with the author, March 24, 2009.

[7] Nordberg Manufacturing Company Engineering Blueprints Collection, Collection MS-871, Michigan Tech Archives.

Smaller groupings of Nordberg material remain scattered across repositories in the United States. As an active design and build engineering and manufacturing industrial firm, Nordberg corresponded with customers on both conceptual and completed projects. For instance, archival collections from both Michigan's Quincy Mining Company and Calumet & Hecla Mining Company contain documentation of the development and construction of specific pieces of equipment. In addition, thousands of historical photographs depict Nordberg equipment in operation at customer sites around the globe.

At Smithsonian, the Nordberg records are preserved in the Archives Center at the National Museum of American history. Although the collection includes a grouping of blueprints representing core pieces in the Nordberg product lines, the collection includes additional record types. Included are documentation of job proposals and customer information, as well as a set of technical engineering reports retained by the company's burgeoning research and development office. Time books record individual workers and the hours spent on certain types of work and company order books which document the number of man-hours and man-days put into each project.[8]

Perhaps most interesting are more than 3,000 photographic negatives and prints which depict almost every aspect of the company's history. Many document the day-to-day activity within Nordberg's massive physical plant, including the company's specialized machine tools used to work large pieces, such as a 12-foot milling machine and a 72-inch crankpin lathe. Additional images include Nordberg's pattern shop and foundry, capable of handling castings of up to 50 tons. The collection includes the company's business office and drafting room, while still others show Nordberg employees outside of the industrial setting at picnics and with the company bowling team.

Uses in Mining Heritage

Surviving archival and print records allow research into the history of the Nordberg Manufacturing Company and its customers. Correspondence with mining company engineers and business agents are complemented by sketches and additional sets of measured blueprints. Working from records at Smithsonian through to those held at other repositories, a researcher may follow a Nordberg machinery order from both sides of the transaction, often including photographs of test assemblies of large steam engines in the company's Milwaukee erecting shops as well as images of final installation on site. Access to this two-way correspondence between Nordberg and the northern Michigan mines, for instance, reveals the creative innovations shared between manufacturer and customer in improving and enhancing operating equipment.[9]

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[8] Vogel declined to take any voluminous amount of correspondence or accounting records from the Nordberg business offices. "Business records really were another category altogether with which we didn't do anything. That wasn't our role, at least as I saw our role. Our role was to record the history of engineering. Not business." Although Vogel suggested that the company contact the Baker Library at the Harvard School of Business, there is no indication that any additional company records were preserved. Interview with Robert Vogel by the author, May 30, 2009. See also letters exchanged between Vogel and Rexnord manager Richard Bains in folder "Nordberg Collection," box 13, Record Unit 397, Division of Engineering and Industry Records, Smithsonian Institution Archives.

[9] See, for instance, the exchange of letters in 1924 between Bruno Nordberg and Calumet & Hecla concerning storage of compressed air in their underground mine, box 71, folder 27**,** MS-002 Calumet and Hecla Mining Companies Collection, Michigan Tech Archives. Another good example is the November 1929 sketch sent from the Nordberg Company to the Quincy Mining

Archival records have also been supportive in the preservation and restoration of surviving Nordberg equipment. Drawings, business correspondence, and photographs have been critical in interpretation of the steam hoisting engine preserved by the Quincy Mine Hoist Association in Hancock, Michigan – and engine purported to be the "world's largest steam hoist."[10] Other examples of non-operating Nordberg hoists, compressors, and steam stamps remain on exhibit at numerous museums and historic sites.

Such records are not only used in service of rusting or inoperable equipment. The new Sanford Underground Laboratory at the former Homestake gold mine in Lead, South Dakota, relies on historic Nordberg hoisting engines to reach the 4850 level of the former Homestake gold mine to access its neutrino and dark matter experiments.[11] Dozens of Nordberg diesel engines continue to operate in municipal power plants around the country, many with ties to the mining industry. Archival records could be of value in the continued operation of such equipment or in the interpretation of these historic pieces to a wider audience.[12]

Many smaller restoration projects have been undertaken by mining and steam engine enthusiasts. For instance, a heritage group in Plymouth, California, salvaged a 1904 Nordberg Corliss engine from a historic site high in the Sierra Mountains and began work to restore the engine to operable condition for demonstration. Although drawings for this specific engine were not preserved, the group was able to locate information in the Nordberg collection at the Michigan Tech Archives on comparable Nordberg Corliss engines to identify critical measurements for cams, connecting rods, and other missing parts.[13]

Conclusions

Archival documents are critical to a variety of investigations in mining history. Records of industrial ventures such as the Nordberg Manufacturing Company pose special preservation problems in lieu of volume, wide-format engineering drawings, and often issues of cleaning and repair relating to use and storage at factory settings. The disposition of Nordberg's corporate records reflects the haphazard and idiosyncratic nature of document appraisal, selection, and preservation. In this case, engineering blueprints and some shop records were selectively retained while other records, such as accounting and correspondence, were not preserved. In other settings, archivists, librarians, and curators lack expertise to make informed decisions on the selection of

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Company suggesting improvements to their hoist overwind safety devices, box 362, folder 47, MS-001 Quincy Mining Company Collection, Michigan Tech Archives.

[10] Nordberg Manufacturing Company, 1961, pp. 6-7.

[11] These hoists are illustrated in Nordberg Manufacturing Company, 1938, pp. 20-21. Information on the Sanford research facility is available online at http://www.sanfordundergroundlaboratoryathomestake.org/ (accessed April 22, 2012).

[12] The City of Marshall, Michigan, still operates Nordberg diesel engines in its municipal power plant. See http://www.cityofmarshall.com/faqs/49 accessed April 15, 2012.

[13] Like many machine producers, Nordberg used a system of interchangeable drawings for many of its product lines. Basic designs for Corliss engines, compressors, and even hoisting engines could be scaled to the customer's power needs. Linen drawings for specific pieces, such as connecting rods, would have blanks for specific dimensions. Once a blueprint copy was made, engineers would add specific dimensions by hand with an oil pencil.

these types of records. As a result, they often preserve everything rather than making an informed selection.

Although important manuscript records from the Nordberg Manufacturing Company survive in a number of archival repositories, most of these collections have seen only minimal processing or description. Material held by Smithsonian and Michigan Technological University has seen limited use in the 40 years since its removal from Milwaukee, yet this may reflect the shortcomings in description and internet-accessibility. While ongoing improvements to collections cataloging at these two institutions may reveal these collections to more users through web crawlers, it is likely that collections in Tennessee and Colorado will remain hidden to potential researchers. Case studies such as Nordberg underline the challenges facing heritage agencies in collecting, preserving and providing access to the archival records of mining and industry.

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