A Place of Work: The Geography of an Early Nineteenth Century Machine Shop

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David Stephen Unger

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Advisor: Professor Peter Galison David S. Unger

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Abstract

Between 1813 and 1825 the Boston Manufacturing Company built a textile factory in Waltham, Massachusetts. Their factory is known for many important firsts in American industry, including the first commercially viable power loom, one of the first vertically integrated factories, and one of the first join stock financed manufacturing concerns. This successful factory became the direct model for the large textile mills built along the Merrimack River and elsewhere, iconic locations of American post-colonial industrialization.

This dissertation looks at the early development and success of the Boston Manufacturing Company from a geographical perspective. It argues that in order build a successful factory, the company, its managers, and its workers, had to transform their "place": a notion that I investigate from an economic-geographical and anthropological point of view, moving from site, to landscape, to geographic networks. On these grounds, I show how the logic of the factory's development was both embedded in and shaping the emerging structures surrounding it, and how, in turn, the company's later move to Lowell as one of the iconic industrial sites depended on its having successfully learned the business of "place-making" in its foundational Waltham decade.

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Dedication

In memory of Harry Rohr and Thomas W. Unger,
who inspired me wonder how things work.

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Introduction: Work-place and the Industrial World

The Boston Manufacturing Company built a cotton factory in Waltham, Massachusetts in 1814. Located ten miles west of Boston, the new factory was in a region undergoing a major transformation. New factories were being built in almost every town. New occupations, new machines, and new ways of communication developed. The economic structure of the region and nation was changing. The transformation was neither sudden, nor complete, but nonetheless, at every scale, from individual sites, to larger landscapes, to entire geographic systems, New England was changing. The region now held new kinds of places, and new relationships between places, as well as new social and labor relationships. The industrial and commercial world that emerged required a great deal of work to create and maintain. New sites were constructed, landscapes and environments were transformed, and people and things were moved around the region in new patterns. This dissertation is about how that world was built.

The story of the Boston Manufacturing Company is one of the mythic stories from the history of industrialization.[1] The Boston Manufacturing Company is often

1 Nathan Appleton, *Introduction of the Power Loom ; and, Origin of Lowell*, Development of American capitalism.Textiles. (Lowell, Mass: Printed by B.H. Penhallow,, 1858). William R Bagnall, *Sketches of Manufacturing Establishments in New York City and of Textile Establishments in the Eastern States* ([S.l: s.n.], 1908). R. Clark Bain, "Eleven Years at Waltham, 1813-1824: The Boston Manufacturing Company Machine Shop as an Agent of Technological Development and Transfer" (B.A. Thesis, Harvard University, 1981). George Sweet Gibb, *The Saco-Lowell Shops : Textile Machinery Building in New England, 1813-1949.* (Cambridge, MA.: Harvard University Press,, 1950). David J Jeremy, *Transatlantic Industrial Revolution : the Diffusion of Textile Technologies Between Britain and America, 1790-1830s* (Cambridge, MA.: MIT Press, 1981). Mailloux, Kenneth F. "The Boston Manufacturing

credited with a long list of American innovations: They built the first working power loom in America and the first vertically integrated textile mill. They were one of the first large textile mills built north of the Rhode Island sphere of influence, and they are often credited with being the first mill to employ New England farm girls on a large scale. They were one of the first manufacturing companies to raise capital from selling shares, and one of the first to employ professional managers.[2] The Boston Manufacturing Company's Waltham mill was also the direct model for Lowell, Massachusetts, New England's first industrial city. Much of the technology, labor organization, book keeping, and management practice used in Lowell were copied directly from the Waltham. From Lowell, the "Waltham system" spread to all of the Merrimack Valley mill towns.[3] Even the red brick architecture that became iconic of the region origi-

Company of Waltham, Massachusetts 1813-1848: The First Modern Factory in America," (Boston, MA: Boston University Press, 1957). Caroline F. Ware, *The Early New England Cotton Manufacture; a Study in Industrial Beginnings,*, Hart, Schaffner & Marx Prize Essays ;48 (New York: Houghton Mifflin company, 1931).

2 Like all "firsts," the achievements on this often repeated list must be qualified. For example, many other mills were producing power looms at the same time, and so the Waltham loom was soon joined by many independently produced, and often superior, machines. By 1820, there were already 1,300 power looms in New England and New York. Close examination also reveals that the complete "Mill Girl" style of labor and accommodations was not present in the first years of the Waltham factory. See especially, Michael Brewster Folsom, "Hype and History: What Really Happened in Waltham? The Boston Manufacturing Company, 1813-1979 (Charles River Museum of Industry, n.d.). Also, David J Jeremy, *Transatlantic Industrial Revolution : the Diffusion of Textile Technologies Between Britain and America, 1790-1830s* (Cambridge, MA.: MIT Press, 1981.), 275. Richard Candee, "Architecture and Corporate Planning In the Early Waltham System" in *Essays from the Lowell Conference on Industrial History 1982 and 1983.* Ed. Robert Weible (North Andover, MA: Museum of American Textile History, 1985).

3 James Montgomery, *The Cotton Manufacture of the United States Contrasted and Compared with That of Great Britain* (Glasgow: J. Niven, jun, 1840). Caroline F. Ware, *The Early New England Cotton Manufacture; a Study in Industrial Beginnings* (Boston,New York,: Houghton Mifflin company, 1931).

nated at the Boston Manufacturing Company.[4]

Histories of the Boston Manufacturing Company often focus on a small number of heroes, especially Francis Cabot Lowell and Paul Moody, and on the obvious economic success of the venture. The factory was not an isolated entity, built from scratch. It was not simply invented by Jackson, Lowell, and the other investors, nor was it conjured from the air by machinists and laborers. Neither was it an expression of abstract economic, political or historical forces. The factory was created by a long series of specific choices and actions made within specific contexts. In this dissertation, I will look at the work required to create the factory and its world.

In order to understand how this innovative factory was built, I will focus on the Boston Manufacturing Company's machine shop and the company's periods of growth. The company was first incorporated in 1813 and operated until 1930, but the first decade was the most dynamic part of this long history. Between 1813, when Francis Cabot Lowell returned from England with the idea to build a power weaving factory, to 1825, when the machine shop moved to Lowell, Massachusetts, the company constructed a complex of factory buildings along the Charles River, full of state-of-the-art machinery. During this period the machine shop was central to the company's

4 Richard Candee, "Architecture and Corporate Planning In the Early Waltham System" in *Essays from the Lowell Conference on Industrial History 1982 and 1983.* Ed. Robert Weible (North Andover, MA: Museum of American Textile History, 1985).

success and expansion.[5] The shop was the source of a number of innovations and improvements in the textile technology, was one of the largest machine shops in New England, and employed some of the region's most gifted mechanics. The true importance of the Boston Manufacturing Company's machine shop, though, is best understood in relation to the larger transformation of New England in the early nineteenth century.

The first decades of the nineteenth century were a watershed time in the development of New England industry. This period marks the transition from the Rhode Island centered system of textile production, to the northern factory towns of Lowell, Lawrence, Manchester, and others. Beyond the textile industry, other kinds of production were changing as well. Larger and more complex factories replaced the old grist and saw mills on the rivers throughout the region. These were not just textile mills. There were also rolling mills, nail factories, shoe factories, paper mills, and dye and chemical works. The development of factories was connected to a host of social, political and economic developments that quickly transformed almost every town in the region.

New England's transformation was not simply a matter of there being more factories, more products, and more workers. As production increased, as the density of factories increased, and as the rate at which these factories were built increased, the sys-

5 George Sweet Gibb, *The Saco-Lowell Shops : Textile Machinery Building in New England, 1813-1949.* (Cambridge, MA.: Harvard University Press,, 1950).

tems that built, outfitted, and supplied these factories also became more complex and more regular.

At the beginning of industrialization, machine building was closely tied to an older craft-based tradition of mill construction. From the region's earliest settlement, small mills ground grain and sawed wood on nearly every stream in every town. These mills were built by itinerant craftsman, called millwrights, using construction methods and labor arrangements that stretched back to the Medieval Europe. Though the first textile mills in the country were larger than the traditional mills, but they were still built in similar ways. A group of mechanics would be assembled and contracted to build a single mill and its machinery. Such groups were assembled only for a single project, as individual mechanics traveled from town to town building mills.

The Boston Manufacturing Company diverged from the tradition and began to make machine-building regular and industrial. It was one of the first factories with a permanent machine shop that employed machinists for daily wages. The shop was also one of the first places to produce textile machines for sale to other factories. The Boston Manufacturing Company's machine shop can be seen as one of the beginnings of a capital goods industry in the United States. They became a model for later textile machine shops, such as Draper or Whitin.

The world around the machine shop also changed as machine-building became an industry. Scattered factories could be built by itinerant millwrights working with local help, and could be supplied by ad hoc networks siphoning materials from preexisting trade networks. As industrialization proceeded, the circulation of materials and machinists was also transformed, as merchants developed trade networks specifically oriented toward supplying industry, and as the training, identity and social standing of machinists became more rigid.

The Boston Manufacturing Company's machine shop was part of this transformation. When they were building their first factory, they adapted preexisting systems: they hired carpenters, blacksmiths, and millwrights, they extracted materials from Boston's re-export trade, and they developed temporary arrangements with other small shops to produce components. By the time the shop moved to Lowell in 1825, the machinist's trade was clearly distinct from its precursor trades. New dedicated supply systems had developed and many components were being made by large, mechanized factories. The Boston Manufacturing Company was not just part of the development of industry, it was also part of the development of the systems that built and maintained the new industries.

Place and Work

The story of the Boston Manufacturing Company that I will tell here is grounded in the mundane details of factory construction and maintenance. I will dwell on the movement of casks of nails, the precise lay of the land along the Charles River, and the comings and goings of dozens of individual machinists. As the machinists and managers built the factory and its machines, they made innumerable choices of how and where to act. Although each choice appears inconsequential, when taken together, larger patterns emerge that help explain and illuminate the larger processes of industrialization. In order to understand the relationship between mundane detail and the larger history, it is useful to develop two interlinked concepts: place and work. Both concepts get at the phenomenological, lived experience of the world in a way that uncovers the sense in apparently meaningless actions and choices. A focus on place and work also allows a new perspective on the history of technology, historical geography, the relationship between different geographical scales, and ultimately, the development of the industrial world.

Philosophers of place make a distinction between *space* and *place* that is useful here.[6] Space is used to refer to an abstract sense of location, as in finding a point in a coordinate system. A spatial view tends to see each point in space as fundamentally equivalent, differentiated by only the things found there. To think about space is to imagine oneself outside of the system, looking down at a map, or a diagram. Place, on

6 Edward S. Casey, *Getting Back into Place : Toward a Renewed Understanding of the Place-world*, 2nd ed., Studies in Continental Thought. (Bloomington: Indiana University Press, 2009.). Edward S. Casey, *The Fate of Place : a Philosophical History* (Berkeley: University of California Press, 1997.). Edward S. Casey, “On Habitus and Place: Responding to My Critics,” *Annals of the Association of American Geographers* 91, no. 4 (December 2001): 716–723. Edward S. Casey, “Between Geography and Philosophy: What Does It Mean to Be in the Place-World?,” *Annals of the Association of American Geographers* 91, no. 4 (December 200): 683–693. E. C Relph, *Place and Placelessness*, (London: Pion,, 1976). Yi-fu Tuan, *Space and Place : the Perspective of Experience* (Minneapolis: University of Minnesota Press, 1977).

the other hand, is an embodied phenomenon. It is the abode of living, moving, intentional bodies. In contrast to the bird-eye view of space, a place-based view is submerged in the world. Further, places are inseparably part of the social world. All social interactions happen in places. Whether city streets, government buildings, or factory floors, social interactions are shaped by the places in which they occur, while at the same time places are shaped, consciously or unconsciously, by the social dramas and struggles that unfold in them. In the language of critical geography, place and social action produce and reproduce each other.[7] Place is both the medium and the outcome of social acts.

Work is similarly phenomenological and specific. Work is the activity of making things. It is the process of shaping the world according to some idea of a desired outcome. Everything is the product of work. Each thing in the human world has to be painstakingly created, shaped, used and maintained. There are two important aspects of work. First, work is specific. It is an activity undertaken by specific actors at specific times and places, under specific circumstances. Second, work is structured. Actions are purposefully undertaken by knowledgeable and self-reflexive actors. Bourdieu referred to this structured nature of action as "habitus" and Giddens referred to

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7 Anthony Giddens, *The Constitution of Society: Outline of the Theory of Structuration* (University of California Press, 1986). Edward W. Soja, *Postmodern Geographies: The Reassertion of Space in Critical Social Theory (Second Edition)*, Second Edition. (Verso, 2011).

it, perhaps more usefully, as "structuration."[8] Despite the theoretical differences between Bordieu and Giddens, both were trying to understand the simultaneously open and structured nature of everyday life. On the one hand, individuals make choices from moment to moment. On the other hand, these improvised performances seem to add up, across many individuals to a coherent social world. The relationship between the two aspects can be understood as a circuit of activity in which both actions and the world come into existence together. So, at the moment of action people's understandings, the objective, social conditions in which they exists and the material possibilities that surround them are brought together (or are made to confront one another), and shape the actual activity and experience. This work changes the world or creates objects, which embody or objectify the circumstances that went into making them. The world, thus transformed, is the basis from which new activities begin. The world is brought into existence and kept in existence by the constant repetition of this circuit, thus creating a world external to any individual's interpretation, but deeply dependent on their understandings. The result is that the things people do, and the world in which they do them, have what Bourdieu calls a "practical coherence."[9]

8 Pierre Bourdieu, *Outline of a Theory of Practice*, (Cambridge ;New York :: Cambridge University Press,, 1977).

9 *Ibid*

An embodied and active understanding of work and place offers a new focus for understanding both technology and geography. A history of work is a history of technology that emphasizes the lived experience of the technical world. Technology is not a force in the world, nor is it a collection of politically or ideologically neutral objects and ideas. It is something that is lived with, and lived through everyday. Through this lived-in-ness, technical objects and methods are continuously produced and reproduced, and so are imbued with a practical coherence that grounds them in social and cultural systems. Similarly, a history of place is a geographical history that emphasizes the interconnections between place and experience. Places are neither neutral setting nor irresistible determinants. Instead, places are created and maintained by actions which are in turn structured and shaped by those places.

This view also gives a way to think about the development of the industrial world. The new industrial world was not an alien order imposed on a traditional world. Actors at beginning of the story were acting within an older world order, but creative action started to change how that world was reproduced. These changes gradually shifted and restructured social relationships and organizations. Soon small changes added up to something new. Looking at en-placed work, makes it possible to see how the change was both revolutionary and evolutionary.

A view of place and work also reconfigures the view of geographical scale. From the smallest scale of individual work, to the larger scale landscapes, and regional (and global) economies, are all created by specific activities and relationships. While all actions are structured by nested layer of place.

Chapter Overview

This dissertation explores the workplace of the Boston Manufacturing Company and the development of New England industry by looking at place at a series of scales. Spiraling outward, from the factory site, to the town's landscape, to the region's geography, each chapter re-tells the story of the company's first decade.

Chapter 1 is about the sites that the Boston Manufacturing Company built and inhabited. These sites must be understood as a combination of the built space, the equipment, the people, and their activities. The chapter begins in Boston in Jackson's Broad Street office, and follows the initial construction of the factory, the early activities of the machine shop, and the later expansion of the shop into its own building. I argue that the story of the site and the story of the company are one, and that over the course of the decade, as the machine shop's role expanded, it became increasingly independent, physically, organizationally.

Places are never isolated. They are always involved with other places. The following chapters continue to expand the focus. Chapter 2 examines the relationship between the company and the landscape of the town in which it was located. The landscape was a complex of different aspects, including the geomorphology of area, environmental resources, social, and industrial aspects of the town. The chapter traces the complex and changing situation in Waltham when the Boston Manufacturing Company arrived, looks at how the company responded to the opportunities and challenges presented, and at how Waltham was changed as a result. I argue that the Boston Manufacturing Company was part of a much longer development of the landscape, in which many features of the later industrial town long pre-date the arrival of the factory.

Place can also be a discontinuous phenomenon. A region can be seen in terms of the density of interaction and connections that create a system of activity. In the two final chapters, I look at material connections across the region and the work needed to create and maintain movements of people and things to and from the shop. Chapter 3 looks at the relationships formed to supply the shop with the raw materials needed to build machines. Nearly all the materials were purchased in Boston. As an active merchant city, Boston offered a great variety of materials sold by a great variety of suppliers. The company developed different strategies for each material that allowed them to obtain the materials of sufficient quality. This chapter argues that the mere presence of material flows cannot account for the shop's activities. In order to take advantage of materials, the shop had to develop relationships, and manage knowledge.

Chapter 4 explores the ways in which the process of making machines was embedded in and distributed across places. I argue that machine building was both a local and regional process. The tasks and skills required were distributed in a variety of places throughout the region. The organization of this system changed as the shop grew. Although the basic process of building machines stayed the same, the distribution of the work across the region and the internal organization of the work changed. The boundary of the shop became increasingly compex as external firms acted as almost like internal departments, and some workers inside the physical walls of the shop acted as independent entities. This chapter shows the interconnections between different scales of place, as the most local activities turn out to depend on regional circulations of people and parts.

Chapter 1: The Sites

The Boston Manufacturing Company began in a counting house in Boston. As the company developed, its managers created an increasingly complex collection of sites. First, a shop and a factory on the Charles River in Waltham, followed by a series of houses, store rooms, and offices. As the company grew, additional factories and workshops were added to the original site, and a bleachery was added a mile downstream. The story of the Boston Manufacturing Company is a story of the development of this collection sites. In this chapter I argue that these sites were not merely locations for action, but were deeply connected to the people and activities involved in creating a factory.

The Boston Manufacturing Company's sites were more than mere containers for activity. Sites are complexes that involve both the material and the immaterial, the fleeting and the permanent. Lives unfold within sites. In Heidegger's terms, sites allow people to dwell, that is to be on earth.[1] Put simply, what happens, and how it happens is largely dependent on where it happens. At the same time, sites are only distinguished through the events that happen there. The people who occupy a site, the things that they do, and the physical

1 Ibid.

form of the site all come into existence together. All three parts create and define each other. The story of the site, then, has three components: facilities (buildings, installations, tools), occupants (people who occupy that place, and whose lives are tied to the place), and occupations (what those people spend their time doing). None can be understood in the absence of the others.

As the Boston Manufacturing Company created their series of sites, they brought together people, created buildings and other facilities, and undertook activities. At the same time, these places were made by distinguishing them from other a background of older places. The Boston counting house became unique as a manufacturing headquarters in the midst of a street of merchants, and the brick factory in Waltham stood out among the town's wooden structures. The development of the company and of the sites it occupied were closely linked, and so throughout the first decade, when the both were changing rapidly, the basic logic of the company can be seen its sites. The company's first sites were closely tied to preexisting kinds of places and activities. As the company developed, it created more complex, specialized and novel kinds of places.

The Counting House: Broad Street, Boston

In November of 1813, with the wind from the nearby Boston Harbor becoming colder, and the days getting shorter, Patrick Tracy Jackson's counting house on Broad Street was busy with a new kind of activity. The samples of indigo, tobacco, and rice that had been the center of Jackson's livelihood for the previous twenty years were now pushed to the corners of the office and were replaced by samples of iron, boxes of blacksmith's tools, and machinery models. On the first floor, the account books tracking coastal and West Indies trading were put away, and new books following orders for lumber, bricks, coal and iron sat on the clerk's desk in their place. Jackson also found himself involved in business relationships with new people. He sent letters to lumber mills in New Hampshire and factory owners in Rhode Island, and machine builders from across New England arrived at his office hoping to find work. The second story of the counting house had also been transformed. Where shipments and goods were once stored, Jackson's brother-in-law, Francis Cabot Lowell, had set up a small workshop in which he had spent most of the previous year struggling to understand the design of the power looms he had seen in Britain. This is where the Boston Manufacturing Company began.

The Boston Manufacturing Company started in an office on a street that was in the heart of Boston's merchant district. Broad street ran between the waterfront and the financial district and was lined with warehouses, counting houses, and auction houses.[2] The street, its buildings and its occupants were all deeply involved in the city's sea-bound trade. The street itself was created as part of the development of the city's waterfront. When Boston was first settled, it comprised a small amount of solid ground surrounded by extensive marshes and mud flats. Large trading vessels had to anchor a great distance from shore, and goods and people had to be ferried back and forth in shallow-bottomed launches. Beginning in the eighteenth century, Bostonians built wharfs out toward the deep water. Over time, they filled the areas between wharfs, creating usable land. This process of "wharfing out" gradually shifted the edge of the city of Boston toward the harbor. At the turn of the nineteenth century wharf building intensified with several large projects, including the construction of India Wharf, and a major expansion of Long Wharf. Broad Street lead directly to these new wharfs, and quickly filled with offices, warehouses, and counting houses that supported the increased trade the new wharfs allowed.[3] Situated in Jackson's counting house, the Boston Manufactur-

2 Annie Haven Thwing, *The Crooked & Narrow Streets of the Town of Boston 1630-1822*, Tercentenary ed., rev. with additional notes. (Boston: Lauriat, 1930).

3 Francis Blouin, *The Boston Region, 1810-1850: A Study of Urbanization, Studies in American History and Culture no. 10 (Ann Arbor, Mich: UMI Research Press, 1980).* Harold Kirker, *Bulfinch's Boston, 1787-1817* (New York: Oxford University Press, 1964). Nancy S Seasholes, *Gaining Ground : a History of Landmaking in Boston* (Cambridge, Mass.: MIT Press, 2003).

ing Company's first site was at the heart of the city's sea-borne commercial life.

This was a familiar setting for the company's organizers. Nearly everyone involved in the initial development of the company, from investors to officers, were part of Boston's merchant trade. For many, their business lives were already centered on Broad Street and the surrounding neighborhood.[4] It is well known that the capital for the new company came from prosperous merchants looking for new areas of investment, but looking at the site at which the company started reveals how tied their day-to-day activities were to the old merchant world. This is especially true of the company's two primary organizers, Patrick Tracy Jackson and Francis Cabot Lowell. Patrick Tracy Jackson was at home in this part of the city. Until 1812, his entire career was centered on merchant commerce. Jackson was born in 1780 in Newburyport, Massachusetts, a smaller port city forty miles north of Boston. He was the the youngest son of a

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Nathaniel Bradstreet Shurtleff, *A Topographical and Historical Description of Boston* (Boston: Printed by request of the City Council, 1871). Annie Haven Thwing, *The Crooked & Narrow Streets of the Town of Boston 1630-1822*, Ter-centenary ed., rev. with additional notes. (Boston: Lauriat, 1930). Walter Muir Whitehill, *Boston: A Topographical History*, 3rd ed., enl. (Cambridge, Mass: Belknap Press of Harvard University Press, 2000).

4 Robert F Dalzell, *Enterprising Elite: The Boston Associates and the World They Made*, Harvard Studies in Business History 40 (Cambridge, Mass: Harvard University Press, 1987).

merchant named Jonathan Jackson. Both of Jackson's older brothers went to sea when young, and eventually became ships' captains. Patrick Tracy Jackson took a different route into the merchant world. He attended Dummer's academy in Newburyport until, at the age of 15 he became an apprentice clerk for a merchant named William Bartlett. Within a few years Jackson had learned enough to be entrusted with a cargo of goods bound for St. Thomas in the Virgin Islands. Upon returning om the voyage, Jackson's brother offered him a position as captain's clerk on a voyage to India. Jackson spent the next years on a series of trips between Boston and Calcutta.[5]

Jackson quickly rose to the position of the ship's "supercargo." As a supercargo, Jackson was responsible for the business of buying and selling the goods that the ship carried, and he earned a percentage of the profit he made for the cargo's owners. The markets in which Jackson traded were complex and constantly changing, so Jackson often had to enter into elaborate series of exchanges to turn freight into profit. On one voyage, for example, Jackson found prices in Calcutta especially low. He bought as much as his cash and credit resources would allow. The goods he bought could not all fit on the ship,

5 Jonathan Jackson et al., *The Jacksons and the Lees; Two Generations of Massachusetts Merchants, 1765-1844,*, Harvard Studies in Business History ;3 (Cambridge, Mass.,: Harvard University Press,, 1937).

so after sending the first ship back to Boston, Jackson stayed behind to find passage for the remainder. The ship that eventually carried him and the excess goods stopped at the Cape of Good Hope during the return journey. Jackson found prices high at the Cape, and so sold his cargo. With the proceeds he bought another set of goods, which he sold on the nearby islands. After a long series of interlocking exchanges, Jackson finally returned to Boston, nearly four years after he had left.[6]

The life of a supercargo was demanding and risky, but an energetic and skilled trader, like Jackson, could quickly earn enough to become an independent trader. Jackson returned from his last India voyage in 1807 and spent the next few years disposing of the goods he had sent back from India. He also invested in East and West Indies trading, imported European articles, dealt in Southern goods, such as cotton, rice, and indigo, and owned a significant number of shares in several ships, mostly with his brothers and other family members.[7] By 1812, Jackson was well established in Boston's merchant community.

Francis Cabot Lowell was one of the other major figures behind the Boston Manufacturing Company, came from a similar background. Lowell was also

6 Jacksons and Lees. Jackson MSS.

7 Jacksons and Lees

from a Newburyport family. Francis' father, John Lowell, was a lawyer and a prominent public servant from Newburyport, who moved to Boston in 1778. During his career, John Lowell served as a Newburyport selectman, one of the framers of the Massachusetts Constitution, a delegate to the Third Congress of Confederation and the first chief judge for the First Circuit of the U.S. Circuit Court. Francis attended Harvard College, as his father and brother had, but did not follow the family trade of law and politics. Instead he studied mathematics and after graduating in 1793, became a merchant. Like Jackson, he served as a supercargo for several years before setting up his own business in Boston on Long Wharf. He traded in cotton and juniper berries, and invested in the construction of India Wharf, the expansion of Long Wharf and the building of Broad Street. He also owned land in Maine, and had an interest in rum distillation. In 1793 Lowell married Hannah Jackson, Patrick Tracy Jackson's sister.[8] Lowell was successful in his business ventures, but unlike Jackson, did not remain in his Boston offices. He had been sickly since a child, and by 1810, the exertions of the previous years had had an ill effect on his health. In addition, Lowell may not have had his brother-in-law's taste for the stresses

8 Ferris Greenslet, *The Lowells and Their Seven Worlds ...* (Houghton Mifflin Company, 1946). Chaim M. Rosenberg, *The Life and Times of Francis Cabot Lowell, 1775-1817* (Lexing-

and uncertainties of merchant business.[9] In the fall of 1810 Lowell put his business activities on hold, and he and his family sailed for Britain for a change of air and scenery.

This trip brought Lowell into contact with the industrial places already built in Britain and introduced Lowell to new industrial activities. While touring England and Scotland, Lowell visited British textile mills, where he saw the newly developed water-powered looms that were just then beginning to transform the British cotton industry. Though spinning was largely mechanized in Britain by the mid-eighteenth century, weaving was still done on hand-looms until the early nineteenth century. This created a major bottleneck in production. Thread could be produced very quickly and cheaply, but weaving the thread into cloth was slow, labor intensive and expensive. The situation was similar in the United States. Water-powered spinning was introduced by Samuel Slater outside Providence, Rhode Island in 1790, and quickly spread throughout southern New England. Factory-made thread was sent out to hand weavers working in their own homes. Unlike in Britain, though, there was not

ton Books, 2011).

9 For speculation on Lowell's attitude toward life as a merchant see, Robert F Dalzell, *Enterprising Elite: The Boston Associates and the World They Made*, Harvard Studies in Business History 40 (Cambridge, MA: Harvard University Press, 1987).

a large community of weavers who could process the thread. Spun thread piled up in factory warehouses, waiting to be woven.[10]

Lowell recognized the potential of the new British looms, and when he returned home in 1811, he was determined to build a water-powered weaving factory.[11] Lowell convinced Jackson of the potential of the new venture, and two years later they began to gather the capital necessary build the machine and a factory to house it. On February 3, 1813, they petitioned the Massachusetts Legislature for a charter to establish a cotton manufactory, to be called the Massachusetts Manufacturing Company, with maximum capitalization of $400,000. At the time it was unusual for a privately owned manufacturing company to receive such a charter. Charters were generally for more public works, such as roads or canals. The Act of Incorporation was approved on February 23, though the name was changed to the Boston Manufacturing Com-

10 John L Hayes, *American Textile Machinery: Its Early History, Characteristics, Contributions to the Industry of the World, Relations to Other Industries, and Claims for National Recognition* (Cambridge: University press, 1879). David John Jeremy, *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1970-1830s* (Basil Blackwell, 1981). James Montgomery, *The Cotton Manufacture of the United States Contrasted and Compared with That of Great Britain* (Glasgow: J. Niven, 1840). Caroline F. Ware, *The Early New England Cotton Manufacture; a Study in Industrial Beginnings,* (Boston,New York,: Houghton Mifflin company,, 1931). Martha Zimiles, *Early American Mills*, 1st ed. (New York: C. N. Potter; distributed by Crown Publishers, 1973).

11 Appleton, Nathan. *Introduction of the Power Loom ; and, Origin of Lowell*. (Boston: B.H. Penhallow, 1858). “1812,” Francis C. Lowell I MSS , Massachusetts Historical Society.

pany.[12]

The incorporation was part of a transformation of the Broad Street site. What had been just one of many merchant offices became a different kind of place. In 1813, Jackson closed his trading business in order to concentrate on the newly incorporated company. He liquidated his holdings, collected his debts, and paid his bills.[13] This proved to be a major turning point in his career. Although in later years, Jackson was occasionally involved in limited commercial ventures, he would focus on manufacturing concerns for the rest of his life.[14] As the Boston Manufacturing Company's agent, Jackson was responsible for its day-to-day operation and organization, much like a modern chief executive officer.[15]

12 William R Bagnall, *Sketches of Manufacturing Establishments in New York City and of Textile Establishments in the Eastern States* ([S.l: s.n.], 1908), 1976-8. "Accounts Current Ledger A," and "Directos Meetings Volume 1," Boston Manufacturing Company MSS, Baker Library, Harvard University (hereafter cited as BMC MSS).

13 Jackson Letter to Joseph Cutler, Nov 21, 1815. Lee Family Papers Volume 16, Massachusetts Historical Society.

14 At first only the Boston Manufacturing Company, though he was later heavily involved in setting up the Merrimack Manufacturing Company and the Locks and Canals Company in Lowell, and started a chemical works in Waltham. Jonathan Jackson et al., *The Jacksons and the Lees; Two Generations of Massachusetts Merchants, 1765-1844,* Harvard Studies in Business History ;3 (Cambridge, MA: Harvard University Press, 1937).

15 Jackson was paid a salary for this work. In the early nineteenth century it was unusual to have this kind of professional manager. Instead the company's owners often had a more direct involvement in operations.

Although the manufacturing focus was new, the tools and skills employed by Jackson and his clerks overlapped with those of his merchant neighbors. He was able to use many of the organizational skills developed in his training as a merchant in the new venture. The success of the Boston Manufacturing Company depended on careful record keeping. At the time, most manufacturing concerns kept basic balance-sheet type records that simply kept track of incoming and outgoing money in order to determine profits. Jackson's books were far more complex. As was common for merchant's books, Jackson tracked the factory's finances in a series of books in which the daily business of the company was distilled to increasingly condensed forms. Journals and waste-books kept track of the daily expenses as they occurred. These expenses were then tallied by account into Ledgers, which were summed into annual or semi-annual reports.[16] These records are almost the only surviving artifact from the company's first years. The complexity and completeness of these records speaks to the work done on Broad Street, and even the series of delicate hand-writings that appear in the book provides a link to the activities of the com-

16 Osamu Kojima, *Accounting History* (K. Kojima, 1995). Edward Peragallo, *Origin and Evolution of Double Entry Bookkeeping: a Study of Italian Practice from the Fourteenth Century* (Printed by the Rumford press, 1938). Herbert James Eldridge, *The Evolution of the Science of Book-keeping* (Gee, 1954). William Newell Hosley, *Theory & Practice of Bookkeeping in America Before 1820: Applications to the Study of Material Culture* (Wadsworth Atheneum, 1984).

pany's early days. Almost every item the company bought while constructing the factory appears in these records. Each cask of nails, basket of coal, and shipment of lumber appears in these books. As work began on the factory and as machines were built, Jackson kept track of it all from the Broad Street counting house. Throughout the company's first decade, Broad Street continued to be the company's organizational center. For the entire period, the Broad Street office was a site rooted in both the established merchant world, through the skills employed there, and in the emerging manufacturing world, through the subjects to which those skills were employed.

In the company's first years, the Broad Street office was also a site for more novel activities. Machine building and the company's machine shop began there. After returning to Boston, Lowell spent nearly two years in the loft above Jackson's offices, trying to recreate the machines he had seen in Britain. No details survive about Lowell's process. It appears that he worked largely alone, though Nathan Appleton later recalled that he had employed an assistant to turn a crank. Jackson may have helped as well.[17] By November of 1813, Lowell had some models and prototypes, but he was still far from having a

17 Nathan Appleton, *Introduction of the Power Loom ; and, Origin of Lowell* (Printed by B.H. Penhallow, 1858).

working industrial machines. It would take a crew of machinists another year to produce a fully operational power loom.

The Broad Street office was also the center for recruiting the machine-builders who would complete the loom and construct some of the machines for the new factory. This process brought the Broad Street office in contact with new places and reinforced connections to familiar places. To begin, Jackson and Lowell needed someone to oversee machine building. They turned to the Massachusetts North Shore, where both were born and still had family connections. Jackson and Lowell initially tried to hire a well known inventor and industrialist from Amesbury, Massachusetts named Jacob Perkins. Perkins declined the offer, and recommended instead his former head mechanic, Paul Moody.[18]

Like Jackson and Lowell, Paul Moody was from the North Shore. Moody was born in 1779 in a small community called Bywater, near Amesbury and Newburyport. The Moody family were farmers of relatively high social standing. All six of Paul's brothers attended the Dummer Academy (where Jackson also went to school), and two of the brothers went on to receive college educa-

18 Perkins was a very optimistic choice for the job. By this date Perkins was a very well established factory owner in his own right. For more on his remarkable career, see Greville Bathe, Dorothy Bathe, and Historical Society of Pennsylvania, *Jacob Perkins, His Inventions, His Times, & His Contemporaries* (The Historical society of Pennsylvania, 1943).

tions. Paul's interests were more mechanical and practical, and he became an apprentice hand-weaver in a woolen mill in Bywater at the age of 12. Moody later worked in a nail factory built by Jacob Perkins, where he became Perkins' assistant and learned machine building. In 1801 the factory moved to Amesbury, and Moody moved along with it. He was later employed by Kendrick and Worthen, a firm that built wool carding machines. Moody set up the machines in mills in New Hampshire and Maine. Sometime before 1812, he entered into association with Worthen and others to construct a wool and cotton mill in Amesbury.[19] When Lowell and Jackson contacted Paul Moody, he was a well established and successful mechanic. Moody left this growing network of North Shore industries to join the Boston Manufacturing Company.

Moody was engaged as the superintendent and an agent of the new company for an annual salary of $1500. He was to oversee the building of the dam, mill, houses, and machinery, as well as to "take charge of the conduct of the workmen, and of every other part of the business of the manufactory."[20] Moody came south to Boston on November 1, 1813 to help Jackson hire more

19 John N. Ingham, "Paul Moody," in *Biographical Dictionary of American Business Leaders* (Greenwood Publishing Group, 1983). Charles Cotesworth Pinckney Moody, *Biographical Sketches of the Moody Family: Embracing Notices of Ten Ministers and Several Laymen from 1633 to 1842 ...* (S. G. Drake, 1847).

20 "Directors Meeting Volume 2", and "Boston Manufacturing Company agreements, volume 187", BMC MSS.

machine-builders.[21]

At the beginning of November prospective machinists began appearing at the Broad Street office in response to an advertisement Jackson had placed in the New England Paladium the previous month. Jackson advertised for twenty workmen who "understand making the different kinds of machinery used in a cotton manufactory," as well as a blacksmith, whitesmith and finisher.[22] The advertisement resembled many others that appeared in New England newspapers. New mill owners generally contracted semi-itinerant mechanics to come to their town to build the necessary machinery, set up the mill work, and sometimes oversee the mill construction. This arrangement paralleled and might have been a direct outgrowth of how traditional mills, such as grist mills and saw mills, had been constructed.[23] Although Jackson's advertisement looked like others, he had a different employment arrangement in mind. Rather than contractors, Jackson was looking for employees to work for a daily wage. Not all of the applicants understood this. One misunderstanding in particular illustrates the difficulty. Lemuel Chase and Nathan Buffington presented them-

21 Lowell Letter to Paul Moody, 12 October 1813, Lowell MSS, Volume 4.

22 Chapter 4 for more on these trades."Wanted, Twenty Workmen," New-England Palladium, 12 October, 1813.

23 Terry S Reynolds, *Stronger Than a Hundred Men: A History of the Vertical Water Wheel* (Baltimore: Johns Hopkins University Press, 1983).

selves at Jackson's Broad Street office and offered to build cotton machinery for the new mill. When Jackson informed them that he only wanted machine makers to work by the day, Buffington left immediately. Chase was willing to accept a day wage, but asked to be paid very highly and demanded the use of a horse to visit his family on his days off. Jackson agreed to check Chase's references but, although no record has survived, it unlikely that he was hired.[24] Both applicants held their independence to be important, and found the idea of submitting to a day wage strange.

Jackson also made direct inquiries to contacts he had in several industrial locations. Just as he had contacted Jacob Perkins looking for a head mechanic, he sent letters to several other mechanics and industrialists located outside the Boston area. He contacted Caleb Stark, who was at that time in Pembroke, New Hampshire. Stark's biography paralleled those of Jackson and Lowell. The Starks were an old and prominent New Hampshire family. After serving in the Revolutionary army at the age of 17, Stark returned to northern New England and developed extensive merchant interests in Dunbarton, New Hampshire and Haverall, Massachusetts. In 1806 he moved to Boston where he had an office on Broad Street, near Jackson's counting house. In 1810 Stark

24 Jackson Letter to John Borden, Lee MSS, Vol 16.

traveled extensively in Britain, and like Lowell, must have been impressed by the industry he saw. On his return in 1812, he closed his importing business and moved back to New Hampshire to begin a textile mill in his hometown of Pembroke.[25]

Though Stark and Lowell returned from Britain at approximately the same time, Stark's mill was nearly complete by the end of 1813. Jackson wrote to Stark to ask if any of his machine makers would be willing to come to Waltham to work for the Boston Manufacturing Company. Jackson was particularly interested in finding a master workman and fine woodworkers, which he referred to as "joiners." Jackson also asked if he could send Paul Moody to New Hampshire to meet the prospective employees and inspect their work.[26]

Jackson also wrote directly to a machine maker in Fall River, Massachusetts, named John Borden.[27] Fall River was located in Southern Massachusetts, and by 1813 was within the expanding sphere of the Providence-based textile

25 Stark devoted the majority of his attention to the cotton factory until the 1830's, when he accepted a government grant of land in Ohio in recognition for service during the Revolutionary War. He died in Ohio, in 1838. Nathan Franklin Carter and Trueworthy Ladd Fowler, *History of Pembroke, N. H*, 1895. Caleb Stark and John Stark, *Memoir and Official Correspondence of Gen. John Stark*, 1860.Ezra S. Stearns, William Frederick Whitcher, and Edward Everett Parker, *Genealogical and Family History of the State of New Hampshire: A Record of the Achievements of Her People in the Making of a Commonwealth and the Founding of a Nation* (Lewis Publishing Company, 1908).

26 Jackson Letter to Caleb Stark, 21 October, 1813 , and 13 November, 1813, Lee MSS.

27 Jackson Letter to John Borden, 13 November, 1813. Lee MSS.

industry. Several textile mills were built there in the first decade of the century, and members of the Borden family were associated with most of them. It is likely that John Borden was involved with the Fall River Manufacturing Company, which was also being completed in 1813. The Fall River Manufacturing Company was organized by local land and mill owners, many of whom were Bordens. Richard Borden and his son Thomas were major shareholders, two more Bordens were subscribers, and thirteen of the thirty-three employees listed in the first time book were Bordens.[28] John Borden may have been one of the seventeen Bordens involved in this company. Whether or not he was involved in this particular company, John Borden was an experienced mechanic who employed his own workmen. Jackson wrote to him to ask under what terms he would be willing to engage at the Boston Manufacturing Company. he also wanted to know how many of Borden's current workmen would be willing to come with him. Although Jackson hoped to find workers and foreman who had already worked together, Jackson was still not willing to deviate from his intention of hiring machine makers as wage employees. He

28 At the time, a significant portion of the Fall River population shared the last name "Borden." They were not, though, all closely related. Henry Hilliard Earl, *Fall River and Its Industries: An Historical and Statistical Record* (New York, Atlantic Pub. and Engraving Co.; Fall River, Mass., B. Earl & Son, 1877). Hattie Borden Weld, *Historical and Genealogical Record of the Descendants as Far as Known of Richard and Joan Borden* (H.B. Weld, 1899).

explicitly wrote to Borden that he was only interested in hiring by the day or month.

In his initial search Jackson overestimated the company's needs. Being a novice industrialist, he might not have understood how much labor was needed. It is also possible that the company was able to purchase more completed machinery than they originally thought (see Chapter 4). Whatever the cause, Jackson hired far fewer than the twenty workmen he originally expected. No record has survived of whom Jackson hired or where they came from, but the payroll expenses that were recorded in the account books suggest that Jackson only hired between three and five machinists.[29] But even the small crew could not work in Jackson's counting house. By the beginning of December, Moody and the machine makers had moved ten miles west, to Waltham, the site of the future factory. The Boston Manufacturing Company, though, did not abandon the Broad Street office. This office became, and remained, the company's administrative center. Jackson and his clerks kept the account books, ordered materials, paid wages, and eventually sold cloth

29 In 1814, the Boston Manufacturing Company spent an average of forty-six dollar per week on machinists' wages. If each machinist earned an average of $1.50 per day (as they would would two years later), and each worked a six day work week, there would have been five machinists working on an average week. These early machinists may have earned more on average, which would mean there were even less of them.

from this site beside the harbor. The winter of 1813-14 marked an watershed moment in the company's story. From that time on, the company occupied a second site where the actual work of making cotton cloth would eventually take place. That winter began the assembly of the new site, which would culminate in the autumn of the following year when the new factory began operation.

Manufactory Number One: Waltham, Massachusetts

In early autumn of 1814, the Boston Manufacturing Company's new factory on the Charles River was almost finished, as was the new water-powered loom. For the first time, Jackson allowed the company's investors to see where their money was being spent. The investors would have traveled the half day's ride out the well-worn post road to Waltham and the company's new site. The factory sat perched next to the Charles River, about three hundred yards down a gentle hill from the center of the town's main street. At four and a half stories, it was taller than the surrounding buildings, and its clean red brick stood out among the wooden buildings that made up most of the town. The new slate roof reflected darkly in the slanting October sun. Ladders leaned against the building where glazers were installing the last window panes. The steep roof was topped with a white tower, containing a newly cast bell and topped with a brightly pol-

ished brass wind vane. Workmen were still at work on the dam, but the water level above the dam had already begun to rise.

On the river side of the factory, blocked from view if approached from the main road, was an older timber framed building that had been part of the paper mill that previously occupied this site and was now in use as a machine shop. Next to it stood a newly built blacksmith's shop. Acrid coal smoke rose from one of the forge chimneys, along with the intermittent clank of a blacksmith at work forging brackets. This was the machine shop where Paul Moody and four or five other mechanics had spent all of the winter and most of the summer, building and perfecting the power loom. By now the loom worked, and the machine-makers were spending less time in the shop and more time in the factory itself. As the builders completed the building's structure, the machinists had been installing the system of gears, shafts, wheels and belts that distributed the water wheel's motion throughout the factory. They were also setting up, adjusting and connecting the textile machines that had recently arrived from another machine shop ten miles to the south-west. The Boston Manufacturing Company's first factory was complete, and the first machine shop's purpose was nearly fulfilled.

The Boston Manufacturing Company's factory could not have been located near the Broad Street office. The new factory would require more space than was available on Boston's cramped peninsula, and more importantly, the factory had to be located on a water-power site. The Act of Incorporation that created the company required it to be located "at Boston, in the County of Suffolk, or within fifteen miles thereof."[30] So while Jackson and Lowell were organizing the investors, they were also searching for a location. They found a failing paper mill, owned by John Boise, on the Charles River in a growing town called Waltham (Chapter 2). In September 1813, Jackson bought the mill, its dam and its mill privilege, along with seven-eighths of an acre near the river, a right-of-way between the dam and the Great Road, and sixty-seven acres across the river in Newton, for $1000. In January, 1814, he transferred ownership of the mill and most of the land to the Boston Manufacturing Company.[31]

Mills along the rivers and streams of Massachusetts often changed owners, and almost just as often changed function. It was not unusual for a lumber mill to become a fulling mill, or a grist mill to be turned into a snuff grinding mill. Such transformations often involved little change to the buildings or the site. The machinery inside the mill could simply be replaced or converted. At other

30 "Directors Meetings Volume 1," BMC MSS

31 Middlesex County Court House, Cambridge Massachusetts, Deeds MSS, Vol 200, p. 429, Vol 207, p. 3.

times new functions were added to an existing mill site, by either installing new machinery along side the old, or adding new mill buildings to the site.[32] Nearby mill sites in Newton and Watertown followed this pattern. The Boston Manufacturing Company, however, did not. The old paper mill was torn down and its machinery sold.[33] Over the course of 1814 the company almost completely rebuilt the site so that in the end the new factory would stand alone.

During the winter, Jackson began to locate the materials needed to build the factory. In the early nineteenth century most mills, including the textile mills in Rhode Island, were made of wood, with timber framing and clapboard siding.[34] Here, again, Jackson departed from the usual pattern. He originally planned to build the factory from stone, but switched to brick. The choice may have reflected the extensive use of brick in fashionable architecture in Boston.[35] Whether intentional or not, the use of brick created a direct archi-

32 Edward Pierce Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the Massachusetts Historical Society* 71, (1953-7): 111. Hamilton Hurd, *History of Middlesex County, Massachusetts, with Biographical Sketches of Many of Its Pioneers and Prominent Men* (Philadelphia: J. W. Lewis & co, 1890).

33 Volume 80, BMC MSS.

34 Gary Kulik, "A Factory System of Wood." in *Material Culture of the Wooden Age*, Ed. Brooke Hindle Tarrytown, NY: Sleepy Hollow Press, 1981), 307-312.

35 Boston Manufacturing Company is also often cited as the first brick mill building in the United States, though the claim is contested. Michael Brewster Folsom, "Boston Manufacturing Company, Historic American Engineering Record Report," Charles River Museum of Industry (n.d.). Pierson

tectural link between the old Broad Street site and the new Waltham site, and gave the two a visual similarity. Brick was not a convenient choice. The necessary amount of brick does not seem to have been available, and Jackson had to advertise in newspapers to locate a supply.[36] He eventually found a suitable supply of bricks, which were delivered to Waltham in the spring.[37] Bricks were only one of many materials needed. The factory also required large amounts of timber for rafters, joists, columns and flooring, as well as glass, shingles, stone, gravel, nails, lime, and a seemingly endless list of small hardware items. Jackson organized the purchase and delivery of most of these materials from the Broad Street office.

Construction began in the spring of 1814. To oversee the project, the Boston Manufacturing Company hired a Boston-based merchant named William Blaney. He was paid a salary approximately equal to Paul Moody's.[38] Blaney appears to have been responsible for the work that took place in Waltham. He also paid the construction laborers and contractors and purchased local supplies.[39] By having Blaney on the new site, Jackson and Lowell could remain in

36 "Bricks," in The Repertory, 2 December, 1813.

37 Jackson Letter to Lowell, 30 January 1814, Lowell MSS.

38 Volume 80, BMC MSS

39 Ibid.

Boston.

The construction work was carried out by a combination of local builders, who were contracted by the job, and a crew of carpenters and laborers, who were on the company's payroll. The contractors included I. Carter, who spent one hundred and twenty-one days excavating, A. Hagar who blasted for both the building and the privilege, and Dennis, Page, and Johnson who did much of the masonry for the new buildings. The bulk of the work was done by workers who, like the machinists, were hired on day wages. Between June and October of 1814, the Boston Manufacturing Company spent nearly four thousand dollars on their wages. This would have been sufficient to pay forty-five full-time laborers.[40] There were almost ten times as many people working on the building as on the machines.

The mill they built ran parallel to the river, and was sited next to the dam. It was forty feet wide, ninety feet long and four stories tall. It boasted little architectural ornament, though it did feature a double, or clerestory roof, with a row of long and narrow windows dividing the roof to allow light into the attic. It also had a granite foundation, a full basement, and an octagonal bell

40 This figure is calculated based on an average labor's wage of $1 per day, for a six day week.

cupola, which housed a bell cast by Paul Revere.[41] The foot print of the factory was not much larger than other textile mills of the period, though it was taller. Compared to the smaller timber structures that made up most of the town, it must have been a striking building.

During the winter on 1813 and 1814, Paul Moody and the machine-builders were already at work in Waltham perfecting the power loom, and preparing the gearing that would distribute power throughout the mill. The Boston Manufacturing Company's machine shop is generally thought to have been in the factory's basement, as was common practice at the time, but machinists were active in Waltham long before construction of the factory had begun. Although the shop may have later moved into the factory's basement, it must have started elsewhere. A new blacksmith's shop was one of the first things built at the new site. In December, 1813, a local builder and property owner, named David Townsend, poured a concrete floor and furnace, while S. Ron did the masonry work for the furnace, and A. Garfield built a small wooden build-

41 This first mill is still standing. It is located on what is now Moody Street in Waltham, just north of the river. In the late nineteenth century the clerestory roof and the copula were removed when a fifth floor was added. Richard Candee, "Architecture and Corporate Planning In the Early Waltham System," in *Essays from the Lowell Conference on Industrial History, 1982 and 1983* Ed. Robert Weible (Museum of American Textile History, 1985). Michael Brewster Folsom, "Boston Manufacturing Company, Historic American Engineering Record Report," Charles River Museum of Industry (n.d.). Oren Helbok, "UROP Report, Summer 1984," Waltham Public Library (1984).

ing. In total the new blacksmith's shop cost four hundred and fifty dollars. The other machine builders may have shared space with the blacksmiths, but it is also possible that they used a building associated with the old paper mill. The lack of shop space might also have contributed to the small size of the initial crew of machinists. When Jackson wrote to Stark looking for machinists, he mentioned that he would be unable to hire many people over the winter because of the limited space.

The machine shop and the construction of the loom was left almost entirely to Moody and his machinists. Lowell was in Washington, DC and Jackson only occasionally left Boston to see the shop's progress. The Waltham mechanics struggled through most of 1814 trying to get the loom to work properly. In January of that year, Jackson reported to Lowell that during his most recent visit to Waltham, he had finally seen the loom weave several yards of fabric, though he also noted that the shuttle still jammed, the stop-motion did not always work properly and ice in the river made the power difficult to regulate.[42] These problems would not be completely solved until the following autumn.

The surviving account books did not record names of the machine builders

42 Jackson to Lowell letter, Lowell MSS.

who worked in the shop during that first winter, though their contributions may have been almost as important as those of Lowell, Jackson and Moody. Later records, though, may give an indication of some general characteristics of people employed in textile factory machine shops in the early nineteenth century. Workers do not appear to have been drawn from a single source, and robably came to Waltham from across New England.[43] Most of the machinists were between eighteen and twenty-two years old. At this age they would have completed their training or apprenticeships, but would not have yet become well established. Many of these machinists would only stay briefly at the Boston Manufacturing Company, before moving onto work at other shops, or to start their own factories or machine shops (Chapter 4).[44]

Machine building was still a relatively new trade in the United States, and as such there was no well established path by which people became machinists. The variety can be seen in the training of the later employees at the Boston Manufacturing Company. Some employees began their careers in older trades.

43 A Lowell machinist who worked in the shop at this time later remembered the shop as being staffed entirely by native-born New Englanders, though his memory may have been colored by the frustrations of a mid-nineteenth century worker in Lowell who faced growing competition with immigrants for work. Mailloux, Kenneth F. "The Boston Manufacturing Company of Waltham, Massachusetts 1813-1848: The First Modern Factory in America," (Boston, MA: Boston University Press, 1957).

44 David R Meyer*, Networked Machinists: High-Technology Industries in Antebellum America* (Baltimore: Johns Hopkins University Press, 2006).

For example, Bethuel Fillebrown was trained as a blacksmith by his father in Bridgewater, Massachusetts.[45] Oliver S. Hawes, who was one of the leading machinists at the shop after 1816, apprenticed as a wheelwright in Boston before leaving to learn machine building in Medway, Massachusetts,[46] and Joshua Swan apprenticed as a carpenter in Methuen, Massachusetts before coming to the Boston Manufacturing Company.[47] Some machinists came from families with connections to industry. For example, George Brownell, who was a long time employee and eventually became the shop's foreman, was born in Portsmouth, Rhode Island, where his family owned New England's only anthracite mine. Brownell left home at the age of twenty to learn machine building in Fall River, Massachusetts.[48] Dean Walker's father, Comfort Walker, was a millwright who constructed flax spinning wheels and had built many mills in the Medway, Massachusetts area before starting a cotton factory

45 Charles Bowdoin Fillebrown, *Genealogy of the Fillebrown Family: With Biographical Sketches* (1910).

46 William R Bagnall, *Sketches of Manufacturing Establishments in New York City and of Textile Establishments in the Eastern States* ([S.l: s.n.], 1908). William Richard Cutter and American Historical Society, *Encyclopedia of Massachusetts, Biographical--genealogical* (American historical society, 1916).

47 Fanny Winchester Hotchkiss, *Winchester Notes* (Printed by Tuttle, Morehouse & Taylor Co., 1912). Levi Swanton Gould, *Ancient Middlesex with Brief Biographical Sketches of the Men Who Have Served the Country Officially Since Its Settlement* (Somerville Journal Print, 1905).

48 William R Bagnall, *Sketches of Manufacturing Establishments in New York City and of Textile Establishments in the Eastern States* ([S.l: s.n.], 1908).

in Framingham.[49] Moses Whiting's family owned mills on the Neponset River from the eighteenth century, and Whiting himself had inherited a mill privilege in 1809.[50]

These machinists were highly skilled, well trained, and ambitious. Isaac Markham was a good example. Markham was born in Middlebury, Vermont in 1795. At the turn of the nineteenth century, Middlebury was a small but dynamic industrial center. By 1795, the town had two grist mills, two sawmills, a forge, a gun factory, and a fulling mill, along with a population of blacksmiths, carpenters, a carriage-maker, and a marble quarry and mill. In the first years of the nineteenth century many technical improvements were introduced into the town's industries, including state-of-the-art wool carding machines, a process for welding cast steel developed and patented locally, new ways to saw marble. A Scotsman, Joseph Gordon, built a power loom in Middlebury in 1817, and by 1820, the Middlebury textile mill was the largest in the state. Isaac Markham began building machinery for the textile mill at the age of 17, in 1812. By 1819, Markham was the superintendant in the mill, and had mastered the

49 George James La Croix, *The History of Medway, Mass., 1713-1885* (J. A. & R. A. Reid, 1886).

50 Erastus Worthington, *Historical Sketch of Mother Brook, Dedham, Mass: Compiled from Various Records and Papers, Showing the Diversion of a Portion of the Charles River into the Neponset River and the Manufactures on the Stream, from 1639 to 1900* (Press of C.G. Wheeler, 1900).

iron and brass work involved in constructing the power looms. Markham was also a skilled draftman, and his drawings are some of the earliest surviving examples of American machine drawing. His notes, sketches and calculations show his conscious effort to master the art of machine design and construction. In 1820, Markham left his prominent position in Middlebury to work as a wage machinist at the Boston Manufacturing Company. While at the shop he earned $1.33 per day, which was the average for the machinists. He worked in the Waltham shop steadily until 1821, when he returned to Middlebury. Markham was soon the superintendent and agent of the cotton factory, a position comparable to that of Paul Moody or Patrick Tracy Jackson. Markham combined a keen technical mind, with extensive manual and intellectual training, and an ambition to reach the upper strata of New England industry. His life and career were cut short before these ambitions could be fulfilled. Markham died of typhus in 1825, at the age of 30.[51]

The machine shop site was also defined by the tools it contained. The first shop contained about one thousand dollars worth of smith's, machinist's and carpenter's tools. One of the first purchases was a set of equipment for a black-

51 David J. Jeremy and Polly C. Darnell, *Visual Mechanic Knowledge: The Workshop Drawings of Isaac Ebenezer Markham (1795-1825), New England Textile Mechanic* (American Philosophical Society, 2010). Markham Family Papers, Shelburne Museum, Shelburne Vermont.

smith, which included an anvil ($44), bellows ($20), dies and punches ($7), and a set of hammers, tongs and other tools ($17). The company also purchased hand tools for the carpenters and machinists, including grinding stones, files, hand saws and tool steel from which they could make other tools. The shop also bought castings for several machine tools from Shepard Leach in Easton, Massachusetts (Chapter 4). These castings included a roller lathe (256 pounds), a fluting engine (300 pounds), and a cutting engine (73 pounds).[52] No details regarding these tools have survived, and with the metal cutting techniques in rapid flux in the early nineteenth century, it is difficult to guess what these machines would have been capable of doing.[53] It is likely that all three were simple tools, designed to speed up the rough and repetitive tasks involved in making large numbers of rollers and spindles. From the combination of machine and hand tools, it is possible to get a sense of the kind of operations the machine builders carried out. Overall, work at the shop was a combination of hot forge-based work, hand-file work, and machine-tool work (chapter 4).

52 BMC MSS.

53 Hugh Fermer and Chalk Pits Museum Amberley, *Machine Tools: A History 1540-1986* (Amberley: Amberley Museum, 1995). Joseph Wickham Roe, *English and American Tool Builders* (New Haven: Yale university press, 1916). L. T. C Rolt and Museum (Great Britain) Science, *Tools for the Job: A History of Machine Tools to 1950*, Rev. ed. (London: H.M.S.O, 1986). W. Steeds, *A History of Machine Tools, 1700-1910* (Oxford: Clarendon P, 1969). Robert S Woodbury, *Studies in the History of Machine Tools* (Cambridge, Mass: M.I.T. Press, 1972).

By early 1815, the new factory was producing more than two thousand yards of heavy, unbleached canvas a week.[54] With the buildings completed, there was no need for the contractors, carpenters or laborers. Neither did the company have further need for its machine builders. With the exception of Paul Moody, payroll expenses for the machine shop ended. Just as there is no evidence as to where the machinists came from, there is also no evidence as to where they went. The machine shop had played its role. The company now consisted of two distinct sites that clearly divided the two major factory functions between them. The organizational work continued to be situated in Boston, while the now complete Waltham factory undertook the work of turning raw cotton into finished fabric. This arrangement proved to be only a brief pause in the company's growth. Within a year, the Boston Manufacturing Company was expanding again. This began a continual process of growth that would create an increasingly complex and subdivided site.

The Expanding Complex and New Machine Shop

At the height of summer in 1825 a Waltham sign painter named Elijah Smith set up his easel in a pasture on the south bank of the Charles River and began a painting of the mill complex he saw across the river. This painting would be one of the earliest repre-

54 "1815," Lowell MSS

sentations of the Boston Manufacturing Company, and illustrated the mill at the end of a remarkable decade of growth.[55] *Smith depicted the variety of the mills buildings with great care. At the center of the complex were two large brick factories perfectly lined up with one another, and running parallel to the river. Between the factory buildings and the river stood a smaller, two story brick machine shop with a one story wooden building attached to it. Several yards down stream, at the edge of the company's property, sat a long, low blacksmith's shop, with its roof punctured at regular distances by chimneys. Other small buildings peppered the site, including a counting house, a picker house, several houses for workers, and numerous storage sheds.*

Whether or not Smith understood the purpose of these buildings, he captured a complex site, carefully divided by function into several smaller sites. No longer a single factory, the Boston Manufacturing Company was now made up of increasingly distinct sections. One of those sections, the machine shop, would detach completely within a few months of the painting's completion. The shop with all its occupants and tools would move thirty miles north to North Chelmsford to begin building what would eventually become the city of Lowell. Such a separation was already foreshadowed in the construction of the Waltham site.

55 For more on the discovery of the painting, see Richard Candee, "Architecture and Corporate Planning In the Early Waltham System," in *Essays from the Lowell Conference on Industrial History, 1982 and 1983* Ed. Robert Weible (Museum of American Textile History, 1985).

Machine building at the Boston Manufacturing Company began again in 1815 after only a brief pause. The first factory was so successful that the company's directors soon decided to expand the operation by building a second, larger factory. The company's capital was increased with a second subscription,[56] they purchased twenty acres between that lay between the original site and the Great Road,[57] and work soon began on the new factory and a series of supporting buildings.

The new factory was to be the same forty feet wide as the first, but would be one hundred and fifty feet long, and house twice the machinery. The process of constructing the building was similar to that of the first factory, including the employment of many of the same contractors. This time, though, there was a model to follow, and many problems such as the sources of building materials were already solved. The factory building was completed in 1816.

The new factory was the largest of several building projects that would

56 Most of the new money was raised from the same group of investors. Among the few new people to be allowed access to the stocks was Paul Moody, who was given a half share, which he was allowed to pay for with his dividends.

57 "Directors Meetings, Vol 2," BMC MSS.

expand the Boston Manufacturing Company mill grounds. The company constructed a two story brick counting house, a picker house, and a number of outbuildings. They also built houses of varying sizes and designs for the workers and managers. By 1820, the Boston Manufacturing Company owned twenty dwellings in Waltham.[58] In 1818 the Boston Manufacturing Company also acquired a second location on the river.[59] The Waltham Cotton and Woolen Company, who occupied the next mill privilege downstream from the Boston Manufacturing Company (Chapter 2), fell victim to the end of the war timeboom, and the difficult economic times that followed.[60] In 1819, the Boston Manufacturing Company bought the failing company's land, buildings and

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58 Richard Candee, "Architecture and Corporate Planning In the Early Waltham System," in *Essays from the Lowell Conference on Industrial History, 1982 and 1983* Ed. Robert Weible (Museum of American Textile History, 1985). Michael Brewster Folsom, "Boston Manufacturing Company, Historic American Engineering Record Report," Charles River Museum of Industry (n.d.). Oren Helbok, "UROP Report, Summer 1984," Waltham Public Library (1984).

59 BMC MSS.

60 John Warner Barber, *Historical Collections* (Warren Lazell, 1848). Samuel Adams Drake, *History of Middlesex County, Massachusetts: Containing Carefully Prepared Histories of Every City and Town in the County* (Boston: Estes and Lauriat, 1880). D. Hamilton Hurd, *History of Middlesex County, Massachusetts, with Biographical Sketches of Many of Its Pioneers and Prominent Men* (Philadelphia: J. W. Lewis & co, 1890). Charles Alexander Nelson, *Waltham, Past and Present; and Its Industries* (M. King, 1882). Kristen A Petersen and Waltham Rediscovered (Organization), *Waltham Rediscovered: An Ethnic History of Waltham, Massachusetts* (Portsmouth, NH: Published for Waltham Rediscovered by P.E. Randall, 1988). Edmund Lincoln Sanderson, *Waltham as a Precinct of Watertown and as a Town, 1630-1884* (Waltham historical society, inc., 1936). Edmund Lincoln Sanderson, *Waltham Industries: A Collection*

privilege.[61] The new site was too close to the old, and the river's power potential was not great enough to support another large factory complex. Instead, the company built a bleaching facility on the site. With these additions, the Boston Manufacturing Company was no longer a single building on the river. It was now a complex of building, each with a distinct function, and which housed different activities. The machine shop was one such newly differentiated site, and found a new independence and importance during this period.

With the beginning of new construction in 1815, the company set up structures that allowed them to continue to grow. One of the most important of these was a large and partially independent machine shop. After 1816, the shop became a long-term presence in the company. It built machines for the new factory, and repaired and replaced machines in the old. It also began to sell machinery to other factories, earning a profit independent from the cotton manufacturing business.[62] In 1816 the Boston Manufacturing Company built eight looms for Poignand and Plant of Lancaster, Pennsylvania.[63] Other orders followed, though it does not appear that the company actively pursued such

of Sketches of Early Firms and Founders (Waltham, Mass: Waltham Historical Society, 1957).

61 "Directors Meetings Volume 2," BMC MSS.

62 George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969).

63 BMC MSS

business, nor kept close account of its profitability.[64] In most cases, the shop declined to sell individual machines. They preferred instead to construct complete sets of machinery to outfit whole factories.[65] In 1825 the shop completed one of its largest orders. They constructed all of the machinery for the Merrimack Manufacturing Company located forty miles north on the Merrimack river in North Chelmsford.[66] It was to be the first of many textile mills in an area that would soon become known as Lowell, Massachusetts.

In order to fulfill this new role, the machine shop required a larger, more permanent setting. In March of 1816 a new shop was completed. At $750.47, it cost twice what the original blacksmith's shop had cost.[67] The shop was built like a miniature of the factories. Like the factories, it was made from brick, and featured a clerestory roof, though it was only two stories tall. In the summer of 1817 the shop was further expanded with a long, low wooden building that adjoined the existing shop. This addition cost only $133 in carpenter's work. In 1822 both the blacksmith's shop and the machine shop were further

64 George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969).

65 Lowell MSS

66 BMC MSS

67 Ibid.

improved.[68]

The new shop had to be outfitted with new tools. In the fall of of 1815, the Boston Manufacturing Company spent $2091 on tools for the new shop, twice what they had spent on tools for the first shop, though they were of essentially the same kinds. They continued to buy hand tools for blacksmiths, carpenters, and machinists. The shop also purchased castings for more machine tools. In early 1815, they bought one hundred pounds of cast iron for a lathe with a slide rest.[69] In 1816 they bought an additional turning engine and cutting engine, and a roller engine in 1817.[70] In 1824, just before the shop was moved north, they bought thirty-three thousand pounds of cast parts for machine tools, probably to outfit the new shop in North Chelmsford, though some may have been used in Waltham before the move. There may have been castings for other machine tools that were not listed separately from large orders of other castings, which were often described simply by weight.[71]

Just as with the earlier shop, much of the tooling for the new shop was constructed in-house. All of Moody's salary for the last quarter of 1815 was charged

68 Ibid.

69 Ibid.

70 Ibid.

71 Ibid.

to the "tools" account.[72] Later, when payroll records began to be divided into different accounts, tools made up a consistent, though small portion of the total. From January to March of 1816 the shop spent $33 on labor on tools, out of a total labor cost of $776. Work on tools continued to account for about 4% of the payroll for the remainder of the year. In 1817, twenty-three individual machinists spent a total of two-hundred and thirty-one person-days on tools. No further work on tools was recorded until 1823, when ten individuals spent one hundred and sixty-one person-days on making tools.

The new shop also needed a larger crew. In 1815, Jackson advertised for a founder (someone who could cast metal), four machine builders, and one wood turner.[73] Unlike the previous year, Jackson hired more people than he advertised for. In January of 1816, the shop began to spend three times as much per week on payroll as they had in 1814. It appears that there were now between six and eight full-time machine-builders. The shop also began to employ inside contractors (chapter 4). In 1816 there were 25 contractors employed throughout the year. The shop continued to grow, though Jackson never again needed to advertise for workers. Between 1817 and 1824 the precise number of employ-

72 Ibid.

73 "Workmen Wanted," Boston Daily Advertiser, 28 August, 1815

ees varied from week to week, with an average of thirty employees at the shop each week. There was also an ever-growing number of contractors and their helpers. By 1824 there were over seventy contractors and helpers working at the shop.[74]

The full and busy machine shop of 1824 existed for only a brief moment. In fact, the Waltham shop's last project was to construct the machinery for a new site for a new company called the Merrimack Manufacturing Company, in North Chelmsford, Massachusetts[75]. The new company was owned by the same investors involved in the Boston Manufacturing Company, and its creation can be seen as a new phase of the original company's growth. Before the year was over most of the machines and people would be moved to a new, much larger building located near the new factory, and at the heart of what would become the largest concentration of factories in the country. The new shop, briefly part of the Merrimack Manufacturing Company before being transferred to the Proprietors of the Locks and Canals,[76] occupied a building as large as the textile mills that it serviced, and employed over three hundred

74 BMC MSS

75 George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969).

76 BMC MSS

machine-builders. Much later the shop would become completely independent as the Lowell Machine Shop. The process was already well underway, as early as 1816, when the shop moved into its own building. Unlike other mills that arranged ad hoc machine building when needed, the Boston Manufacturing Company made the machine shop an enduring part of the place, and increasingly a separately defined space.

Chapter 2: The Landscape

The Boston Manufacturing Company's factory site was located in a landscape of a small town on the Charles River called Waltham. It was surrounded by other sites, and embedded in natural, social and political systems. The site was built among the gentle hills of the Boston Basin. The tallest point in the area reaches only 635 feet above sea level, but very little of the land is flat. Many small brooks and streams drain into the larger, slow moving Charles River, which winds its way to the wide tidal flats of the Boston Harbor. Before the company arrived, Waltham was a growing farm community. It was not a dramatic landscape, but even so the stories that unfolded there were subtly, though inexorably, shaped by the structure of the land, the flow of the river and the layers of history.

The development of the company's site, and of the company itself, was connected to the development of the town of Waltham in which it was located and the river on which it was set. Both the town and the river underwent a major transformation in the first decades of the nineteenth century. By 1830, the population more than doubled.[1] The Main Street was crowded with shops,

1 For more on Waltham demographics see, Howard M Gitelman, *Workingmen of Waltham: Mobility in American Urban Industrial Development, 1850-1890* (Baltimore: Johns Hopkins University Press, 1974).

tradespeople, and inns. The town supported fraternal organizations, social clubs, a number of religious congregations, a bank, and even a library. New streets connected newly constructed houses, and parks lined sections of the river. There were districts in which nearly every inhabitant worked in the factory, and elegant summer houses of the company owners stood among old farms. Even the river had changed, with nearly one hundred acres of former armland underwater. By the 1830's Waltham was an industrial town.[2]

It is tempting to see the arrival of the Boston Manufacturing Company as the sole cause of this transformation. The company's buildings and employees were the most conspicuous feature in the new landscape. Most of the new population worked at the factory, and many of the new institutions were introduced for their benefit. By looking at the history of the landscape as a whole, though, it is possible to see that this development was a longer and more complex phenomenon. The Boston Manufacturing Company did not build their factory in an empty "greenfield" site, or in a timeless agricultural community. The Waltham factory was part of a longer process. Many of the features so

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2 Timothy Dwight, *Travels in New England and New York*, (Cambridge, Mass: Belknap Press of Harvard University Press, 1969). *Geographical Gazetteer of the Towns in the Commonwealth of Massachusetts* ([Boston: Printed by Greenleaf and Freeman,, 1784),

apparent in the later industrial town, such as significant manufacturing, technological innovation, Boston-based investment, ties to commodity production, and population concentration and power divisions, were already developing before the company arrived. The activities of the Boston Manufacturing Company and its employees accentuated and accelerated some of these process, while slowing or stopping others. The apparently new industrial landscape was only one point in a story that stretched back to the area's first settlement, and indeed back to the structure of the rock and soil, and the flow of the river and streams.

To tell the story of this kind of place, it is useful to look closely at the term "landscape." The term is almost too familiar to convey much of anything. Today "landscape" is used to mean a variety of geographic scales. It refers to scales ranging from the minute details of a flower beds and turf lawns, as in a house's "landscaping," to the generic features of a whole region, as in the "western Landscape." It also finds such wide metaphoric use that it is easy to forget the figurative nature of phrases like "the political landscape." Back-constructions like "cityscape" or "seascape" further confuse the situation. A brief examination of the word's origin highlights some important features of the concept.[3]

The term “landscape” is of Germanic origin. Its ancestor words, “landskipe” and “landscaef” denoted a small administrative unit. The word was a compound of “land” which once denoted a plowed field, but was generalized to refer to any well-defined portion of the earth's surface, and “scape,” which is related to the modern word “sheaf” and meant a collection of similar things. The modern word “township” has a similar origin. In the eighteenth century, “landscape” was brought out of the obscurity of archaic legal terms by painters, who used the term to describe their scenes of the countryside. Gradually the term was applied to the subject matter, as well as to the art form. The transfer of the concept was accelerated by the newly developed field of landscape architecture, which sought to recreate the aesthetic sensations of the painting within actual scenes. Viewers of vistas learned to look at the scenes they beheld in the same manner they might look at a painting.[4]

3 Simon Schama, *Landscape And Memory* (Vintage Books, 1995). John R. Stilgoe, *Common Landscape of America, 1580 to 1845* (New Haven : Yale University Press,, c1982.).

4 Ralph H Brown and J. Russell Whitaker, *Historical Geography of the United States*, Harvard Social Studies Textbooks Preservation Microfilm Project ; 02583. (New York: Harcourt, Brace and Co., 1948). John Brinckerhoff Jackson, *Discovering the Vernacular Landscape* (New Haven : Yale University Press, c1984.). Matthew Johnson, *Ideas of Landscape* (Malden, MA: Blackwell Pub, 2007). D. W. (Donald William) Meinig and John Brinckerhoff Jackson, *The Interpretation of Ordinary Landscapes : Geographical Essays* (New York : Oxford University Press, 1979). David E. Nye, *Technologies of Landscape : from Reaping to Recycling* (Amherst : University of Massachusetts Press,, c1999.). Simon Schama, *Landscape*

In all of these definitions, a landscape is not a natural or given entity. It is an organizational unit applied to a complex world. A landscape is held together by the viewer's gaze, the painter's brush, or the administrator's files, and as such it is a combination of elements. It is a collection of sites, a union of the natural and the human, and a compromise between the past and the future. As a collective production, a landscape always encompasses tension, drama, and the possibility of transformation. To see the Boston Manufacturing Company as part of the landscape is to see how it was connected to the natural and human history of Waltham and the Charles River. This chapter will look at three aspects of the area's landscape history-- the development of manufacturing, the interactions along the Charles River, and the distribution of people across the landscape. These aspects reveal the context for three core features of the industrial landscape that emerged at the beginning of the nineteenth century-- a connection to non-local markets, the transformation of the river course, and the division of the development of a manufacturing district. In each instance the Boston Manufacturing Company fit into developments that were already in progress.

And Memory (Vintage Books, 1995). John R. Stilgoe, *Common Landscape of America, 1580 to 1845* (New Haven : Yale University Press,, c1982.). John R. Stilgoe, *Landscape and Images* (Charlottesville : University of Virginia Press, 2005).

Manufacturing in Waltham

The Boston Manufacturing Company was part of a longer development of manufacturing in Waltham that stretched back to the area's earliest settlement. The development occurred in several overlapping phases that gradually increased the area's connections to non-local markets, dependence on novel technologies, and density of manufacturing. Although the Boston Manufacturing Company was larger than any of the manufacturing endevors that came before, most of the new factory's features were already present in the landscape.

Mills were built along side the area's earliest settlement. These early mills were built along the small brooks and streams that ran down the slope to the Charles River. A fulling mill was built on Beaver Brook, in the eastern portion of the area, as early 1662. A grist mill was built on Stony Brook in the western side in 1690, followed by several corn mills along the brook's length. A malt mill was built on Chester Brook sometime before 1690, and was joined by a grist mill in 1731.[5] As the population grew and spread, more mills were built, until all of the small drops in the streams and brooks were utilized.

5 Samuel Adams Drake, *History of Middlesex County, Massachusetts: Containing Carefully Prepared Histories of Every City and Town in the County* (Boston: Estes and Lauriat, 1880). D. Hamilton Hurd, *History of Middlesex County, Massachusetts, with Biographical Sketches of Many of Its Pioneers and Prominent Men* (Philadelphia: J. W. Lewis & co, 1890).

There were only a few types of early mills. Most were grist or corn mills, which ground grain into flour and meal. Other types included fulling mills, which processed woven woolen cloth, saw mills, which cut lumber into planks, and malt mills, which crushed malted barley for beer-making. Despite the differences in the products, these mills were similar in a number of ways. First, they shared many of the same technical features. The drive systems of these mills were all almost identical. Power was derived from the fall of water across the landscape. These mills had relatively low power requirements, and two or three horse-power from a small stream was often enough. Often the stream was completely or partially dammed, creating a mill pond. Some mills had water wheels directly in the water's flow, but more often water from the mill pond was diverted through channel, called a mill race. The water was brought to the wheel and was returned to the stream below the dam. The water wheel would turn a short series of mostly wooden trundles and gears which transferred the wheel's motion to the mill's processing machinery. This machinery varied depending on the material to be processed, but in all cases, the motion was simple and continuous. Though generally the motion had to be reasonably steady, the precise speed made little difference.[6]

6 Louis C. Hunter, *A History of Industrial Power in the United States, 1780-1930: Steam Power,*

These mills also all played similar roles in the community and the economy. For the most part they processed local raw materials and made products for local consumption. For example, the grist mills ground local wheat, which was used to make bread locally. Though Waltham as a whole was not a self-sufficient or isolated community, these mills did not develop into the large merchant grain mills of Pennsylvania, or the export lumber mills of New Hampshire. They were also owned and operated by local individuals or families. They represented relatively little investment, and required minimum labor to operate, so did not require elaborate financing or administration. From time to time mills changed owners, and sometimes were converted to process different materials, but the basic pattern stayed the same.[7]

Even one of the apparent exceptions fit this pattern. In the late eighteenth century Moses Mead built mill on Chester Brook, near Hardy Pond in the northern portion of town, that produced wooden ware using relatively com-

Volume 1 (Published for the Eleutherian Mills-Hagley Foundation by the University Press of Virginia, 1979). Terry S Reynolds, *Stronger Than a Hundred Men: A History of the Vertical Water Wheel*, Johns Hopkins Studies in the History of Technology new ser., no. 7 (Baltimore: Johns Hopkins University Press, 1983). Martha Zimiles, *Early American Mills*, 1st ed. (New York: C. N. Potter; distributed by Crown Publishers, 1973).

7 Edward Pierce Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the Massachusetts Historical Society* 71, (1953-7): 111. Edmund Lincoln Sanderson, *Waltham Industries: A Collection of Sketches of Early Firms and Founders* (Waltham, Mass: Waltham Historical Society, 1957).

plex and novel machinery. He is remembered in local history as a mechanical genius. He made a variety of small wooden objects, including rolling pins, mortar and pestles, hay rakes, and hoe handles in part of his father's grist mill.[8] Mead operated the mill until it was sold to Isaac Stearns in 1810, who does not appear to have continued Mead's wooden ware operations. Although no details of the mill have survived, the list of products suggest that he had a water powered wood turning lathe.[9] Although Mead's mill stood out among the grist and fulling mills of the area, it was ultimately a similar operation. He also used local materials, and although Mead's work was locally quite popular, there is no evidence that he sought a larger market for his products.[10]

These early mills did share some features with the later industry. Simple as they appeared, the early mills still took careful calculation and experienced judgment to design, and a great deal of skill to produce.[11] The mills were built

8 Phineas Lawrence, "Trapelo Past and Present" Trapelo: Past and Present, series of articles by Phineas Lawrence, from Waltham Sentinel Oct-Dec 17, 1858, in Waltham Histories 1630-1896, Massachusetts State Archives.

9 Carolyn Cooper and Patrick Malone, "The Mechanical Woodworker in Early Nineteenth Century New England as a Spin-off from Textile Industrialization," Presented March 17, 1990, Old Sturbridge Village (American Textile History Museun, Lowell, MA).

10 Phineas Lawrence, "Trapelo Past and Present" Waltham Sentinel Oct-Dec 17, 1858, in Waltham Histories 1630-1896, Massachusetts State Archives.

11 For an example of an attempt to capture this knowledge, see Oliver Evans, *The Young Millwright and Miller's Guide* (1795).

and maintained by specialized craftspeople. Millwrights were generally itinerant tradesmen, who traveled from location to location, working with local materials and helpers to produce the dam, races, wheel, millwork, and sometime processing machinery.[12] The early mills cost far less to build than the later, larger mills, but they still represented a sizable concentration of capital for their individual owners. Although such mills were distributed throughout the area, within their own neighborhood, they too concentrated production in a single site. Finally, as we will see in the next section, these mills changed the flow of the river, and transformed the natural landscape.

The Boston Manufacturing Company was not the first establishment to break from the general pattern of the older mills. At the turn of the nineteenth century several larger mills and mill complexes were built that displayed many features of the Boston Manufacturing Company, including the processing of imported material for a non-local market, the concentration of production in a few areas and an interest in continuing innovation.

By the mid-eighteenth century there were mills built on most of the mill seats on the brooks and streams in Waltham, but the Charles River was largely

12 Louis C. Hunter, *A History of Industrial Power in the United States, 1780-1930, Volume 1* (University Press of Virginia, 1979).

unused. The Charles River was not an easy river from which to draw power. From its source in Hopkinton to its mouth, the river drops two hundred feet, but at most points the fall is only about one foot per mile, far too gradual to effectively drive machinery. Most of the fall is concentrated in a small number of more drastic drops. The river drops 40 feet in just two miles at Newton, and another 20 feet in a mile in Waltham.[13] The drops offered significant power, but were not well suited to small mills with small capital. Dams were difficult and expensive to build, and the large amount of power was not needed for the early mills.

The first dam on the Charles River was built in 1778 by Enos Sumner and David Bemis downriver from Waltham, in Watertown at what became known as Bemis' Station.[14] Other mills followed at Waltham's upper falls (future site of the Boston Manufacturing Company) in the 1780s, at Waltham lower falls in 1800, and at the mouth of Stony Brook in 1802. Mills were also built at Newton upper falls in 1790 and at the lower falls in 1800. Within a few decades all of the mill seats between Newton and Watertown were occupied.[15]

13 Frederick G Clapp, *Geological History of the Charles River.* (Boston,, 1901).

14 Small mills were built earlier further up the Charles where the river was much smaller. *E*dward Pierce Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the Massachusetts Historical Society* 71, (1953-7): 111.

15 Edward Pierce Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the*

The new mills made paper, ground chocolate, processed dye and medical plants, and rolled iron.[16] The basic technology of these mills was similar to that used in the older mills. For example, a chocolate mill uses grinders and rollers similar to those used in a grain or malt mill, and a paper mill uses beaters similar to those found in a fulling mill. Even so, the new mills differed in important respects. The raw materials were imported, and the products were brought to Boston, where they could be sold in a wide-ranging market.

Individual mills were often larger, but they were also built as complexes with several types of mill sharing a site. The mills at Bemis Station in Watertown are a good example. Bemis' complex of mills just downstream from Waltham was one of the most elaborate and longest surviving of these first large mills. David Bemis built the first mill at this site in 1779. On the southern side of the river, he built a paper mill and shortly thereafter built a snuff and grist mill on the northern side. At David Bemis' death, his three sons took over the mills. Luke and Isaac ran the paper mill together until Luke took over the whole concern at his brother's death in 1794. Luke Bemis' paper mill operated

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Massachusetts Historical Society 71, (1953-7): 111. Edmund Lincoln Sanderson, ***Waltham Industries: A Collection of Sketches of Early Firms and Founders*** (Waltham, Mass: Waltham Historical Society, 1957).

16 Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the Massachusetts Historical Society* 71, (1953-7): 111.

until 1821, when he sold the company to his brother Seth. Meanwhile, the third son, Seth, took over the southern side and he almost immediately began to expand the operation. Under his direction the mill began to process chocolate and to grind and process exotic woods used in dyes and medicines. In 1803 expanded his facilities to house the first cotton spinning machinery along the Charles River. He employed a large number of hand loom weavers to produce cotton duck, sheetings, bed ticking, bagging, cotton yarns, and the first heavy sail cloth produced in the US. Seth Bemis operated the mill until his death in 1850 and his son, Seth Bemis Jr, ran the mill until he sold it to the Aetna Manufacturing Company in 1860.[17]

The larger mills also required more investment and had more profit potential, which meant these mills often had several investors, and drew investment from outside the local community. The paper mill at Waltham's lower dam, for example, was started by Christopher Gore, a lawyer and politician from Boston, but also had investment from other wealthy inviduals.[18] These mills

17 Thomas Draper, *The Bemis History and Genealogy, Being an Account, in Greater Part of the Descendants of Joseph Bemis, of Watertown, Mass.* (San Francisco: The Stanley-Taylor Co, 1900). Charles Alexander Nelson, *Waltham, Past and Present; and Its Industries* (M. King, 1882). Edmund Lincoln Sanderson, *Waltham Industries: A Collection of Sketches of Early Firms and Founders* (Waltham, Mass: Waltham Historical Society, 1957). Samuel Francis Smith, *History of Newton, Massachusetts* (American Logotype Co., 1880).

18 Charles Alexander Nelson, *Waltham, Past and Present; and Its Industries* (M. King, 1882).

also depended on innovation and development. Paper-making technology was changing, as was rolling mill technology. Seth Bemis, son of David Bemis, was in a constant process of updating and upgrading his mills, including the first use of coal gas lighting in the United States.

The Boston Manufacturing Company was even more similar to a mill built at Waltham's lower dam. In 1810 Christopher Gore sold his paper mill and water rights to agents for the Waltham Cotton and Woolen Company (in which he was an investor), and before the end of the year the company was spinning cotton and wool. Reverend Samuel Ripley described the mill: "The cotton factory is a large wooden building of four stories; there are besides four dwelling house, two of them very large, for the convenience of the people, a large store and warehouse, dye house, grist mill, mechanick's shop, woolen factory, weaver's, and school house. These buildings, situated near to, or upon the bank of the river, and shaded by a grove of lofty oak and ash trees, present a pleasant object to the traveler upon the main road, about half a mile north. They are at the South East extremity of the town, within a few rods of the line."[19] Although soon dwarfed by the Boston Manufacturing Company, the

19 Samuel Ripley, "A Topographical and Historical Description of Waltham, in the County of Middlesex, Jan 1. 1815." in *Mass. Historical Society Collections*. Series 2, Volume 3, 1815. pg 261-284.

Waltham Cotton and Wool mill stood out as by far the largest manufacturing establishment along the river, and one of the largest in Middlesex County. In 1812, the cotton factory had 2,000 spindles which spun 300 pounds of cotton per day, and the woolen factory had 380 spindles, 4 jennies, and 2 jacks, and spun 60 pounds of wool per day. They had 14 hand looms in constant operation on the premises. Like most American spinning mills of this time, much of the weaving was done "under direction" in neighboring towns. With both the in-house and put-out weaving, the Waltham Cotton and Woolen Company produced about 10,000 yards of cloth each month.[20]

Waltham Cotton and Woolen also employed many more people than the surrounding factories. In 1812, 200 people worked for the company, about 150 of whom were women and children. Although the company did not build housing as the Boston Manufacturing Company would later, they did provide carefully controlled living situations for their workers. Ripley's praise of the arrangement was similar to later comments on the living arrangements in Lowell: "There is perhaps no institution of the kind in our country, under better regulations. Unlike most manufacturing establishments, this is free from the disorder and immorality which, in general, are found to exist, and by many are

20 Ibid.

supposed to be almost necessary evils."[21] The company apparently employed families of "established good character" with whom children and unmarried women were obliged to live.[22]

The result was that the factory population was concentrated in a single area, distinct from the rest of the town. The area along the river near the water privileges which had been only sparsely populated soon began to fill. By 1813, before the Boston Manufacturing Company manufactured its first foot of cloth, the area was populous enough and distinct enough for a new school district to be carved out of the southern district. The new district was called "factory village."[23]

The changes that occurred in the character of the mills were also reflected in other parts of the town's economic life. At the turn of the nineteenth century, at the same time that the new mills were being built, the town also saw an influx of Boston-based investment, an increase in the the agricultural involvement in larger markets, and an intensification of farming technique.

The most obvious of these changes was the construction of two country estates by wealthy Boston families. At the turn of the nineteenth century

21 Ibid.

22 Ibid.

23 Waltham City records 1812-1828 (Waltham Public Library).

Christopher Gore and Theodor Lymann each bought land in the southern part of Waltham and built large, modern houses, and both introduced extensive land improvements on their estates.

In 1793 Theodor Lyman, a Boston merchant, built a country residence, called "the Vale" in the south-eastern section of Waltham. His stately federal-style house became one of the principle sites of interest for visitors to the town. Samuel Ripley described the setting in glowing terms: "when there, you behold so much to admire and approve, so much taste and elegance, so great convenience and comfort, that you desire no other prospects, than those before and around you; you are satisfied with contemplating the improvements of art and refinement upon nature, how they can render her more charming, more instructive, and bring into more full display the wisdom and goodness of nature's God."[24]

Christopher Gore retired to Waltham in 1806 after a successful political career as the Governor of Massachusetts and as a Senator. Like Lyman, Gore built an estate on the eastern edge of the Plain. His house was designed in part by the Parisian architect, Jacques-Guillaume Legrand, and like Lyman's house,

24 Samuel Ripley, "A Topographical and Historical Description of Waltham, in the County of Middlesex, Jan 1. 1815." in *Mass. Historical Society Collections*. Series 2, Volume 3, 1815. pg 261-284. 272

became an attraction for visitors.

These houses were not just summer residences. They were places where newly developed farming techniques were being introduced. Not only were Lyman's park grounds built to the highest standards, but his lands were cultivated with the newest techniques. He brought land that was previously in a "rough state" to the "highest state of cultivation, and arranged and laid out in a most convenient and regular manner."[25] Such changes were part of a larger process of change occurring in Waltham and across New England in the early nineteenth century. At the turn of the century, New England farmers were turning increasingly toward production for regional, national, and international markets. While farms and farming communities were never self-sufficient,[26] seventeenth and early eighteenth century hinterland farms had limited interaction with larger markets. In the late eighteenth century their access to and dependence on larger markets increased.[27] These changes brought with them an increase in the scale and intensity of farming.

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25 Ibid.

26 Ruth Schwartz Cowan, *A Social History of American Technology* (Oxford University Press, 1997).

27 Allan Kulikoff, *The Agrarian Origins of American Capitalism* (Charlottesville: University Press of Virginia, 1992). T. H. Breen, *The Marketplace of Revolution: How Consumer Politics Shaped American Independence* (Oxford University Press, USA, 2005). Charles Sellers, *The Market Revolution: Jacksonian America, 1815-1846* (Oxford University Press, 1994).

Waltham took part in this process. Samuel Ripley noticed changes in farming practices within a few years of his arrival. In 1815 he noted that his neighbors were increasingly producing "with a view to the constant supply of the market of the metropolis,"[28] and that they were finding it "more profitable to cultivate a few acres highly than many in the ordinary way."[29] Although many of the old families remained in Waltham, even the farming community was changing. Farming developments may appear different from industrial development, but the two changes had much in common. Both focused on export via the markets in Boston, and both depended on new technical procedures.

Natural Course and Current of the River

The Boston Manufacturing Company did not fit easily into the landscape. The new factory was almost constantly in conflict with others along the river. The conflicts and relationships between the Boston Manufacturing Company and its neighbors was shaped by long-standing patterns of topography, law and custom, and so were part of an older story.

Mills have a long history of not getting along with their neighbors. Although to modern eyes a grist mill next to its mill pond is an idyllic image,

28 Ripley, 262

29 Ripley, 262

such mills were the result of a major and sometimes highly destructive transformation of their surroundings. In particular the dams and the mill ponds changed the behavior of the river and effected the ability of others to use it for fishing, irrigation, or manufacturing. Watertown residents, for example, complained about a mill blocking fish as early as 1738, and in 1749 a complaint was filed against a mill owner named Matthew Hastings for flooding farm lands in Natic with a mill dam.[30]

By the turn of the nineteenth century Massachusetts a long case history and an elaborate legal structure had been built to deal with the conflicts between mills and their neighbors. The complex relationship between owners and the river was summed up in the concept of the "mill privilege." Watercourse law in the early United States was based on ownership of the land on river banks.[31] Land that bordered by flowing fresh water, called "riparian" land, extended to the center of the water.[32] Because the rights of land ownership extended upward from the ground, and included everything on the land, the

30 Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England*, Studies in Environment and History (Cambridge [England]: Cambridge University Press, 1991), 29.

31 Joseph Kinnicut Angell, *A Treatise on the Law of Watercourses*, 1854. John W Johnson, *United States Water Law: An Introduction* (Boca Raton: Taylor & Francis, 2008).

32 Land bounded by lakes, ponds, or the ocean did not extend in this way.

water flowing over that half of the river bed was part of the riparian property. Land owners had a right to the flow of the water, but did not own the water itself. They could make any use of the water while it was on their property, but had to return all of the water to the river without disrupting its use by other riparian owners. So, one could not, for example, permanently divert water from the river. Other riparian owners could sue for damages if their water use was disrupted.

In practice, though, it was almost impossible to use the river's water without effecting its flow and riparian owners were often at odds with each other. Massachusetts, and several other states, had laws designed to encourage the development of water power sites by simplifying the determination of damages caused by mill owners. The first of these "mill acts" was passed in 1713, and was updated and strengthened in 1796. Under these acts, the damages caused by a mill were to be determined by a jury. Once the value of the damage was determined the mill's proprietor was simply required to pay those damages each year. Thought the mill was still considered to be at fault, these acts gave mills significant protection by limiting the uncertainty and expense of repeated lawsuits. The laws also outlawed the old common law right to immediately remove a nuisance to one's property, which in these cases meant destroying the dam, often with a keg of gun powder.[33]

The Boston Manufacturing Company's interactions with its neighbors were largely determined by this legal landscape. The way that these conflicts unfolded was related to the nature of the Charles River, the density of mills and the Boston Manufacturing Company's building program.

Because of the topography of the Charles River, changes made at any mill site have major consequences for a long way along the river. As mentioned earlier, most of the Charles Rive is nearly flat, with nearly all of the river's fall concentrated at a small number of falls. This meant that there were a small number of potential mill sites along the river. There were only ever twenty-two dams on the river. Even as the total number of mills on the Charles grew, the number of water power sites stayed the same.[34] Second, because of the gentle slope of the rest of the river, changes in one of these dams could have major effects for miles in either direction. If a dam was raised two feet, the change could raise or lower the water level for two miles up and down stream. Such

33 Joseph Kinnicut Angell, *A Treatise on the Law of Watercourses*, 1854. John W Johnson, *United States Water Law: An Introduction* (Boca Raton: Taylor & Francis, 2008). Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England*, Studies in Environment and History (Cambridge [England]: Cambridge University Press, 1991).

34 Edward Pierce Hamilton, "Early Industry of the Neponset and the Charles," *Proceedings of the Massachusetts Historical Society* 71, (1953-7): 111.

changes could then reduce the amount of water power available at other sites, or could flood or drain large areas. Any change the Boston Manufacturing Company made to their dam effected their neighbors both upstream and down.

The Boston Manufacturing Company transformed their privilege significantly, which had a proportionally large impact on their neighbors. When P.T. Jackson bought the Boise paper mill, he also bought the mill's privilege. This privilege was a complex of both natural and man-made parts. As discussed above, the privilege included the use of the water that would naturally flow past the site, as well as all of the improvements made to the site in order to take advantage of this water. It included land on both sides of the river, the wooden dam built along with the raceways and flumes.[35]

The Boston manufacturing company began to change the site almost immediately, and continued to extend and improve the privilege for the rest of the decade. By December 1814, barely a year after purchasing the site, they had spent $9243.83 on the dam, flume and raceway, nearly twice what the land and

35 For turn of the nineteenth century ideas about water power see *Louis C. Hunter and Eleutherian Mills-Hagley Foundation, A History of Industrial Power in the United States, 1780-1930: Volume 1 (University Press of Virginia, 1979).* Terry S Reynolds, *Stronger Than a Hundred Men: A History of the Vertical Water Wheel* (Baltimore: Johns Hopkins University Press, 1983).

privilege had originally cost.[36] Boise's wooden dam was replaced by a new stone dam, and a new raceway was run on the northern side of the newly constructed mill building. The new dam was completed in May of 1815. Over the next year, the Boston Manufacturing Company constructed a second factory building and extended the raceway to take water to the second water wheel. They spent $1257.45 on the excavation and masonry on this substantial stone structure. In 1817 they built a bridge across the river at their dam at what is now Moody Street, a back water dam on the downstream side of the property, and raised the dam again, this time by adding flashing boards along the top. In 1818 the Boston Manufacturing Company spent an additional $40667.31 on further developing the privilege. [37] The privilege required constant work. Each spring the company repaired the damage that occurred over the winter, and each summer they made improvements and extensions to the works. Each of these changes had effects that were felt beyond the limits of the company's property.

As a result of the changes in the company's mill privilege, the Boston Manufacturing Company was constantly at odds with its neighbors. Problems began the first spring when the Waltham Cotton and Woolen Company, a half

36 Volume 10, BMC MSS.

37 Volumes 10-13, BMC MSS.

mile downstream, rebuilt or extended their dam on April 21, 1814. The new dam changed the balance of the river, and the water at the Boston Manufacturing Company dam rose. They sued the Waltham Cotton and Woolen Company for $5000 in damages and lost profit due to difficulty running their machinery and delays to repairs on their own dam. They claimed that the Waltham Cotton and Woolen Company dam "so impeded and obstructed the natural course and current of the water of said river, that the water thereof could not flow and fall as before it used to do to the nature of said river, but by means of said dam the water forced back upon a certain dam across said river of the Plaintiffs."[38] The Waltham Cotton and Woolen Company pleaded that they were not guilty and the Middlesex County Court of Common Pleas ruled in their favor in September 1815.[39] The Boston Manufacturing Company appealed the case to the Middlesex Supreme Judicial Court. This time the company elaborated the claim about the natural course of the river by stating over the past year, "water of said river ought to have run and flowed and still of

38 Middlesex County Court of Common Pleas, Sept-Dec 1815. Massachusetts State Archives.

39 Ibid.

right ought to run and flow by, through and from the said mill of the plaintiff, the wheels, mill dam and raceway thereof to Boston harbor so freely along the bed or course of said river that the source should not be thrown back and penned up and raised in and upon the said mill of the plaintiff." Because the dam interrupted that flow, the Boston Manufacturing Company claimed that it was an illegal and unfair edition to the river. Beyond this, they suggested that the Waltham Cotton and Woolen Company maliciously raised the level of the river in order to disrupt the Boston Manufacturing Company's business. This time the suit worked. The jury ruled in favor of the Boston Manufacturing Company, awarding them $700 of the $5,000 claim.[40] In January, 1817 the Boston Manufacturing Company paid for half the bill to lower the Waltham Cotton and Woolen Company dam by two feet, thus returning the water its previous level.[41]

Even while the Boston Manufacturing Company was suing their down-stream neighbors, they were also inflicting damage on the farmers that bor-dered the factory site. Even before the new dam, some upstream land was already flooded by the old paper mill dam. When the Boston Manufacturing

40 Middlesex County Supreme Juridical Court, Jan 1816. Massachusetts State Archives.

41 BMC MSS

Company bought the property, they took over a standing agreement to pay Abraham Pierce $236 for flooding, or "flowing", some portion of his land.[42] The new dam, completed in the spring of 1815, flooded nearly 200 acres.[43] In August of that year alone, the Boston Manufacturing Company spent nearly $7500 on damages. The company paid damages to twenty six people. Ultimately the Boston Manufacturing Company ended up buying much of the flooded land, significantly extending their stake along the river, and creating a mill pond much larger than those of the older industries in town.[44]

Few owners of flooded land sued the Boston Manufacturing Company. The suits against the company followed the proceedures outlined in the mill acts, whereby a jury determined the damages to be paid to injured parties. The few cases that did go to court followed the same procedure. In June of 1816 the children and widow of Nathan Upham sued the Boston Manufacturing Company for damages to a total of three and a half acres. The court ordered the sheriff to convene a jury to determine if the flooding was necessary, and if so to determine the yearly damages to be paid to the Uphams. The jury decided that

42 Ibid.

43 Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England*, Studies in Environment and History (Cambridge [England]: Cambridge University Press, 1991).

44 Ibid. BMC MSS

the flooding was unavoidable and that the Boston Manufacturing Company should pay the Uphams $32 each year, continuing through 1818.[45] The Boston Manufacturing Company did not buy the land, and the Uphams became one of a small number of people who received annual payments.[46] In these cases, there was no mention of the natural course of the river, or of unfair or illegal changes to its flow. Instead it was simply a matter of determining the value of the land and crops destroyed by the flooding.

Divided Landscape

Another conspicuous aspect of the Boston Manufacturing Company's presence in town was the division between the people related to the company and the older parts of town. Contemporaries who described the town often noted the distinctiveness of the "factory village," but even this was part of a long running tendency in Waltham toward the development of distinct districts. The history of Waltham can be seen as the history of the development and differentiation of districts.

Waltham was founded in a fissioning process similar to that which formed most of the towns in the Charles River basin. Like many New Enlgand towns,

45 Middlesex County Court of Common Pleas, Sept-Dec 1815. Massachusetts State Archives.

46 Volume 10, BMC MSS.

each of the towns surrounding Boston was organized around a meeting house that was both a religious and civil center of authority. The importance of this central building shaped the process of founding new towns. As the population of an area grew, new inhabitants found themselves having to settle further and further from the closest meeting house, and so also found themselves increasingly disconnected from the political, religious, and social life of the town. Occupants of distant districts might start attending meetings at another town, or if there were no close meeting houses, they might petition to build a new meeting house. A new meeting house was often the first step toward petitioning to create an new independent town. Towns tended to fission into smaller units, based on convenient walking distances.[47] Waltham was founded through just such a process.

Waltham began as a western district of Watertown. As the area became more populous, its inhabitants became frustrated by the distance to the meeting house, and began to argue that the meeting house should be moved to a more central location. After years of struggles, a meeting house was finally built in the western precinct, near the modern-day intersection of Lexington

47 John R. Stilgoe, *Common Landscape of America, 1580 to 1845* (New Haven : Yale University Press,, c1982.).

street and Lincoln street. For a short time town taxes were divided between the two congregations and town meetings alternated between the two locations. This compromise proved unstable and in 1737 the area surrounding the new meeting house was incorporated as an independent town. Even at this early date, Waltham was not a settlement founded in the wilderness, but one place within a system of places. It was created a part of the process of filling in gaps in the map and populating the remaining "wastes" at the edges of other communities.

The new town was not a coherent entity. The fissioning process by which it was founded was repeated at smaller scales within town. The early shape of these divisions was based on the shape of the land and the structure of its soil and rock. Waltham sits on a gradually sloping hill that runs from the northern edge of town southward to a wide sandy plain that runs along the river.[48] The early divisions in the town cut across the slope, roughly following the landscape's contour lines. Even before the area was populated, such divisions existed. When the area was common grazing land for Watertown, the cows that grazed there were divided into three herds. Each herd was brought across Beaver Brook at a different point and ranged across the hillside. Later, when

48 The southern bank of the river was part of Newton until the mid-nineteenth century.

the common grazing land was divided into privately owned property, the paths taken by the three herds became the northern and southern property boundaries for the grants, as well as the basis of the main east-west roads.[49]

In 1738 the districts within the newly formed town were explicitly defined by the creation of three school districts for a rotating summer school. These districts echoed the north-south division. Everything south of Beaver Street was defined as the third district. In 1813 the "Factory Village" along the river was carved out of the southern district.[50] These districts represent distinct centers of population and activity which even today hold individual characters and histories. By the early nineteenth century Waltham was divided into two clearly distinct areas.

In the northern portion of town, two farming districts occupied the upper portions of the slope. The population in this area centered around a meeting house, in the north-western part of the town called "Piety Corner."[51] The first

49 These three roads still later became the basis of the modern Main Street, Beaver Street, and Trapelo Road. Edmund Lincoln Sanderson, *Waltham as a Precinct of Watertown and as a Town, 1630-1884* (Waltham historical society, inc., 1936).

50 Waltham City Records (Waltham Public Library). Samuel Adams Drake, *History of Middlesex County, Massachusetts: Containing Carefully Prepared Histories of Every City and Town in the County* (Boston: Estes and Lauriat, 1880).

51 This area was originally known as "Hosier's Corner." The name "Piety Corner" became popular in the nineteenth century.

meeting house was located here in 1732, along with Waltham's first school house. Both buildings were enlarged and replaced, but they remained at this location. Until a second meeting house was built in the southern part of town in the 1820's, everyone had to travel to this location for church and town meetings. The area surrounding the meeting house was also home to the Sanderson and Livermore families, who were both influential throughout Waltham's history. Though the thick oak woods of this area resisted early settlement, the soil here proved to be the most fertile in town, and the southern exposure of the slope meant that frost set in here later and lifted earlier than other parts of town. The north-west corner of town supported a number of prosperous farms.

The second population center in the norther part of town lay just to the east, and centered on Trapelo Road. This area had much in common with Piety corner. It, too, was settled early. Although the ground here was not as good as to the east, larger meadows allowed for easier exploitation. This area also had a strong connection to Cambridge Farms (now Lexington) to the north and to Harvard University, through University farms. Like the Piety Corner area, Trapelo was dominated by agriculture and was home to several old and influential families.[52]

Waltham's southern districts had a distinct landscape and population. A wide, sandy and often muddy plain extended along the northern bank of the Charles River. The ground was less rocky, and much of the area was cleared before European settlement,[53] but the soil was less fertile and the micro-climate was cooler. The southern district was not centered around a meeting house, or a collection of old farm families, but rather around the "Great Road," which ran westward from Boston. This path was one of the major east to west routes in the region. It was roughly the path taken by Governor Winthrop and his party when they first mapped the area. Later, it became the route for settlers headed west to Weston, and parts of central Massachusetts and Connecticut. As the colonial population increased, the path became a major branch of the Post Road system that connected Boston to New York and Western Massachusetts.[54]

52 Phineas Lawrence, "Trapelo Past and Present" Waltham Sentinel Oct-Dec 17, 1858, in Waltham Histories 1630-1896, Massachusetts State Archives.

53 Native Americans used controlled burning to clear many areas, especially along rivers and streams. There was, however, few people left in the area when European settlers arrived. William Cronon, *Changes in the Land : Indians, Colonists, and the Ecology of New England*, [1st ed.]. (New York :: Hill and Wang,, 1985). Tom Wessels and Brian D. Cohen, *Reading the Forested Landscape: A Natural History of New England* (Countryman Press, 1999).

54 Stewart Hall Holbrook, *The Old Post Road; the Story of the Boston Post Road*, 1st ed. (New York: McGraw-Hill, 1962). Stephen Jenkins, *The Old Boston Post Road* (New York: G. P. Putnam's sons, 1913).

By the mid-eighteenth century, the Great Road was the main route for goods of all kinds moving between western areas and the markets in Boston. Herds of cattle, carts of grain, and a wide variety of agricultural goods passed through Waltham on the way to markets in Boston. Sugar, molasses and other imports flowed in the opposite direction. Travelers to and from the west and the south also traveled through Waltham. Until the West Boston Bridge (now the Longfellow Bridge) was constructed in 1793, much of the over-land traffic to and from Boston passed through Waltham.

This busy road became the center for Waltham's commerce and tradespeople. Some of the businesses on what would eventually become Main Street were services for travelers. At the height of traffic on the Great Road, there were nine taverns along one mile of the road.[55] Wheelwrights and blacksmiths also gathered along the road to perform repairs for travelers. As more routes into Boston opened, less traffic came through Waltham, but by then the area had already become the center of the town's businesses and trades, and continued to grow. The most prominent inhabitants here were builders, innkeepers and landlords, rather than farmers. Although the civic and religious center of town remained with the farming families in the North, Main Street and the

55 Charles Alexander Nelson, *Waltham, Past and Present; and Its Industries* (M. King, 1882), 92.

plain developed a distinct and parallel center. The arrival of the Boston Manufacturing Company and other factories would only further enforce this division.

The company's employees accentuated Waltham's north-south division. The Boston Manufacturing Company's significantly increased the population in the southern district. From 1810 to 1820 the town grew by 65%, from 1,014 to 1,677 people.[56] When the factory opened in 1815, it employed 175 people. Five years later it directly employed 264 people. Much of the rest of the growth could be tied to the increased demand for services for the factory employees. Although, as we will see later, the company did not buy many materials locally, nor employ many local tradespeople, they did pay employees in cash, rather than "scrip" as did other mills. Employees were not confined to the closed world of company stores, but could participate in the town's economy.

In the commonly told story, the Waltham factory was the first instance of the boardinghouses system that would later find full fruition in Lowell, Massachusetts. In this system the company built and maintained dorm-like accom-

56 US Census 1810, 1820, 1830. Howard M Gitelman, *Workingmen of Waltham: Mobility in American Urban Industrial Development, 1850-1890* (Baltimore: Johns Hopkins University Press, 1974).

modations for the mostly female workforce. The attribution of this system to Waltham and the early days of the Boston Manufacturing Company is derived largely from remembrances of one of the company's investors, Nathan Appleton, a half century later. A closer examination of the evidence suggests that no such boardinghouses existed in Waltham in the early days.[57]

The company did build housing. Between 1816 and 1822 the company built or bought twenty-five residences.[58] Some of these were reserved for company officers and agents. Paul Moody for example rented a brick house just north of the factory which the company had purchased from Seth Ross. In 1817 the company built a new larger house for Moody.[59] Moody's house appears to have been nicer than most of the Boston Manufacturing Company-owned residences, but like Moody's, most of the residences housed families. In 1817 the Boston Manufacturing Company built a series of four single story and two double story cottages on the north edge of the mill property. There is no record of the company building or owner larger boardinghouses. Census

57 Richard Candee, "Architecture and Corporate Planning In the Early Waltham System," in *Essays from the Lowell Conference on Industrial History, 1982 and 1983* Ed. Robert Weible (Museum of American Textile History, 1985). Michael Brewster Folsom, "Boston Manufacturing Company, Historic American Engineering Record Report," Charles River Museum of Industry (n.d.). Oren Helbok, "UROP Report, Summer 1984," Waltham Public Library (1984).

58 Ibid.

59 Ibid.

returns from 1820 also do not give evidence for a high concentration of employees living in large residences. Of the households that reported members involved in manufacturing, most only reported a single person employed in manufacturing. Only twelve households listed more than one person in manufacturing, and nearly all of those had less than six people involved in manufacturing. There were two households that reported fifteen residents who worked in manufacturing, but these thirty people make up only a small portion of the population.

The company's machinists give a glimpse into the lives of at least the better paid company employees. Most of the machinists were between twenty and thirty. Even the super-intendant of the machine shop, Thomas Borden, was only twenty-two when he appeared on the first surviving payroll from 1817.[60] Most of the machinists were unmarried when they arrived in Waltham. Though many left after a short time (Chapter 4) those who stayed started familes. Between 1814 and 1826 forty-eight Boston Manufacturing Company machinists were married, both to women who worked in the mill and to local women. During this time many children were born as well.[61] The long-term

60 Higginson Book Company, *Lowell, Massachusetts Vital Records: (1930)*

61 Waltham (Mass.), *Vital Records of Waltham, Massachusetts, to the Year 1850* (New-England historic genealogical society, at the charge of the Eddy town-record fund, 1904).

machinists lived in small households which were only slightly extended beyond the nuclear family. In 1820, for example, only two households headed by Boston Manufacturing Company machinists had more than three industrial workers in them.[62] Other machinists, who only worked at the shop for a few months might have rented rooms from other company employees, or from other townspeople.

The probate inventories of the few machinists who died while working at the Boston Manufacturing Company give a glimpse of their material lives.[63] Boston Manufacturing Company machinists each owned between three hundred and seven hundred dollars worth of personal property. Most of what they owned was household furniture that would have been typical of a tradeperson's house, including tables, chairs, bed frames. Some had a small number of more luxurious items, such as silver spoons, feather beds, or satinet clothing. A few machinists owned small libraries. Thomas Borden, the super-intendant, owned fifty-one books when he died in Lowell, MA in 1826.[64] Another machinist owned thirty-one volumes of the Edinburgh Encyclopedia, a largely technical

62 US Census 1820

63 There is no record of how these machinists died; whether natural or work-related.

64 Thomas Borden, Middlesex County Probate Records (Massachusetts State Archives).

encyclopedia that contained among other things detailed drawings of textile machines, and which was worth nearly a quarter of his portable property. The machinists did not own tools and implements that would have been involved in raising animals for food, so it does not appear that they kept agricultural pursuits on the side. Nor did most machinists own tools for their trade, though carpenters and blacksmiths did.

Few of even the best paid machinists owned land in Waltham. Most rented their houses either from the company or from local landlords. As traditionally understood, the new manufacturing population had little stake in the town. They did not own land, and even their church membership was in the second meeting house, which was populated almost entirely by mill workers.

The new factory and its workers did not become part of the town's older civic structures. The new comers were especially separate from the old power-center of the old meeting house at Piety Corner. Few mill employees attended the meeting house, in part because the old meeting house was half an hour's walk away, but it also appears that they were not welcome among the old congregation. In one story the town planned a sleigh ride in the winter of 1819-1820 to which many moderately prominent citizens were invited. No one from mill was invited, though several felt that they should have been.[65] It was a small slight, but one could imagine many such events building up over the years. Neither did mill employees become involved in local civic matters or hold positions of authority. In 1822, for example, all of the town's selectmen, two out of three of its tax assessors, and the tax collector were all born in Waltham, and none were directly involved with the factory.[66] The new factory was almost never even mentioned in the town meetings.[67] Whether they were excluded or chose not to participate, neither the company nor their employees were officially involved in the town's civic life.

The presence of the Boston Manufacturing Company and its employees did unintentionally transform Waltham's church politics, which eventually lead to a permanent division between ecclesiastical and civic life. Although the Company's politics may have aligned with some of Ripley's federalist sympathies, a simple fact of distance began the split. Further, the Boston Manufacturing Company's employees were more religiously diverse than the native

65 Mailloux, Kenneth F. "The Boston Manufacturing Company of Waltham, Massachusetts 1813-1848: The First Modern Factory in America," (Boston, MA: Boston University Press, 1957).

66 Howard M Gitelman, *Workingmen of Waltham: Mobility in American Urban Industrial Development, 1850-1890* (Baltimore: Johns Hopkins University Press, 1974).

67 Waltham Town Records (Waltham Public Library).

Waltham citizens. Early mill-workers represented many of the divisions that dotted the New England country-side, including Methodists, Unitarians, Trinitarians, Congregationalists, and later even a few Catholics.[68] Soon after the factory went into operation religious meetings were held by Reverend Sewall Harding in the company's school house. In 1820 this group officially split from the town's church and formed their own religious society. Soon the Boston Manufacturing Company built a second meeting house for the second religious society.[69] As religious tastes changed, the balance between Unitarianism and Trinitarianism shifted and new denominations were introduced. Apparently indifferent to the doctrinal differences, the Boston Manufacturing Company supported all such developments. When the majority of employees were Unitarian, the company-built meeting house had a Unitarian minister. As Trinitarianism returned to popularity, the ministers was replaced. The meeting house became Trinitarian, and the Unitarians were allowed to meet in the

68 The religious make up of the work-force changed as the population changed. Early on it was mostly native-born New Englanders. Later, immigrants from many different countries became common. Elizabeth D Castner, *Tercentennial History of the First Parish in Waltham, Massachusetts 1696-1996* (Waltham, Mass: First Parish in Waltham, 1998). Kristen A Petersen, *Waltham Rediscovered: An Ethnic History of Waltham, Massachusetts* (Portsmouth, NH: P.E. Randall, 1988).

69 This was the second society to be called the "second religious society" Edmund Lincoln Sanderson, *Waltham as a Precinct of Watertown and as a Town, 1630-1884* (Waltham historical society, inc., 1936).

school house. In 1830, as the factory population grew, the company built a second church for the increasingly diverse mill workers, in 1830.

Although the center of civic power remained with the old families, and centered around the old meeting house, the new Boston Manufacturing Company related congregations forced a change in the role of the meeting house in town life. No longer could the population, the church, and civil authority be simply contained in a single building. Town funds were used briefly to support both religious societies, but soon both were cut off from such funding, and had to support themselves as independent institutions. Although the company and its employees appear to only have considered their own needs, and completely skipped the town-meeting process, their actions contributed to the transformation of the structure of the whole town.

The presence of the company, though, did introduce many novelties and "improvement" into the town's civic life. The Boston Manufacturing Company and its people simply created what they needed for themselves, at their own cost. Some of the services the company provided were exclusively for the use of employees, though many had further reaching effects in the town's civic life. For example, the company created a bank, initially for employees' use, which was operated entirely by the company. In 1815, the Boston Manufacturing Company built a library. Although only Boston Manufacturing Company employees were allowed to use the library, it later became the foundation of the Rumford Institute, which became the center of cultural and intellectual life in Waltham.[70]

The company invested in other services that became directly useful for others in the town. The town had already divided off a “factory village” school district before the Boston Manufacturing Company arrived, but the school house was near the Waltham Cotton and Woolen factory. In 1817, the Boston Manufacturing Company built a new school house at their own expense, and hired a teacher, closer to the factory.[71] Initially the whole school was supported by the company, though later the town contributed funds, which were paid directly to the Company. This suggests that children of other townspeople might also have been attending the school. As the Boston Manufacturing Company's mill expanded, they also expanded the schools. In 1819 after purchasing the Waltham Cotton and Woolen Company buildings and construct-

70 Mailloux, Kenneth F. "The Boston Manufacturing Company of Waltham, Massachusetts 1813-1848: The First Modern Factory in America," (Boston, MA: Boston University Press, 1957).

71 The school was ungraded, with up to seventy students under the tutelage of a single teacher.

ing a bleachery in that location, they also rebuilt the old factory village school. In 1822 they also built an infant school near the second manufactory.[72] Although each school was built for the convenience of the factory population, they ultimately became part of the town's school district structure.

The company also directly improved parts of the town, and in particular built and improved roads. In 1818, they laid out River Street[73] to connect the newly purchased lower dam to the main mill complex. They widened Newton Street, improved Willow and Pleasant Streets, and planted shade trees along some of the roads. The company also built a park between River Street and the river.[74] The company also purchased a fire engine, which was a novel and expensive piece of machinery. Cotton mills were highly flammable, so the engine was primarily intended for the mill's own protection, but the company agreed to allow the engine to be used by the town in general, if the town provided a fire crew. In 1816 the Waltham Volunteer Fire Department was founded at town expense, though it was staffed entirely by Boston Manufac-

72 Directors Reports, BMC MSS. Waltham Town Records (Waltham Public Library).

73 This is the contemporary name for the street. Waltham streets were not officially named until the middle of the nineteenth century.

74 Mailloux, Kenneth F. "The Boston Manufacturing Company of Waltham, Massachusetts 1813-1848: The First Modern Factory in America," (Boston, MA: Boston University Press, 1957).

turing Company employees. The engine was housed near the factory, and would have initially been of the most use to houses near the factory, but it did serve the whole town, and gradually became a fully civic department.[75]

The Boston Manufacturing Company and its employees were both part of the town and outside of it. Ironically, such a status fit perfectly with the town's previous trajectory. Waltham was never an isolated, unified, self-sufficient community. Long before the new factory arrived, the town had already fragmented into different districts and different populations, each of which pursued their own interests. Town meetings were still dominated by the old families, and the old issues, but the fact of the town had already changed. As a result, the Boston Manufacturing Company did not take over the town, or replace what already existed. Waltham did not become a "company town," even though the Boston Manufacturing Company was one of only two large employers. Instead the "factory village" simply became another district, though one more closely aligned with the main street district than with the upland districts of Piety Corner and Trapelo. In fact, the agricultural base of the town remained a vital force at least until the middle of the nineteenth century.

75 Ibid.

This chapter has explored the ways in which the Boston Manufacturing Company was embedded in the local landscape. The factory was not an isolated entity, nor was it simply a force of change in the town. Instead the development of the factory was part of a longer and larger development of the countryside. Similarly, the Waltham landscape was embedded in larger regional and global geographies. The construction and operation of the factory depended on the movement of people and things within an evolving network of places, spread out across New England, and around the world. The next two chapters examine the logic and operation of these systems.

Chapter 3: The Geography of Supply

In 1815 the Boston Manufacturing Company's machine shop built the first functional power loom in the United States. Building the loom required thirty pounds of iron, one hundred and twenty board feet of lumber, thirty nuts, bolts and screws, and hundreds of pounds of coal.[1] As the shop built hundreds of additional machines over the next decade, it consumed thousands of tons of coal, iron, hardware and lumber. Without a constant supply of high quality raw materials, not even the most skilled mechanic could work. As the shop bought materials to build machines it defined a geography of supply that tied the Waltham shop to the stores, warehouses and docks of Boston, and through them to a world-wide system of trade and production. In this chapter I examine how the shop shaped its supply chains, and how it managed a complex and changing market.[2]

Few of the basic materials that the shop needed were produced locally. In

1 These estimates are based on a reproduction of the 1814 loom built by the Charles River Museum of Industry. Dan Yaeger, Personal Communication.

2 P.T. Jackson, the company's agent, was responsible for most purchases, but there is no record of how purchasing decisions were made or what role the mechanics played in picking out materials. In the absence of this information, I will use the shop's corporate identity as the primary actor in this chapter. In the following chapter I look in more detail at the bounds of this corporate identity.

order to build machines, the managers and machinists at the Boston Manufacturing Company depended the availability of materials from around the world. In the language of economic geography, the shop needed to be positioned at the intersection of numerous commodity chains.[3] Located only ten miles west of Boston, a well established center of Atlantic trade, the shop had access to a rich landscape of imported resources. Among the cotton, indigo, rice and sugar that made up the bulk of the city's trade one could also find coal, iron, hardware, lumber and most of the other materials needed to build textile machines. The shop did not have to establish a supply network from scratch. They did not have to manage tariffs, changing trade restrictions, or shipping insurance. Nor did they have to keep ships, captains or crews in working order. Everything they needed could be found within a few blocks of the company's Boston offices.

This abundance proved to be a challenge. The quality of the materials available varied, as did the merchants' ability and willingness to distinguish the good from the poor. In the early nineteenth century there were few government controls or officially sanctioned grading systems. Even the basic theoreti-

3 "Global Commodity Chain Analysis and the French filiére Approach: Comparison and Critique," Philip Raikes, Michael Friis Jensen, Stefano Ponte, in economy and Society, vol 29 num 3 August 2000: 390-417

cal understandings or testing techniques that would later allow precise material specifications, were only beginning to develop. The result was that buyers had to develop their own methods of ensuring quality. Each material offered a different challenge, which the shop met with a different strategy. The shop managed the uncertainty in material quality by strategically managing relationships with merchants. Ultimately, the shop did not draw on an abstract flow of materials, and did not have a global view of the entire system. Instead, with the limited knowledge and partial view of a located actor, they bought materials through a series of transactions with individual suppliers. By following the patterns of these transactions this chapter follows the shop's integration into the geography of supply.

Boston and Waltham

Almost all the materials used to make textile machines shared the final stage of their journey to Waltham. The road from Boston left the city along the narrow strip of land, called "the neck," that connected the peninsula to the main land, and followed the southern bank of the Charles river through Brookline. It crossed the river at the Watertown Bridge near the arsenal and Seth Bemis's mill complex, and came into Waltham along Main Street. Almost all of the materials were brought along this path. It would have taken a heavily laden horse-cart half a day to make the journey, and cost about one tenth of a cent per pound.[4] In 1814, when the Boston Manufacturing Company's shop first began to build machines, this path was already well established and heavily traveled. As early as the seventeenth century, settlers followed this route out of Boston to settle central Massachusetts and parts of Connecticut. In the eighteenth century it became part of the post road system that linked Boston and New York, and by the beginning of the nineteenth century it was one of the major routes used to bring the products of central and western Massachusetts to Boston, and imported goods from the port to the countryside.[5] The lumber, metal, and fuel needed to build textile machines joined this well established traffic.

For the Boston Manufacturing Company's materials, the road to Waltham began at Patrick Tracy Jackson's counting house on Broad Street in downtown Boston.

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4 The company owned some of their own horses and carts, but Waltham residents were also contracted to bring materials from Boston. Journal, Vol 13, Boston Manufacturing Company Papers, Baker Library (hereafter cited as BMC MSS).

5 Stephen Jenkins, The Old Boston Post Road (New York: G. P. Putnam's sons, 1913); Stewart Hall Holbrook, The Old Post Road; the Story of the Boston Post Road, 1st ed. (New York: McGraw-Hill, 1962); Charles Alexander Nelson, Waltham, past and present; and its industries (M. King, 1882).

As the company's agent, Jackson ordered materials, arranged prices, paid suppliers, and posted each transaction to the proper accounts in the journals, ledgers and cash books. No record remains of how detailed Paul Moody's, or the other mechanic's, requests for materials were, but Jackson maintained ultimate control over the transactions. Jackson was well placed to manage these transactions. His Broad Street office was in the heart of Boston's commercial district, and prior to his involvement with the Boston Manufacturing Company, he had operated an extensive business importing cotton and indigo.[6] Like all of the initial investors in the Boston Manufacturing Company, Jackson was also part of the complex familial and business ties that knit together the city's merchant class.[7] Despite these ties, neither Jackson, nor the other people directly involved in the company dealt in the materials necessary for constructing machines. Jackson could not depend on his own trade networks. Nor did he begin importing materials himself. Instead, Jackson depended on other

6 For details on Jackson's pre-Boston Manufacturing Company business see, Jonathan Jackson et al., The Jacksons and the Lees; two generations of Massachusetts merchants, 1765-1844, (Cambridge, Mass.,: Harvard University Press,, 1937).

7 For more on the complex familial and business relationships among "Boston Associates," the company's founders, See Jonathan Jackson et al., The Jacksons and the Lees; two generations of Massachusetts merchants, 1765-1844, Harvard studies in business history 3 (Cambridge, Mass.,: Harvard University Press,, 1937); Robert F Dalzell, Enterprising Elite: The Boston Associates and the World They Made, Harvard studies in business history 40 (Cambridge, Mass: Harvard University Press, 1987)

trade networks already developed by his colleges who operated the warehouses, wharfs, and ships that surrounded his offices.

Everywhere one looked in early nineteenth century Boston, one saw the clean brick and stone of newly built buildings, and the damp, raw piles of newly dug ground. When Jackson began to buy materials for the new manufactory, the city of Boston was at a brief pause in a remarkable season of growth. By 1812 Boston had finally recovered from the trauma of the Revolutionary War and its economic aftermath, during which the city lost a third of its population. As the population returned to pre-Revolution levels, new construction appeared throughout city. A new state house was built in 1798, Faneuil Hall was expanded in 1808, and numerous mansions and elegant brick houses were constructed throughout the city. New land was also literally created. The Mill Pond in the north end was filled in 1807, and in 1814 a dam was built across the Charles River and the Back Bay was partially drained, beginning the largest of Boston's land reclamation projects. The harbor-front was also being developed. Long Wharf was extended and India Wharf constructed next to it. New warehouses lined the harbor, and new streets were laid out a few blocks away for rows of counting houses and stores. Broad Street, where Jackson's offices were located, was less than a decade old.[8]

Despite the rapid growth and building, this period also brought a great deal of turmoil to the city and its merchants. Boston had dominated American trade in the early eighteenth century, but by the eve of the Revolutionary War it had been surpassed by Philadelphia and New York, and would soon be overtaken by the phenomenal growth of Baltimore. The West Indies trade, which had been the cornerstone of the city's early growth, had less and less importance as access to the British West Indies was restricted following independence. In addition, the Embargo of 1807 nearly ceased foreign trade, and halted the rapid growth of the previous decade. More immediately, when the Boston Manufacturing Company began to buy materials in earnest in 1814, the country was embroiled in a second war with England and a British blockade closed ports from Maine to Georgia. Warehouses stood empty, ships rocked at their moorings, and out-of-work seamen and longshoremen lounged in harbor-side pubs while the sails of warships peaked over the horizon. Despite the

8 Harold Kirker, Bulfinch's Boston, 1787-1817 (New York: Oxford University Press, 1964); Annie Haven Thwing, The Crooked & Narrow Streets of the Town of Boston 1630-1822, Tercentenary ed., rev. with additional notes. (Boston: Lauriat, 1930); Walter Muir Whitehill, Boston: A Topographical History, 3rd ed. (Cambridge, Mass: Belknap Press of Harvard University Press, 2000); Wilfred E Holton and William A Newman, Boston's Back Bay : the story of America's greatest nineteenth-century landfill project (Boston: Northeastern University Press, 2006).

blockade, trade continued and goods were still advertised almost daily in the Boston newspapers. Some goods were brought over land on the terrible early American roads, some arrived on small fast vessels that slipped through the blockade whenever the British ships were blinded by fog or blown of their stations by storms, and some were obtained from newly developed domestic sources.[9]

During the war, while American wharfs emptied, goods piled in British warehouses. When the war ended and trade resumed in 1815, those goods flooded the American market. While some of the old trade patterns were re-established, other changed. The "tramp" traders who traveled from port to port trading in whatever was profitable lost ground to regular traders, and ship-owning merchants were edged out of the market by merchants and agents who transported their goods on common carriers and packet ships that traveled on regular and scheduled routes.[10]

9 Donald R. Hickey, "American Trade Restrictions during the War of 1812," The Journal of American History 68, no. 3 (December 1981): 517-538; Samuel Eliot Morison, The Maritime History of Massachusetts, 1783-1860 (Boston: Houghton Mifflin Company, 1921); George Rogers Taylor, The Transportation Revolution, 1815-1860 (New York: Harper & Row, 1968)

10 Norman Sydney Buck, The Development of the Organisation of Anglo-American Trade, 1800-1850 (Hamden, Conn.: Archon Books, 1969); For a fictionalized, though well researched, view of Boston during the War of 1812, see Patrick O'Brian, The Fortune of War (W. W. Norton & Company, 1994)

The Boston marketplace of the 1810's and 20's was a complex landscape of many different kinds of merchants, each with different kinds of expertise. Some owned ships, some transported goods on common carriers, and others traded in goods imported by others. While many merchants dealt in a dizzying variety of goods, other merchants specialized in one kind of good, in goods from one region, or acted as outlets for particular mills. The Boston Manufacturing Company had to choose whom to buy materials from. As they navigated the market, they developed different kinds of relationships with different merchants. In this chapter I characterize the machine shop's relationship to the supply chains by tracking patterns in the types of merchants and suppliers with whom they dealt, and in the nature of these relationships.

First I look at who sold materials to the shop. As already mentioned, merchants varied in the level of their involvement with the details of ocean-transport, their degree of specialization, and the extent of their connection to industry. I argue that the shop depended on specialized and expert merchants when the quality of the material was difficult to determine, and dealt with general merchants for simpler materials.

Second, I examine the nature of the relationships that the company formed with merchants. They bought some materials from many different merchants, while they relied on a small number of merchants for other materials. To use terms from the economics of information, these relationships varied from "extensive" to "intensive."[11] *Extensive strategies* are those that involve exploring a wide range of possibilities with a large number of possible sellers. Extensive relationships form where information is cheaply and readily available, which allows buyers to compare products and sellers.[12] *Intensive strategies* prevail in circumstances in which information is difficult to obtain, and comparison is time consuming.[13] Under these circumstances buyers tend to focus their resources

11 These terms come from G.J. Stigler, "The Economics of Information," in The economics of information, ed. Kenneth Joseph Arrow, (Cambridge, Mass. :: Belknap Press of Harvard University Press,, 1984); and are used to great effect by Clifford Geertz "Suq: The bazaar economy in Safrou," in Meaning and order in Moroccan society : three essays in cultural analysis, ed. Clifford Geertz, Hildred Geertz, Lawrence Rose (Cambridge ;New York :: Cambridge University Press,, 1979).

12 Most classical economics ignores the cost of information and so assumes intensive relationships among market participants. William Cronon's example of the development of the Chicago Corn Exchange and its grading system shows the amount of work necessary to control quality enough for something to circulate as a perfect commodity. Geertz's description of a Morocan Suq market is an example of a situation in which the quality of products cannot be taken for granted. He argues that the entire organization of the suq is focused towards the management of information about the things being sold. William Cronon, Nature's metropolis: Chicago and the Great West (New York: W. W. Norton, 1991); Clifford Geertz "Suq: The bazaar economy in Safrou," in Meaning and order in Moroccan society

13 The contemporary American used car market is the classic example of a market in which intensive relationships are the norm. A. Rees, "Information Networks in Labour Markets," in The economics of information, ed. Kenneth Joseph Arrow, (Cambridge, Mass. :: Belknap Press of Harvard University Press,, 1984), 109-118.

on a small number of possibilities, each of which are deeply researched. In the Boston Manufacturing Company's case, materials with great variation in quality were purchased intensively, while materials with little variation were bought extensively.

Each of the four materials that I examine in this chapter presented the shop with different possibilities and different constraints, and the shop responded with different strategies. The examples of coal and iron demonstrate the bounds of these strategies. Coal, which was relatively simple to buy, came from a large number of general merchants. Iron, which was complex to buy, came from a small number of specialized suppliers. Hardware and lumber fall between these extremes.

Coal Suitable for Smiths

Fires in the blacksmith's forges and the foundry furnaces consumed a large amount of fuel. In 1814, the shop's first year of operation, the Boston Manufacturing Company spent $313.65 on about 32,000 lbs of coal and 416 baskets charcoal.[14] As work at the shop intensified over the next decade, fuel use

14 A chaldron was a volume measure, used primarily for coal. The amount of coal in a chaldron varied from place to place, but in London a chaldron was 36 bushels. A chaldron of Newcastle coal would have weighed about 3,136 lbs. Charles Hutton, A philosophical and mathematical dictionary containing... memoirs of the lives and writings of the most eminent authors (the Author, 1815), 302.

increased. In 1818 they spent $768 on coal, and in 1822, shortly before the shop moved to Lowell, Massachusetts, they spent $593.[15] Fuel was one of the simplest commodities to purchase; it was readily available and its quality varied little.

Charcoal made up a significant portion of the shop's fuel usage for only a single year. In 1814 about a third of the money spent on fuel went to this type of fuel. Charcoal had been used for thousands of years for processes that required high temperatures, and was the traditional fuel of blacksmiths as well as of potters, brewers and smelters. It was made by allowing wood to smolder slowly in an oxygen starved atmosphere. This burned away the volatile chemicals and impurities and left pieces of almost pure carbon. The resulting fuel burned hot and clean.[16] Its production varied from small operations conducted

15 Journals 10-16, Boston Manufacturing Company MSS.

16 Although the exact shape, dimensions and materials varied, all charcoal making followed a similar pattern. Cut and split pieces of hard wood were stacked in and enclosed in an earthen mound. The wood was then set on fire and allowed to slowly smolder for a several days. The slow fire burnt away most of the impurities in the wood, and all of the water, leaving blocks of almost pure carbon. Charcoal burnt much hotter than raw wood, which allowed smiths and iron-makers to heat their materials to the necessary temperature. Robert Gordon, American iron, 1607-1900 (Baltimore, Md. :: Johns Hopkins University Press, 1996); Patrick M Malone and Robert B. Gordon, The texture of industry : an archaeological view of the industrialization of North America (New York :: Oxford University Press,, 1994); John Percy, "Analysis of Charcoal," in Journal of the United States Association of Charcoal Iron Workers, Vol 5, 1884, 33-34; Ernst Sjostedt, "Charcoal and Charcoal Manufacture," in Journal of the United States Association of Charcoal Iron Workers, Vol 4, 1883, 247-251.

by farmers on their own land using temporary dirt mounds, to industrial enterprises with semi-permanent masonry structures, but almost all of these ventures produced fuel for local consumption. Charcoal was difficult to transport. Not only was it bulky, it was also soft and brittle. If stacked too high the weight of the pile would crush the charcoal on the bottom to dust.[17] Even worse, if a few pieces in a wagon or a ship's cargo were still smoldering, the whole load could ignite. As a result, charcoal did not appear along side the many commodities available at the merchant stores of Boston, it was never advertised in Boston papers, and was not listed with imports and exports.[18]

It is difficult to track local, small-scale charcoal suppliers. The names of some of the charcoal suppliers are listed in the company records, but none of these suppliers appeared in the Boston directories, nor did they advertise in the newspapers. Without more information it is hard to say who they were,

17 Patrick M Malone and Robert Gordon, The texture of industry : an archaeological view of the industrialization of North America (New York :: Oxford University Press,, 1994)

18 The only charcoal listed in Boston papers from this time was a charcoal-based tooth cleaning powder. Otherwise, no charcoal is advertised between 1790 and 1830 in the Boston Daily Advertiser, Boston Gazette, Columbian Centinal, or New England Palladium. It also does not appear in United States. Census Office., A series of tables of the several branches of American manufactures, (Philadelphia: Tench Coxe, 1813); Tench Coxe and United States. Dept. of the Treasury., Abstract of goods, wares and merchandize exported from each state from 1st October 1790, to the 31st September, 1791 (United States, 1792); or Timothy Pitkin, A statistical view of the commerce of the United States of America (Printed by Charles Hosmer, 1817).

but they do not appear to have been merchants. Often the company's records do not even record the source of charcoal. In several instances Paul Moody or P.T. Jackson were reimbursed for charcoal they had bought on their own account.[19] The suppliers who sold charcoal to the shop were small enough not to have left marks in the historical record.

The amount of charcoal used dropped quickly after the first year, and 1816 was the last year the shop bought this type of fuel. Over the course of that year only $37.25 was spent on charcoal, a twelfth of the total fuel expense.[20] This early prevalence of charcoal might have been in part due to the smith's familiarity with the fuel, but it is also likely that the blockade made charcoal an attractive local alternative to imported rock coal, which was selling at double its usual price in 1814. Unlike charcoal, which could be made anywhere that had trees or could get wood, rock coal was mined in only a few places. As a result, coal had long been associated with ocean-bound trade. In the early thirteenth century Londoners referred to fuel imported from Newcastle as "sea coal," and by the fourteenth century the term had become the generic word for any rock coal and was used even in coal producing regions.[21] The term was still

19 Journal 10, BMC MSS.

20 Journal 10, 12, BMC MSS.

21 The term "sea coal" fell out of use in the mid-nineteenth century, but returned later in the

in use in nineteenth century Boston, and indeed, the coal available in Boston was imported. Massachusetts had almost no coal deposits, and Middlesex county had none. Coal arrived on a great variety of vessels because ships returning from Britain with partially filled holds would often carry coal as ballast. Hardware merchants, naval store suppliers, West Indies merchants, cotton merchants, consignment houses agents and auctioneers all sold it. Even in the parched trade climate of the 1814 blockade, merchants almost daily advertised coal in the Boston papers.

Coal advertised in these papers was clearly categorized by where it came from and by its quality. The variability inherent in the material was simplified to a two axis scale, which in turn simplified the process of selecting coal to purchase.

First, the source was simplified by referring only to the port that it came from. All information about individual mines or particular coal deposits were lost in the process. Most of the coal available in Boston came from a small number of ports. Coal from Britain appeared in advertisements as either "Newcastle coal" or "Liverpool coal." Newcastle had been a major city in

century to describe coal that washed up on beaches from water coal beds. "Sea-Coal", The Oxford English Dictionary. 2nd ed. 1989. OED Online. (Oxford University Press. 4 Apr. 2000); Herbert Stanley Jevons, The British coal trade (K. Paul, Trench, Trübner, 1915).

Britain's coal trade since the sixteenth century when a royal act awarded the city a monopoly over coal shipments from the surrounding region.[22] Similarly, Liverpool served as a gathering point of coal from a variety of other English sources. American produced coal was also available in Boston. In the late eighteenth and early nineteenth century deposits of soft coal were discovered in the hills surrounding Richmond, Virginia.[23] After 1785, "Virginia coal" or "Richmond coal" was regularly advertised in Boston papers.[24] This method of describing coal erased the geography of coal production. The buyer had no way to know which mine, which vein, or even which county the fuel came from.[25]

The simplification of information about production was possible because coal buying was further simplified by a grading system that identified only two levels of quality. Low quality coal that was used for heating was referred to as either "coarse coal" or as "coal for grates." High quality coal that was used in

22 John Hatcher, The history of the British coal industry (Oxford University Press, 1993); Herbert Stanley Jevons, The British Coal Trade (K. Paul, Trench, Trübner, 1915).

23 Howard N. (Howard Nicholas) Eavenson, The first century and a quarter of American coal industry, (Pittsburgh, Pa: Baltimore weekly press, 1942)

24 The first Virginia coal advertisement appeared 1785. Advertisement, *The Massachusetts Centinel,* 25 June 1785.

25 This is a close parallel with the development of the corn elevators and the corn-grading system in mid-nineteenth century Chicago, which similarly elided the source of the grain. See William Cronon, Nature's Metropolis: Chicago and the Great West (New York :: W. W. Norton, 1991).

pyrotechnic processed was called “fine coal” or, more frequently, “coal suitable for smiths.” Fine coal had consistent sized pieces, which burned evenly and predictably, and was free of impurities such as sulfur that might be absorbed by the hot metal. These grades were not legally defined, but the vocabulary was used consistently and nearly all the coal advertised in early nineteenth century Boston was described using these terms. The result was that coal was readily available and simple to buy. One simply had to locate the proper grade for one's needs.

The Boston Manufacturing Company generally bought coal in small transactions spread throughout the year. In 1814, the Boston Manufacturing company made eleven coal purchases. On average they bought one chaldron, which weighed about three thousand pounds and cost an average of fourteen dollars, at each purchase. Over the first decade, the average amount of coal bought at each transaction remained constant, though it was more often measured in baskets. Between 1816 and 1825, they bought coal eighty-one times. The average purchase was seventy baskets, which together weighed about thirty five hundred pounds and cost eighteen dollars. Even as the total amount of coal increased the size of each purchase stayed constant.

These small purchases were spread out over many suppliers. The eleven coal transactions in 1814 were divided among nine different suppliers. Between 1814 and 1825, the shop had an average of one and a half transactions with each supplier, each year.[26] It appears that the machine shop did not develop long lasting relationships with trusted suppliers. In other words, they pursued an *extensive* strategy.

The merchants who sold coal to the Boston Manufacturing Company were not specialized coal suppliers. Most were directly involved with ocean-going or coastal trade, and many owned or operated their own ships. They transported coal along with a variety of other goods. The two merchants who supplied the most coal between 1814 and 1825, Thomas B. Wales and Perez Bryant sold Virginia coal as part of their regular trade in southern staples. In 1815, Wales had recently moved from the crowded docks of Long Wharf at the center of Boston's inner harbor to Sea Street where he built his own wharf and operated at least two ships.[27] He was mainly involved in bringing southern goods up the coast to Boston to be sold, re-exported or processed. He regularly advertised southern staples like cotton, tobacco and rice, along with other products

26 Journals 10-15, BMC MSS.

27 Wales appears in the every edition of the Boston Directory between 1803 and 1829. The Boston Directory (Boston: Edward Cotton).

picked up along the journey north, like Providence-made rum and gin.[28] Wales also advertised to take cargo or passage on ships bound for North Carolina and Virginia, and was involved in shipbuilding.[29] Richmond coal appeared among these varied offerings. He occasionally offered New Castle coal, but unlike the Virginia coal for which he often advertised the ship on which it arrived, he gave no clue about the arrival of the British coal. Nothing else Wales advertised came from Britain, suggesting that while his own ships brought coal from Virginia, he bought the New Castle coal from other merchants. Though Wales' wharf never specialized solely in coal, he dealt in large enough quantities to have a storage building devoted to coal.[30]

The second largest coal supplier carried on an almost identical coastal trade. In 1815, Perez Bryant had recently moved to Long Wharf. Bryant began with a shoe and leather store on Ann Street, but beginning in 1803 had moved to a series of wharfs, and finally settled on Long Wharf.[31] Bryant, too, dealt mainly in tobacco, cotton and rice from southern ports. He too had a close

28 For example, Advertisement, Boston Gazette, 29 Mar 1810; Advertisement, Boston Daily Advertiser, 22 Feb 1815.

29 In 1816, he offered a newly build ships hull for sale. Advertisement, Boston Gazette 21 Sep 1815; Advertisement, Boston Commercial Gazette 28 Oct 1818.

30 In 1816 a fire broke out in the coal building at Wales' Wharf. "Fire," Boston Gazette, 21 Oct 1816.

31 The Boston Directory, 1787-1820

connection with the sea, and also offered to freight goods to southern ports on several ships. Like Wales, Bryant offered Virginia coal among his other goods.

The Boston Manufacturing Company's machine shop bought Newcastle and Liverpool coal from merchants who were both less specialized and less directly connected to the details of ocean transport than the southern merchants who supplied Virginia coal. These merchants sold goods from around the world. William Marston, for example offered bandannas, claret, wrapping paper and sugar, as well as ironware and salt from Liverpool.[32] William Little offered an even wider range of goods including molasses, sugar, Connecticut cheese, tea, wine, iron rods, and suspenders.[33] Although their trade was connected with the sea, none offered passage on ships, nor do they advertise the name of the ship landing the goods for sale. It seems likely that these merchants dealt in goods brought to Boston by others. Unlike the southern merchants, these less specialized merchants were not located directly on the wharfs. Instead they operated from counting houses and stores a few blocks away on busy streets like State Street and India Street.

There were specialized coal merchants in Boston in the early nineteenth

32 Advertisement, New-England Palladium 25 Sept 1810; Advertisement, Boston Gazette, 26 Jan 1809.

33 Advertisement, The Democrat, 4 Jan 1809;

century, but the Boston Manufacturing Company machine shop did not favor them. Only one appears in the records. George Guild, who's store was on Front Street on the thin strip of land that connected Boston to the mainland, began to advertise that he had Richmond coal constantly for sale in 1815.[34] The following year he added high quality New Castle coal to his offerings.[35] Between 1814 and 1824 the Boston Manufacturing Company only bought four chaldrons of coal from him.

Although each of these merchants sold a slightly different set of goods, coal played a similar role in all of their businesses. It was one of many goods in which they dealt. Not only did they not specialize in coal, but they offered little else of use to the machine shop. Some of these merchants occasionally offered iron and ironware for sale, but the Boston Manufacturing Company did not buy other supplies from them. Though the Boston Manufacturing Company, and perhaps other shops and smiths, bought coal from these suppliers, these merchants kept their focus on the sea and on the great movements of goods into and out of the harbor.

Of all the materials the shop purchased, coal offered the least resistance.

34 Advertisement, The Repertory, 2 May 1815.

35 Advertisement, Boston Daily Advertiser, 6 Jun 1816

The material itself varied little and came from a relatively small number of sources, which were further simplified by the manner in which it circulated. The machine shop treated coal as a simple commodity: they bought it from whom ever was selling at the best price. They worried little about who they bought it from, and each transaction happened with little reference to any other. The shop did not treat all materials so simply. Iron offers an almost complete contrast.

Iron of All Varieties

The shop bought wrought iron in a variety of cross-section shapes, including rods, bars, and square stock of various dimensions which blacksmiths forged into brackets, levers, wheel, linkages and numerous other parts. Although the early Boston Manufacturing Company machines used far less iron than their British equivalents, or than they would fifteen years later, the shop still used a lot of iron.[36] In 1814, they spent $403 on about 2,600 lbs of ferrous metals (excluding cast iron).[37] Iron usage gradually rose as the shop's output and the

36 For a contemporary comparison of British and American iron usage, see James Montgomery, The Cotton Manufacture of the United States Contrasted and Compared with That of Great Britain (Glasgow: J. Niven, jun, 1840).

37 The weight of the iron purchased is only listed occasionally. 2,600 lbs assumes an average cost of 0.15 $/lb. Cast iron was bought directly from foundries, already cast into roughly shaped components, and will be discussed in the following chapter.

amount of metal in each machine increased. In 1816 the shop spent $1905 on about 12,700 lbs of iron. The height of machine building at the Waltham shop in 1822, they spent $4118 on about 27,400 lbs of iron.

Iron, like coal, was widely available from a variety of sellers. Almost every category of merchant dealt in some quantity of ferrous metals. People who sold spices, leather goods, household goods, paint, cotton, lumber and hardware all advertised iron from time to time. It could be bought directly from local rolling mills, from their agents in Boston or from specialty iron warehouses. Unlike coal, though, iron came from a wide variety of places and in many different qualities. In the early nineteenth century there was no simple grading system for iron and in fact there was little theoretical understanding of variations in the material. Buying iron was no simple matter. The Boston Manufacturing Company machine shop responded to this by developing lasting relationships with specialized iron dealers.

In the early nineteenth century, Boston offered a great variety of types of iron. An advertisement from an iron merchant named John F. Priest gives a sense of the choices available at a single store. In January of 1810 Priest offered: "Russia, (old sable) Swedish, English Iron, of various sizes, and of the first quality; steel of different kinds, such as American Blistered, English dito, Hessenelever, Halback, and Heart and Club; shoe shapes, spike and nail rod…"[38] At other times he offered Philadelphia and Spanish iron, other kinds of Russian iron and German steel. Each region made iron of a different quality. The conventional wisdom, first recorded by Joseph Moxon in 1678, and still being repeated in technical books in the early nineteenth century, was that Russian and Swedish iron were the best, British iron was indifferent and German iron was poor.[39] Although Moxon's specific ideas about good sources of iron may have been out of date, iron quality remained closely tied to its country of origin.[40] Not only was iron from some countries generally considered better than iron from others, metal from these various sources was also suited to different uses. Purchasers of iron often specified exactly which kind of iron they wished to buy. The early Boston Manufacturing Company records often distinguish Swede, British and American iron used for different parts of the

38 Advertisement, New-England Palladium, 12 Jan 1810.

39 Joseph Moxon, Mechanick Exercises (London : Printed for Joseph Moxon, 1677). For a late restatement of Moxon's opinions, see Abraham Reese, "Iron," in Cyclopaedia, or, An Universal Dictionary of Arts and Sciences (London: Printed for J.F. and C. Rivington, 1786); Ephraim Chambers, "Iron," in The Edinburgh Encyclopaedia, 1st ed. (Philadelphia: J. and E. Parker, 1832).

40 The prevalence of the association between iron quality and its point of origin can be seen in the vehemence of Henry Horne's argument against his ideas. Henry Horne and René-Antoine Ferchault de Réaumur, Essays Concerning Iron and Steel (London: Printed for T. Cadell, 1773).

same machine.[41]

Each furnace, forge or rolling mill also produced a different quality of metal from its neighbors. A great deal could go wrong when making iron. Ores, fuels, fluxes and even the refractory linings of furnaces could introduce impurities such as sulfur or phosphorous that made the metal brittle or unworkable. Some wrought iron became brittle when heated and shattered under a smith's hammer. Other iron was tough while hot, but broke easily once cooled.[42] If wrought iron was not hammered properly or sufficiently while being made, the finished billets might have too much slag, or might have poorly distributed slag particles. Such iron was said to have a weak grain and was liable to fracture.[43] In the early nineteenth century these sources of trouble were not well understood or consistently controlled. As a result the quality of iron produced by a furnace depended on the particular chemical make up of the ore, fuel, flux and even of the refractory materials in the furnace, on the particular habits and quirks of different iron-making traditions, and on the skill of particular iron masters.

41 For example in May of 1816 Walter Rogers used English iron, old sable iron, and tub steel making levers, flier tops and lever slants for throstle frames. Journal 13, Boston Manufacturing Company MSS, 20.

42 This was called "red short" and "cold short," respectively.

43 Robert Gordon, American iron, 1607-1900, Johns Hopkins studies in the history of technology (Baltimore, Md. :: Johns Hopkins University Press, 1996); Robert B. Gordon, "Strength and Structure of Wrought Iron," in Archeomaterials 2 (1988), 109-137.

Small changes, like a changing ore supply or a new furnace lining might change the quality of iron produced. Even skilled iron-makers could often only make good iron with the particular materials used in thier region.

Iron quality was a constant concern. Almost every discussion of iron included a discussion of iron quality.[44] Laboratory investigation into iron quality and strength was just beginning in the early nineteenth century. Problems of quality became increasingly important as the material was used in new applications. Apparently good metal in railroad car axles, bridge members, floor joists, cannons and boilers sometimes failed catastrophically and spectacularly. The Franklin Institute began to investigate the strength of iron in the early nineteenth century, but their results had little practical use.[45]

Buying iron required a great deal of skill and knowledge. People who dealt in iron had to be connoisseurs of metal.[46] They needed detailed knowledge of

44 For example, Henry Horne and René-Antoine Ferchault de Réaumur, Essays Concerning Iron and Steel (London: Printed for T. Cadell, 1773); The Emporium of Arts and Sciences (Philadelphia: Joseph Delaplaine, 1812); Parker & Delaplaine's American Edition of the New Edinburgh Encyclopaedia (Philadelphia: [Edward Parker & Joseph Delaplaine, 1813); Jacob Bigelow, Elements of Technology, 1829; The Edinburgh Encyclopaedia, 1st ed. (Philadelphia: J. and E. Parker, 1832).

45 For a review early iron testing, see Robert B. Gordon, American iron, 1607-1900 (Baltimore, Md. :: Johns Hopkins University Press, 1996); I. Todhunter, A History of the Theory of Elasticity and of the Strength of Materials, from Galilei to the Present Time (Cambridge: University Press, 1893).

46 Connoisseurship, outside art history, has received surprisingly little attention. William Reddy's study of textile guides in pre- and post- revolutionary France an suggestive begin-

the qualities and uses of iron from many countries and regions. Further, they had to know particular furnaces and perhaps even individual iron-masters. Furnaces often stamped bars, billets and ingots with symbols such as eagles, angels and stars. An iron buyer not only had to recognize these symbols but also had be able to identity fraudulent stamps. To the trained eye, the metal itself could also give clues about its quality. There were several techniques for assaying iron. The most common was to notch the bar and bend it back until it broke. The quality of fracture revealed the brittleness of the iron. Good iron had a dull fracture and brittle iron had a bright fracture.[47] The metal's taste, smell, color and ability to take a bright polish also gave clues as to its quality.[48] Like a modern-day wine enthusiast,[49] the nineteenth century iron connoisseur had to combine detailed knowledge of the geography of production with finely honed senses.

The machinists and blacksmiths who worked at the Boston Manufacturing

ning. Reddy, William, "The structure of a cultural crisis: thinking about cloth before and after the Revolution," in The Social Life of Things, ed Arjun Appadurai (Cambridge University Press, 1988).

47 Modern micrographic understanding is that malleable iron fibers stretch before it breaks, leading to a dull surface. Brittle iron breaks at the intersection of crystals. The smooth crystal faces give the bright appearance

48 Johann Andreas Cramer, Elements of the Art of Assaying Metals (London: Printed for Tho. Woodward and C. Davis, 1741).

49 Steven Shapin, "Hedonistic Fruit Bombs," London Review of Books, 3 February 2005.

Company's machine shop understood the working properties of metal, but the shop did not depend on their expertise when buying iron. Instead, they relied on a small number of specialized and trusted suppliers. Unlike coal, the shop regularly bought iron from only a few merchants. In 1814 all of the iron came from only two sources, and from 1815 to 1824, sixty percent of the iron purchased came from a single source. Particular suppliers gradually came and went, but each year two or three suppliers provided the bulk of ferrous metals. In 1817, for example, two suppliers account for eighty-four percent of the iron purchased. Over the course of the first decade of machine building the Boston Manufacturing Company had an average of two and a half transactions with each supplier, each year.[50] When purchasing iron, the shop developed regular and lasting relationships with suppliers. In other words, they pursued an *intensive* strategy.

These trusted merchants all specialized in iron. Unlike the coal suppliers, these ironmongers dealt almost exclusively in iron and ironware. In the shop's first years most of the iron they bought came from iron merchants who were extensively involved in the trans-Atlantic and coast-wise trade, and who oper-

50 As compared to one and a half transactions per supplier for coal. Journal 10-15, Boston Manufacturing Company MSS.

ated stores that carried many kinds of iron from around the world. The shop gradually shifted away from these harbor-side merchants as new local iron rolling mills developed in Waltham and South Boston. In both cases though, the shop relied on their suppliers' knowledge and skill.

From 1813 to 1815, the Boston Manufacturing Company bought iron from merchants who where closely associated with seaborne trade and who's stores and warehouses were located on or near Boston's wharfs. In 1814, Jeffery Richardson provided the largest amount of iron. Richardson was the son of a Boston rope-maker and hemp surveyor. He was born in 1789 and at the age of sixteen he apprenticed with the major mercantile firm of John and Samuel Harris and later served them as a clerk. In 1811 Richardson set up an iron store on Kilby Street. The following year he moved to the corner of India and Milk streets and was joined by his brother James B. Richardson who had just completed an apprenticeship with one of Boston's most prominent hardware importers, Samuel May. Richardson was actively engaged in the development of Boston's waterfront and was one of fifty investors in the construction of Central Wharf. When the Wharf was completed in 1817, the Richardsons moved their store there. In the same year a third brother, Benjamin P.

Richardson, joined the company.[51]

Richardson offered a “complete assortment of iron, nails, steel &c, &c” from his store on Central Wharf.[52] He moved a large amount of metal through the store. Between October and December of 1823, for example, he paid E.R. Williamsburg $71.39 to haul about 162 tons of iron between his store and various wharfs and docks.[53] The metal he sent out went to a variety of customers. Richardson received orders from village blacksmiths and small-time nail makers from as far away as Hallowell, Maine, Portsmouth, New Hampshire, and Bristol, Massachusetts. He also supplied iron to larger industrial operations like Oliver Ames' shovel factory in Easton, MA and Johnathan Leonard's steel-making furnace in Canton, Massachusetts.[54] In addition to written orders, his store received business from smiths, farmers, and householders from the surrounding countryside. Richardson, like other iron merchants, offered a number of services to his customers. They could have iron bars cut to

51 Jeffrey Richardson, Genealogical and biographical sketch of the name and family of Richardson (Printed by A. Mudge for the author, 1860).

52 Advertisement, Boston Commercial Gazette, 18 Oct 1819.

53 J & JB Richardson to ER Williamsburg, December 1823. J. Richardson Papers, Vol 8, Baker Library (hereafter Richardson MSS).

54 Rodger Williams to J Richardson, 25 Mar 1814, Richardson MSS, Box 1; J.S. Thimball to J Richardson, 19 Nov 1813, Richardson MSS, Box 1; Nathan Moody to J Richardson, 30 Oct 1817, Richardson MSS, Box 3; Oliver Ames to J Richardson, May 1816, Richardson MSS, Box 1; Jonathan Leonard to J Richardson, 2 Feb 1814, Richardson MSS, Box 1.

length or bent into simple shapes. Country smiths who traveled into Boston could get help loading the metal into their cart, and those unable to come to Boston personally could have iron forwarded to them on the ship of their choice.[55] Customers also depended on Richardson to select high quality iron that was appropriate to their needs. Oliver Ames, for example, requested, "1 ton old sable Russia iron" and asked that Richardson "would be particular and not send any that is not the true stamp or that is flawed or scamy."[56] Another buyer wished to buy a particular batch of iron he had seen earlier: "I wish to know whether you have any of that particular lot of good steel on hand that you had when I was down the other day, and if you have I wish you to leave me about a hundred pounds."[57] Although many merchants offered iron for sale, only specialized iron merchants like Richardson dealt in such a high volume of metal and offered so many services to their customers.

Though Richardson imported the iron he sold, he did not own or operate his own ships. He depended on packets, regular traders and common carriers to both bring iron to his store and to carry orders to distant customers.

55 Francis Wyman, Advertisement, Boston Gazette, 16 Sep 1813; J.F. Priest, Advertisement, New-England Palladium, 15 Dec 1807; J.S. Thimball to J Richardson, 19 Nov 1813, Richardson MSS, Box 1.

56 Oliver Ames to J Richardson, May 1816, Richardson MSS, Box 1

57 Roger Williams to Jeffery Richardson, 25 Mar 1814, Richardson MSS, Box 1

Through the transportation network he developed, Richardson was also able to trade in other materials. Richardson was in frequent communication with S.G. Bronson, who was the captain of a regular trading brig called the New Packet. Bronson brought iron and manufactured goods to Boston, took nails and rolled iron bar from Boston to Charleston, South Carolina, and carried cotton from Charleston to Liverpool. On each cycle, Bronston carried some of these goods on Richardson's account.[58] Richardson also regularly sent pot ash and whale oil to Liverpool to be sold by a commission merchant firm called Lodges & Tooth.[59]

Other iron merchants with whom the Boston Manufacturing Company shop did business carried on almost identical businesses. Abraham Gibson began his career as a West India merchant, but by the 1790s West India goods warranted only a passing notice in his ads. In 1801, Gibson began only listing iron for sale at his store on Long Wharf.[60] One of the most successful iron merchants was John Fox Priest, who was born in Rindge, New Hampshire in 1786 and died in Boston in 1846. At the time of his death he is said to have been one of the one hundred wealthiest people in Boston. He operated an iron

58 S.G. Bronson to J Richardson, Richardson MSS, Boxes 3 and 4.

59 Lodges & Tooth to J Richardson, Richardson MSS, Boxes 1 and 2.

60 Advertisement, Columbian Sentinel, 31 Dec 1796.

and nail store on India street from 1809.[61] Similarly, Francis Wyman owned an iron story in Cambridge Port from 1810.[62]

Beyond the basic cutting and bending services, these iron merchants were not directly involved in the use of iron. Though some may have later invested in manufacturing concerns, their role was as a source of funds, materials and perhaps management, not technical expertise. Nor were these merchants involved in iron smelting. Ironmongers were only expert in one portion of the vast range of things that could be known about iron. They were knowledgeable in the craft of business in and around the harbor and wharfs. The schedules of ships, the reputations of captains, the seasonal rhythms of the ocean, the circulation of goods, the arrangement of credit, the management of duties and customs, and the array of counting-house practices were all important to success. In addition to the general mercantile expertise, iron merchants also required a more specialized knowledge. Although he would not have known how to turn ore into metal as a smelter would, or how to shape the metal as a blacksmith,

61 William Richard Cutter and William Frederick Adams, Genealogical and personal memoirs relating to the families of the state of Massachusetts, Vol 4 (Lewis historical Pub. Co., 1910), 2477; The Boston directory (Published by Hunt and Stimpson and John H.A. Frost, 1809); Advertisement, New-England Palladium, 15 Dec 1807; Advertisement, Boston Gazette, 1 Aug 1808; Advertisement, The Repertory, 9 Jan 1810.

62 The Boston directory (Published by Hunt and Stimpson and John H.A. Frost, 1810); Advertisement, Boston Gazette, 6 Sep 1810; Advertisement, Boston Gazette, 17 Feb 1814.

the iron merchant would have offered his customers an intimate knowledge of the topography of iron product, trade, and quality, and would have been able to guide them through the varied selection in his store.

In the first decades of the nineteenth century new iron mills were built throughout Massachusetts. As these mills became established, the Boston Manufacturing Company's machine shop shifted their business away from the Boston-based iron merchants. By 1818 almost all the bar-iron they bought came from the Newton Iron Works and its Boston agent and later owner, Rufus Ellis. The Newton works was located a few miles up the Charles River at Newton Upper Falls. With a twenty foot perpendicular drop followed by another thirty-five foot descent over a half mile, the upper falls was home to small complex of mills. The earliest was a saw mill built in 1638. When the Newton Iron Works began in 1799, there was already a grist mill, four snuff mills, a wire mill, and a screw factory. The rolling mill gradually expanded over the years. They added a nail cutting factory in 1809 and a cotton mill in 1813. By 1835 the iron works produced fifteen hundred tons of bar-iron and five hundred tons of cut nails each year.[63]

63 Samuel Francis Smith, History of Newton, Massachusetts (American Logotype Co., 1880), 269; George Clarke, History of Needham, Massachusetts, 1700-1911 (Heritage Books, 2000), 163; 1. Samuel Adams Drake, History of Middlesex County, Massachusetts: Containing Carefully Prepared Histories of Every City and Town in the County (Boston: Estes

Rufus Ellis, born in 1777 in West Dedham, was the Newton Iron Works' agent from the company's beginning. Like Patrick Tracy Jackson, Ellis operated out of a counting house in downtown Boston where he obtained raw materials, arranged for the sale of products and organized the books. While the daily operation of the mill was left to others, Ellis was intimately tied to its activities. In 1821 Ellis became the sole owner of the Newton works. In 1823 Ellis and six other investors re-incorporated the works as the Newton Factories, and in 1835 Rufus Ellis and his brother David Ellis became the owners. Sometime before 1840 Ellis left his Boston offices to live full-time in Newton, where he died in 1859.[64]

In 1824 the Boston Manufacturing Company's machine shop also began to

and Lauriat, 1880).

64 The Boston directory (Published by Hunt and Stimpson and John H.A. Frost, 1801-1825); US Census, 1840 and 1850.

buy iron from the newly opened Boston Iron Works at the Roxbury end of the Boston Mill dam. The iron works was part of an ambitious plan to develop extensive manufacturing in Boston. It was based around a series of dams that were to turn the Back Bay at the mouth of the Charles river into a enormous mill pond with mills along the thin strip of land called “the neck” that attached down town Boston with the main land. The full dream was never realized, but several dams were built, including one that ran from Cambridge about one and half miles along the line that is now Massachusetts Avenue to Tremont Street.[65] The engineer behind the Boston Mill Dam project was David Moody, who was the younger brother of the superintendent of the Boston Manufacturing Company's machine shop. David Moody was also the agent for the the Boston Iron Works. The iron works was incorporated in 1822 and was in operation by 1824.[66] It featured a rolling mill, a screw mill and nail-cutting mill. The

65 This dam partially drained the Back Bay and was the first step in the project to fill the entire bay. Wilfred E Holton and William A Newman, Boston's Back Bay : the story of America's greatest nineteenth-century landfill project (Boston :Hanover :: Northeastern University Press ;University Press of New England, 2006); Benjamin Dearborn, A plan of those parts of Boston and the towns in its vicinity : with the waters and flats adjacent which are immediately or remotely connected with the contemplated design of erecting perpetual tide-mills, Harvard Map Collection (Boston : Benjamin Dearborn,, 1814); James Eddy, R. H. (Robert Henry) Eddy, and Pendleton's Lithography, Plan of East Boston : shewing the location of a mill dam and other improvements, Harvard Map Collection digital maps (Boston :: Pendleton's Lithography,, 1834).

66 Legislative Acts, New-Bedford Mercury, 14 Jun 1822; Advertisement, Portland Advertiser, 20 Oct 1824; Contributions of the Old Residents' Historical Association, Lowell, Mass, Vol 1(The Association., 1892), 221; Thomas Patrick Hughes and Frank Munsell, American

iron works made almost exactly the same set of products as the Newton Iron Works.

The rolling mills heated roughly shaped billets of wrought iron and squeezed them between heavy, water-powered rollers to extrude various shapes of bar and rod iron. The Newton mill was one of hundreds of similar mills built across the country in the first decades of the nineteenth century. These rolling mills brought different kind of expertise than that held by the iron merchants. Rather than understanding the global flows of metals, fuels and ores, and the complex geography of iron quality, these mills dealt directly with the metal itself. Rolling mills were themselves consumers of iron. They operated at a greater remove from global iron trade, but unlike iron merchants they had direct experience with the use and therefore of the mechanical properties of different kinds of iron. The mills selected what kind of iron to roll, sometimes mixing different types together to balance their properties. In the process the diversity of iron sources and qualities was simplified. Iron from the mill was no longer Russian, British or Swedish. Instead it was only described by its shape. While the expertise of the iron merchants allowed the shop to manage the complexity of the iron market, the expertise of the rolling mills

Ancestry, Vol 7 (Munsell, 1892), 271.

removed the complexity itself. In both cases, though, the shop depended on trusted and knowledgeable suppliers to help them navigate the supply chain.

Iron and coal represent two extremes of purchasing strategies. The distinction makes it possible to examine the patterns developed in other materials. Hardware and lumber show a mix of features of both extremes.

Sundry Hardware

The Boston Manufacturing Company's machine shop did not just buy raw iron bars, rods and sheets. They also bought many small iron items, such as fasteners. In 1818, for example, the shop spent $959 on screws, nails, nuts and bolts. Fastener purchases were often mixed in with other iron goods such as anvils, files and sand paper, and they frequently appeared in the records as “screws &c” or even simply as “sundries.” The shop's hardware purchasing pattern resembled both their pattern for coal and for iron. As with coal, they purchased hardware from many different sellers. As with iron, these suppliers were specialized hardware dealers. The shop also gradually shifted to local sources of fasteners as the nail and screw industries of Massachusetts grew.

Iron goods could be bought from a wide variety of sellers, but the market was dominated by specialized hardware merchants. The term “hardware” was used to describe small metal items as early as the sixteenth century.[67] In early nineteenth century Boston, the term referred to a stable set of goods that included time glasses, sheet lead, shot, white and red leads, skates, coffee mills, kettles, anvils, vises, locks and files.[68] In 1813, when the Boston Manufacturing Company first began to build machinery, the Boston Directory listed twenty-one hardware merchants. In 1818 Boston boasted thirty-four hardware merchants. Like iron merchants, hardware merchants sold goods imported from British sources. Much of this hardware was manufactured in factories in Northern England, and gathered in trading centers like Liverpool to be shipped around the world. The first decades of the nineteenth century also saw increasing development of screw and nail mills Massachusetts. Many hardware merchants began to offer locally made hardware and many became directly involved with the new industries, and some began to further specialize in supplying metal goods for industrial concerns. The shops' purchasing patterns followed these developments.

Many of the fasteners bought in the first years of machine building came from Samuel May, one of Boston's most prominent hardware merchants. Born

67 Oxford English Dictionary, s.v. "Hardware."

68 Advertisement, Boston Gazette, 7 Novem er, 1814.

in 1776 in Roxbury, he was the son of a builder and lumber merchant. May opened his hardware business on Union Street in 1803 and in 1807 moved to Broad Street where he stayed until shortly before his death in 1870. May was active in public life as a deacon in the Hollis St church, co-founder of the Massachusetts Asylum for the Blind, a supporter of the Boston Athenaeum, and the overseer of the poor. His son, also named Samuel May, became a leading abolitionist in Worcester, MA.[69]

May was a typical hardware merchant. His store offered a typical range of hardware goods to a variety of customers. May offered iron bars, billets of non-ferrous metals, tools such as files, anvils, knives and saws, crucibles for melting lead, grinding stones, and numerous other items. May was not, though, only an industrial supplier. He also carried items of interest to householders, such as coffee mills, iron kettles, fire tongs and ice-skates. At the hardware store one might meet blacksmiths restocking their iron supply, fishermen buying chandlery, house-wrights buying nails and window glass, store owners buying locks, or farmers buying lamps.

Like the iron merchants, May did not operate his own ships. Instead the

69 Almon Danforth Hodges, jr. "John Joseph May," in New-England Historical and Genealogical Register, Vol 53, April 1904, pg 111.

goods he sold came to Boston on packet ships that made regular voyages between Boston and Bristol or Liverpool.[70] May's store was several blocks away from the harbor, but other hardware merchants kept their warehouses on the wharfs to receive these many shipments. In addition to the regular stock, merchants like May also often advertised newly arrived or specially available goods, generally listing the ship on which they arrived. For example in 1815 Montgomery Newell and George Dana, hardware merchants next door to May at 6 Broad Street, advertised that they had "received by the Milo and Liverpool packet, an extensive assortment of Birmingham and Sheffield goods, which they will sell on good terms..."[71] The hardware business was dependent on the rhythms and cycles of sea-trade.

In addition to imported stock, some hardware merchants were also directly involved with newly developing domestic industries, and especially with rolling mills and nail factories. Samuel May, for example, regularly sold iron brought directly from the Monkton Iron Company in Vermont and could take custom

70 Packet ships that traveled on strict schedules and that carried exclusively paid cargo were only just developing in the early ninteenth century. Before that though, regular traders had been supplementing their owner's cargo with paid freight for decades. Robert Greenhalgh Albion, *Square-riggers on Schedule: The New York Sailing Packets to England, France, and the Cotton Ports* (Archon Books, 1965).

71 Advertisement, Columbian Centinel, 21 June, 1815 (Boston).

orders for bar stock shapes.[72] He invested in manufacturing concerns in Montreal, Buffalo and Pennsylvania.[73] Many hardware sellers had special arrangements with inventors and manufacturers. Charles Scudder offered Abel Stowell's patent screws from the inventor's factory in Worcester, Massachusetts and machine cards made by David Holmes in Amherst, New Hampshire.[74] People interested in purchasing Jacob Perkins' (the Amesbury manufacturer who also trained Paul Moody) patent bank locks were also directed to Scudder's store where they could see demonstration models and have the lock's features explained.[75] Scudder even offered to pay cash for wire that could be used in a card making factory with which he was involved.[76] Although Scudder sold the ubiquitous ironmongery from the Bristol and Liverpool packets, he, like many hardware merchants, became increasingly involved with American manufacturing concerns.

Other hardware merchants became even more closely associated with man-

72 Advertisement, New-England Palladium, 30 June, 1815.

73 Ellery Bicknell Crane, Historic Homes and Institutions and Genealogical and Personal Memoirs of Worcester County, Massachusetts: With a History of Worcester Society of Antiquity (Lewis Publishing Company, 1907).

74 Advertisement, Boston Daily Advertiser, 27 May, 1814. Advertisement, Repertory, 25 November, 1815 (Boston).

75 Advertisement, Newburyport Herald, 10 June, 1814.

76 Advertisement, Boston Daily Advertiser, 22 July, 1813.

ufacturing, and became almost exclusively outlets for a factory's products. For example, the other main source for hardware in 1815 and 1816 was a former salted fish merchant named Ezra Hyde who also developed direct ties to the emerging metal working industries in the Boston hinterlands. Hyde began as a general merchant, selling mostly animal products like leather, beef and smoked herring from a store on Broad Street, just west of the bridge.[77] In 1810, shortly after dissolving his partnership with Alexander Bowers, he moved to Central Wharf where he had a West India commission store.[78] In 1818, Hyde's business shifted away from the West Indies towards hardware sales. He advertised to hire nail makers familiar with Ordiorne's newly developed nail cutting machine to work at Lazell, Perkins & Co in Bridgewater, Massachusetts.[79] Soon Hyde's business was focused almost entirely on selling Bridgewater nails. Many of the packet ships coming from Weymouth (the closest port to Bridgewater) carried casks of Bridgewater nails for Hyde's store. Ezra Hyde's involvement with Bridgewater and its nail factory seems to have run deeper than just the source of nails; both his marriage in 1805 and his death in 1821 appear in the Bridgewa-

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77 Advertisement, Connecticut Courant, 22 December, 1788.

78 Advertisement, Boston Gazette, 23 May, 1808.

79 Advertisement, Boston Daily Advertiser, 26 May, 1818.

ter Vital Records.[80] The variety of iron goods Hyde sold grew as Lazell, Perkins & Co expanded their operations. At Hyde's death in 1821, his store offered anchors, cut nails, iron work for ships, forged or finished capstan spindles, windlasses, gudgeon and wrought iron shafts for factories.[81] Unlike many of the other hardware merchants, Hyde's hardware business had little to do with over-seas trade. As a result, he also gradually became more specialized, selling mostly parts used in ship building and mill building.

Clear, True and Merchantable Lumber

The machines built by the Boston Manufacturing Company's machine shop, like most machines built in early nineteenth century America, were composed largely of wood. Frames, rollers, gears, cams, some kinds of bearings, spindles, shuttles and parts of the water wheel were all made of wood. Only parts that absolutely required the strength, hardness or durableness of metal were made of brass or iron.[82] In 1814 alone the shop spent $570 on lumber, which is one

80 Vital Records of Bridgewater, Massachusetts, to the Year 1850 (New England Historic Genealogical Society, 1916). Bradford Kingman, *History of North Bridgewater, Plymouth County, Massachusetts: From Its First Settlement to the Present Time, with Family Registers* (The author, 1866).

81 Advertisement, Boston Daily Advertiser, 7 October, 1823.

82 For a comparison of the use of wood and metal in the US and Britain, see James Montgomery, *The Cotton Manufacture of the United States Contrasted and Compared with That of Great Britain* (Glasgow: J. Niven, jun, 1840). For a general perspective on the importance of wood in early American technology, see Brooke Hindle, ed. *America's Wooden Age: Aspects of Its Early Technology* (Tarrytown, N.Y: Sleepy Hollow Restorations, 1975).

and a half times as much as on iron. Between 1814 and 1818 the machine shop spent $5000 on lumber; about equal to what was spent on iron in the same period. At an average cost of $0.035 per board foot, this comes out to over 140,000 board feet.[83] From year to year the ratio of wood to iron varied from a high in 1818 when the shop spent almost 2.5 times as much on lumber as on iron, to a low the following year when they used 12 times more iron than wood. Overall, though over the first few years of machine building, expenditures on wood approximately equaled those on iron.

The shop bought many different kinds of wood. Between 1814 and 1822 they bought eleven different species, though the majority was birch, ash and pine. Each of these three kinds of wood has its own properties, but in general all three are light, springy and strong. The ratios between the three vary at each year and it appears that they were all used for frames and other large applications. The shop also used small amounts of more specialized kinds of wood. Cherry and walnut were both hard and smooth woods that could be used in gearing, Mahogany resisted rot and was used in parts of the mill work frequently exposed to water, and lignum vitae, which is also called ironwood, is

83 This excludes lumber used to construct the buildings themselves, which far exceeds this number.

an extremely dense and hard wood with natural oils that resist rot and provide lubrication. The shop could use such wood for bearings. Because these various kinds of wood came from trees that grew in different regions, the lumber presented a varied landscape to the consumer, and the Boston Manufacturing Company's machine shop pursued several strategies simultaneously.[84]

The first English settlers found eastern Massachusetts, like the rest of New England, thickly wooded with a mix of white pine and hardwoods such as oak and chestnut. Early visitors described pines large enough to make a ship's main-mast in one piece.[85] In each settlement, saw mills were built along with the first houses. Waltham followed most towns in this regard. The hills and gentle slopes of the town were thickly covered in oak and pine, while large cherry trees lined the river.

Despite the abundance of trees, Massachusetts never developed a large lumber industry. The export of local lumber was limited by the sparse growth of trees along the coast and by the lack of large rivers that could be used to float logs to the ocean. Beyond this, though, local needs consumed most of the

84 R. Bruce Hoadley, Understanding Wood: A Craftsman's Guide to Wood Technology, Rev. ed. (Newtown, CT: Taunton Press, 2000).

85 For more on early explorers and settler's views on forests and lumber see 'Charles F. Carroll "Forest Society of New England" In *America's Wooden Age: Aspects of Its Early Technology*, Ed. Brooke Hindle (Tarrytown, N.Y: Sleepy Hollow Restorations, 1975).

lumber. Massachusetts was one of the fastest growing states and the trees were needed to build the timber framed, clapboard covered houses and barns of the rapidly filling countryside.[86]

Despite the limited development of the Massachusetts lumber industry, lumber played a major role in Boston's merchant history. Timber crowded the Boston wharfs and storehouse from the seventeenth century.[87] Between October 1791 and September 1792 nearly 30 million feet of boards, planks and scantling were exported from Massachusetts, representing about half of the country's total lumber exports. Most of this lumber moved through Boston. From early on, Boston merchants brought lumber from Maine and New Hampshire to be re-exported (along with salted fish and later whale oil) primarily to the British West Indies, where it was used to build structures on the largely treeless islands. This re-export trade allowed Boston merchants to obtain a favorable balance of trade in a region with no significant cash crops or mineral deposits, and thus formed the foundation of Boston's merchant economy. This trade continued to grow throughout the first half of the nineteenth century. A

86 James Elliott Defebaugh, *History of the Lumber Industry of America*, (1907). Michael Williams, *Americans and Their Forests: A Historical Geography* (Cambridge University Press, 1992).

87 The first recorded use of the term "lumber" to mean sawn wood was in a Boston police order in 1663. Before that the term referred to excess furniture that crowded a room. It might have been applied to timber in reference to how it blocked up the harbor.

lumber buyer in early nineteenth century Boston would have had access to a tremendous volume of wood flowing through Boston.[88]

Like iron, lumber quality varied greatly. There were many things that could make a piece of lumber unsatisfactory. The conditions under which a tree grew effected the lumber it produced. Trees that grew slowly in poor soil or in crowded conditions had smaller growth rings and a denser texture, but the tree could bend or twist as it strained to accommodate its neighbors and so would have grain that was difficult to work. Trees growing in the open would grow straight and have straight grain, but would also be lighter and weaker. The time of year when the tree was cut also effected the quality of the wood. Bark was easy to remove from trees cut in the spring because of the soft new growth between the bark and the previous year's wood, but lumber cut in the winter dried faster because there was little moisture in the dormant tree. Treatment of wood after felling also made a difference. It had to be dried before it rotted, but could check, warp or split if dried too quickly. Different methods of drying also affected the quality of the lumber. Wood dried slowly in the air was harder and was less likely to warp than wood dried quickly in a kiln. Even if nothing went wrong in lumber production, wood could always be ruined by improper

88 James Elliott Defebaugh, *History of the Lumber Industry of America*, (1907).

storage. Conditions that were too wet, too dry, or that changed too quickly could all make wood useless.[89] As with iron, there was a great deal that could go wrong, and so there was also a correspondingly large variation in the quality of the lumber available for sale.

Much of the wood brought into Boston was probably of low quality. American lumber had a poor reputation in England. So little care was taken in drying and storing wood that dock workers had to shovel a thick layer of fungus from the cargo before unloading them.[90] With large amounts of lumber flowing through the port, Boston instituted an official survey system to help control the quality of lumber. The Boston Lumber Survey was instituted at a city level in 1783, and was soon expanded to cover the whole state. The Boston systems later became the basis for lumber surveys in Baltimore, New York and a number of other cities. All lumber sold from Boston to out-of-state buyers had to be surveyed by a city official, at the expense of the parties involved in the sale. Lumber bought or sold locally could be inspected on the buyer's prerogative.

89 George Simonds Boulger, *Wood*, (1908). Charles Fergus, *Trees of New England: A Natural History*, 1st ed. (Falcon, 2005). R. Bruce Hoadley, *Understanding Wood: A Craftsman's Guide to Wood Technology*, Rev. ed. (Newtown, CT: Taunton Press, 2000). Peattie, Heman Howard, and Paul Landacre, *A Natural History of Trees*, 1966. Eric Sloane, *A Reverence for Wood* (New York: Ballantine Books, 1965).

Donald Culross

90 Peattie, Heman Howard, and Paul Landacre, *A Natural History of Trees*, 1966.

In its initial form, there were two grades: merchantable and not merchantable. Merchantable lumber had to meet a basic level of quality. For specific forms, like barrel staves, it had to be cut to the right dimensions and had to be packed in standardized forms. By the early nineteenth century this basic grading system was too simple to effectively regulate the lumber passing through the system. In 1825 the grading system was elaborated to include five grades of merchantable lumber, with different standards defined for different kinds of wood.[91]

The result was that unlike other commodities, lumber circulated in a partially controlled environment. The quality of the material was not only controlled by the producers and sellers, nor was it only the responsibility of the buyer. Instead the process of judging quality was an official function to be carried out by official inspectors.

The Boston Manufacturing Company's machine shop pursued a number of different strategies to procure the lumber needed to build their machines. Between 1814 and 1824, the ratio of transactions to the number of suppliers averaged 1.5, the same as the ratio for coal. As with coal, the shop bought lumber from many different people. These purchases were not evenly distributed.

91 Ibid.

Each year a few large transactions made up the bulk of the purchases. Even so, the shop did not develop lasting relationships with the lumber suppliers; each year the large purchases were made from different suppliers. The suppliers were from a variety of different places and played different roles in the supply chain.

Early on, some lumber came directly from farmers and small mills near the shop. In 1814 the shop spent $371.06 on oak planks and timber, which probably came from local sources. Much of the land in Waltham was cleared long before the beginning of the nineteenth century, but the stands of oak that had once populated the rocky soil of higher ground still remained in spots. The largest supplier was Elijah Hastings, who was born in Waltham in 1775 and died there in 1842.[92] He was listed as a farmer in the 1820 census, though he also worked occasionally as a blacksmith for the Boston Manufacturing Company.[93] There is no record of whether the lumber came from his own land, or if he served as a middle man for others, but it is unlikely that he had extensive contacts or that he was importing lumber from great distances. Paul Moody, the superintendent of the machine shop, was also paid for oak. Moody was often reimbursed

92 *Vital Records of Waltham, Massachusetts, to the Year 1850* (Boston: New-England Historic Genealogical Society, 1904).

93 US. Census 1820. BMC MSS.

for purchases he made on his own, and it is likely that he had bought the wood from a local source and only the reimbursement remains on record.

After the first year, the Boston Manufacturing Company shop bought no more oak and very little local lumber. Instead, they bought primarily ash, birch and pine. All of this wood was imported to Boston from northern New England and the South. Unlike almost all the other basic materials, some of this lumber came directly from distant suppliers. The first of these transactions was arranged by David Moody, Paul Moody's brother, who was in Hollowell, Maine at the time. Hollowell was located on the Kennebec river and in the late eighteenth and early nineteenth centuries was a growing center of trade, shipbuilding, granite and lumber export. The river fell over a series of cascades as it went by the town and served to power a number of mills and factories, including a wire factory and later a cotton mill. In late 1813, P.T. Jackson wrote to a Hollowell cabinet maker named Joseph Dummer to inquire about purchasing 20,000 feet of ash timber. Several weeks later he wrote to David Moody to ask him to make further inquiries of Dummer and included a list of lumber dimensions needed and the maximum price he was authorized to accept.[94] Pine also came directly from northern suppliers from like Richard H. Ayer, of Dunbar-

94 Jackson Letter to Joseph Dummer, 3 Dec, 1813, Lee MSS.

ton, New Hampshire. Ayer sold lumber and was involved in transportation projects that brought lumber from the inland forests to the coast such the Merrimac Canal (which was later the basis for the Lowell canal system) and the Londonderry turnpike. P.T. Jackson ordered materials directly from Ayer, who delivered them to the Watertown dam.[95]

As machine building at the Boston Manufacturing Company intensified, an increasing amount of lumber came from Boston lumber merchants. For example, in 1816 the shop bought lumber from Otis Vinal, who was a partially specialized lumber merchant on Long Wharf. Vinal was actively involved in this northern trade. He regularly advertised the spruce and pine boards that frequently arriving on his schooners, along with other goods brought from Europe by way of Halifax, especially Dutch goods and salt. Other northern pine came directly from the owners of the newly built Central Wharf.

The shop also bought lumber brought from the south. Most of the southern lumber was yellow pine, which grew in the high Appalachian mountains. Southern pine came from Boston Merchants who dealt in a variety of southern goods. Josiah Whitney, for example, was a merchant who brought goods to his store on Long Wharf on the Savanna packets. He dealt in a variety of Southern

95 Jackson Letter to Richard H. Ayer, 7 Feb, 1814, Lee MSS.

goods, including rice, coal and cotton. Pine formed a regular, though not dominant portion of his trade. Like Virginia coal, yellow pine fit neatly into the already well established coastal trading routes that brought a wide range of goods into Boston for processing or re-export.

The Boston Manufacturing Company pursued several different strategies for getting wood. And unlike most other materials, they got it from many different kinds of sources. This is partly explained by the fact that each type of wood was different, and so presented slightly different problems. The lumber survey also meant that the lumber market was more standardized than other markets, allowing greater flexibility. Not all the lumber the Boston Manufacturing Company bought was surveyed, but the categories and language of the survey permeated every transaction. In letters to lumber merchants, for example, Jackson used language directly from the survey standards. When he asked for "merchantable" lumber, he was invoking these standards, essentially asking for lumber that would pass the survey. Already in 1814, the terminology was stable enough to not require further explanation.

Across all of these materials, the Boston Manufacturing Company had to react to the materials and markets available to them, at their specific location.

Through the materials needed to build machines, the shop became deeply embedded in the workings of Boston trade and with the growing industries that functioned through Boston agents. Buying materials was not simple, and by following the materials bought, we can see how the shop positioned itself in relation the surrounding commercial possibilities.

Chapter 4: The Geography of Work

The Boston Manufacturing Shop was in the midst of an industrial landscape. New mills were built on the rivers and the small grist and saw mills were being replaced by textile, nail, and rolling mills, along with a whole set of new industries. As we saw in the second chapter, the Boston Manufacturing Company was not a factory in the wilderness. By the beginning of the nineteenth century almost all of the mill privileges on the Charles River from Dedham to Back Bay were occupied, and towns throughout New England were developing manufacturing. The Boston Manufacturing Company's machine shop was an integral part of the industrial landscape, and the landscape was an integral part of machine building. This chapter is about how the material processes required to build a functioning factory were distributed across the landscape. The shop was not an independent, isolated, or even clearly bounded entity. It was, instead, continuous with its surroundings. Parts, machines, people and ideas moved across the boundary of the shop. Locations twenty miles away functioned almost as departments in the shop, while several machinists operated independent crews within the shop. Between 1814 and 1825, as machine building in Waltham grew, the organization of these boundaries and this distribution changed. The shop not only became larger, its role in the industrial landscape changed as well.

Recent studies of business organization have begun to question the assumption that firms act as coherent and rational entities.[1] Such studies break down the boundaries of the firm from inside and outside. Internally, firms are seen as communities, with internal divisions, competing concerns and problems of communication. Externally, firms also operate in concert through contracts, agreements, legal structures, voluntary associations, and informal communities. Rather than taking the unity of the firm as a given, such studies take the bounds of the firms as a topic of study. This chapter takes up this project, in order to re-open a basic assumption made in the previous chapters of the shop as a corporate actor. Here the bounds become crenelated and complicated as the shop grows, as the machines it makes develop, and as the workforce expands.

Several types of connections between early nineteenth century machine shops and their industrial surroundings are already familiar parts of the story of industrialization. The most obvious of these connections was the circulation

1 Joseph L. Badaracco, Jr, "The Boundaries of the Firm," In *Socio-Economics: Toward a New Synthesis* , Ed. Amitai Etzioni and Paul R. Lawrence (New York: M.E.. Sharpe, 1991). Peter Dickens and Anders Malmberg, "Firms in Territories: A Relational Perspective," In *Economic Geography*, Vol. 77, No. 4 (Oct., 2001), 345-363.

of machine designs. The history of the American textile industry is garnished with heroic stories of technology transfer as industrial espionage. Samuel Slater's covert emigration from Britain, and Francis Cabot Lowell's memorized machine design are the most familiar. Beyond these stories, technology transfer and exchange was both more prosaic and more complex. Small ideas were remembered, translated, and re-applied. American mechanics adapted British technology to new conditions, and made advances in some areas. Parallel developments solved similar problems in different ways, or re-invented already extant solutions.[2] Some connections followed official channels. Inventions were patented, machines were licensed, and people sued each other over the rights. Beyond this, a great deal of communication occurred through informal channels. Mill owners, machine builders, and inventors visited each others' shops and factories. New manufacturers asked advice from established industrialists. Machinists and laborers also moved from firm to firm, taking ideas, processes, and ways of doing things with them. Early nineteenth century America, and New England especially, was abuzz with this technical conversation.[3]

2 David John Jeremy, *Transatlantic Industrial Revolution: The Diffusion of Textile Technologies Between Britain and America, 1970-1830s* (Basil Blackwell, 1981).

3 David R Meyer, *Networked Machinists: High-Technology Industries in Antebellum America*,

The Boston Manufacturing Company participated in formal and informal information exchanges. They bought and sold licenses for machines.[4] Lowell, Jackson, Moody and even some of the machinists obtained patents for new machines developed for the company. They reverse-engineered machines bought from others. Jackson, Lowell and Moody all visited textile mills in search of new ideas, and mill owners as far away as Philadelphia wrote for advice.[5] The Boston Manufacturing Company developed a number of innovations, but they certainly did not do so in a vacuum. Everything that happened, happened in a world of extensive communication.

As foundational as these connections were, they played little role in the day-to-day, manual process of building a working factory. Information was not the only, or even the most important, connection between New England's shops, factories and mills. Each machine that the Boston Manufacturing Company's machine shop built involved people from across the industrial landscape. Machine building was not confined to the shop floor. In this chapter I follow the chain of jobs and processes that wound across the countryside,

Johns Hopkins Studies in the History of Technology (Baltimore: Johns Hopkins University Press, 2006).

4 List of licenses.

5 Thomas Gilpin of Philadelphia Letter to Lowell, 2 April, 1816, and Lowell Letter to Joshua and Thomas Gilpin, 20 April, 1816, Lowell MSS.

through the shop, and ended with a functioning factory. I look at two distinct periods. As the company built the first manufactory between 1813 and 1815, they depended heavily on a new support network that grew up around New England's rapidly expanding textile industry. The machine shop itself played a tightly circumscribed role in the process. Many of the machines and components were built by others. The relationships formed with these producers fell along a gradient, from those who simply provided parts and machines, to those who acted as almost part of the machine shop. During this early phase, the machine shop itself was devoted to tasks that needed to be local, like installing the mill's gearing, or that were not easily specified, like building the new loom. In the second phase, between 1816 and 1825, the shop expanded to include much of what had previously been done externally. The new shop's organization shared an underlying logic with the older system. Many of the tasks that had been contracted to external shops were now contracted to machinists working within the shop, while shop employees continued to work on necessarily local or exploratory work. As the shop's organization developed, its role in the landscape changed as well. Work became less geographically distributed, and the company became less dependent on other places. Instead the products of the shop traveled out into the landscape. At the same time, machinists began to circulate more intensively, with new machinists constantly joining and leaving the shop.

In order to understand how work was embedded in the landscape, it is necessary to understand how tasks and operations were distributed across space and between people. Such a view makes it possible to move between the grimy particulars of a blacksmith at his forge or a machinist at his vise, and the large scale development of the industrial landscape. Although the details changed over time, the basic sequence of operations[6] required to produce a working textile mill remained essentially the same over the period. Where these operations took place, how they were grouped together, and how they were organized and coordinated changed significantly over the period.

One of the central tasks required to build the factory was the construction of textile machines. The new factory needed machines for carding, spinning and weaving. Each operation of which required several distinct machines.

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6 Mark Edmonds, "Description, Understanding and the Chaine Operatoire," in A*rchaeological Review from Cambridge* 9:1 (1990). Glenn Adamson, *Thinking Through Craft* (Berg Publishers, 2007). Charles M. Keller and Janet Dixon Keller, *Cognition and Tool Use: The Blacksmith at Work* (Cambridge University Press, 1996). Pierre Lemonnier, *Technological Choices: Transformation in Material Cultures Since the Neolithic* (Psychology Press, 1993). Nathan Schlanger. "Mindful Technology: unleashing the chaine operatoire for an archaeology of mind," in *The Ancient Mind: Elements of Cognitive Archaeology,* Ed. Colin Renfrew and Ezra B. W. Zubrow (Cambridge University Press, 1994).

Carding required pickers, beaters, rough cards and fine cards. Spinning required double speeders, mule frames and throstle frames. Weaving required warpers, dressers, and looms. Though the details of the designs changed these categories remained constant. Though each machine posed its own challenges, they all shared the same fundamental structure.[7] First, a machine required a rigid frame to hold the moving parts in place. For most of the Boston Manufacturing Company machines this frame was made of wood, and was constructed like a timber framed house. Second, a machine needed working points, or tools, which interacted directly with the material and transformed it. This part of the machine varied the most with the machine's purpose. In a loom the shuttle that carried the filling yarn back and forth, the reeds that packed the filling against the warp, and the cloth beam that took up the finished cloth all act essentially as tools to transform thread into fabric. Similarly, a carding machine has cards, and a spinning machine has spindles, bobbins and fliers. Third, at the heart of the machine, as system of moving parts transferred power to the working points and controlled the speed, direction and timing of their movement. Most of what one imagines when one thinks of a machine

7 The following analysis is based on Kinematic Analysis, see Franz Reuleaux, *The Kinematics of Machinery: Outlines of a Theory of Machines* (Macmillan, 1876)

falls into this category. In the loom the cam shaft that controlled the timing of various operations and the system of levers, straps and gears that operated the various parts fall into this category. In a drawing machine, the gears that spin the rollers in the correct direction, at slightly different speed, also fall into this category.

The working and moving parts of the machine were made of a combination of iron, brass and wood. Whatever the material, each part went through a similar process. First, the part was roughly shaped out of the raw material. The shape was then refined and the required surface finish produced. Finally, the part was fit and assembled with the other parts. For example, parts made from bar-iron, were roughly shaped by hot forging, and refined and fit by filing and machining. Parts made of brass or cast iron were cast to rough shapes, and again were filed and machined to their final dimensions.[8]

Building machines was not the only task the needed to be accomplished. Ignoring the construction tasks of building the factory, the dam and the race way (which fell largely outside the purview of the machine shop), this included setting up a machine shop, building or obtaining the necessary tools (including

8 It is possible to continue to refine this kind of analysis, down to individual actions with specific tools, but the sources for this case do not allow such fine resolution.

machine tools), setting up the factory (which included building and installing the power train and installing machinery), maintaining the machinery and developing new machines. Each of these tasks could be further analyzed as machine building was above.

The sequence of operations required to build the factory was distributed across the landscape, and this distribution changed as the shop grew. I will begin with the most external portions of the process, and spiral toward the center of the shop with the most local and specific parts.

Components and Commodities

As I discussed in the previous chapter, raw materials were already available.[9] As a consumer, the shop had little contact with the production of these materials. The relationship between the shop and all of its material suppliers was that of buyer and seller. As the company constructed their first factory between 1813 and 1815, many individual machine components were purchased in the same manner. In particular, the working parts of machines were bought from semi-specialized producers. The working parts of machines were first and

9 By the time materials like iron and lumber arrived at the shop, they had already been handled by many people. In reality they were far from "raw" materials. Wrought iron was made from pig iron, which was made from iron ore, which had to be mined. Lumber was just as far from a forest as iron was from rocks. By participating in the global flow a goods and materials, the shop was already part of a world-wide (or at least Atlantic-wide) division of labor. Already a great deal of work was done by others in other places.

foremost adapted to the material to be processed, and so remained essentially the same even as the machines developed. For example, the shuttle in a power loom worked the same as the shuttle in a fly-shuttle hand loom.[10] Similarly the bobbins and spindles of a spinning wheel work similarly to the bobbins and spindles of a throstle frame. Such parts were common to many different machine designs. The working parts of machines also incurred more wear than other parts of the machine due to their constant contact with the materials being processed, and needed to be replaced frequently. The result was that as textile mills were built throughout New England, a market for textile machine components developed. The Boston Manufacturing Company took advantage of this market to buy components from traditional tradespeople who had recently begun to specialize in textile machine parts.

Like all textile mills, the Boston Manufacturing Company required an constant supply of spindles, shuttles and bobbins.[11] Such parts were needed in great numbers. For example, in 1820 the Blackstone Manufacturing Company

10 Fly shuttles were a standard feature American and English hand looms by the mid-eighteenth century. Walter English, *The Textile Industry: An Account of the Early Inventions of Spinning, Weaving, and Knitting Machines* (Longmans, 1969).

11 Spindles and bobbins were in spinning machines to hold thread. A shuttle was a small carrier that held a bobbin full of thread. It traveled back and forth between the warp threads, leaving the filling thread behind it. Reeds were either split natural reeds or metal tines that separated warp strands and were used to pack each pass of filling thread against the completed fabric.

factory in Rhode Island had 7836 spindles, and a total of 39,252 bobbins. Companies like the Waltham Cotton and Woolen Company that put out yarn to be spun by hand weavers in their homes generally did not collect the spindles they sent the cotton out on, and so would have needed to constantly replace their supply. As shuttles were knocked back and forth in the fly-shuttle looms commonly used by hand-weavers, they quickly wore out, and the delicate reeds were easily damaged in packing each pass of the filling thread. A small industry producing these consumable parts grew up along side the growing textile industry in the late eighteenth and early nineteenth centuries. These parts were some of the first standardized, mass produced machine parts. Many producers were small, part-time artisans who spent the slow winter months when there was little farm work turning parts on simple foot or water powered lathes.[12] These items appeared regularly in newspaper advertisements and were regularly sold by hardware merchants, but the Boston Manufacturing Company bough all of these supplies directly from a limited number of small tradesmen who partially specialized in these parts.

Almost all the shuttles and spindles the Boston Manufacturing Company

12 Carolyn Cooper and Patrick Malone, "The Mechanical Woodworker in Early Nineteenth Century New England as a Spin-off from Textile Industrialization," Presented March 17, 1990, Old Sturbridge Village (American Textile History Museun, Lowell, MA).

used came from Chester Bullard and Jotham Gay of Dedham, Massachusetts. Dedham was a medium sized farming town and the county seat of Norfolk county, located ten miles up the Charles river from Waltham. At its founding in the early seventeenth century the area had good soil and wide, well watered meadows, but few mill sites. Settlers solved this problem in 1639 by digging one of the first canals in the United States. By the early nineteenth century Mother Brook, as the canal was called, diverted one third of the water from the Charles River and carried it past five mill sites before emptying into the Neponset River.[13] These mill sites were home to a variety of mills, including saw, grist, paper, leather, wire and nail mills. In 1804 a new turnpike from Boston to Providence opened and provided Dedham with convenient access to both cities. In 1807, shortly after this road opened, the first cotton mill was built along Mother Brook. As the Boston Manufacturing Company began to assemble its first machines, Dedham and the neighboring towns already had a growing textile industry.[14]

Bullard and Gay made spindles, bobbins and shuttles for the new industry.

13 For more on the canal and the controversy it sparked with mills on the Charles River, see Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England, Studies in Environment and History* (Cambridge [England]: Cambridge University Press, 1991).

14 Duane Hamilton Hurd, *History of Norfolk County, Massachusetts* (J. W. Lewis & Co., 1884).

Gay was an established turner with a shop in the middle of what was then called Upper Dedham (later Dedham Village), near the court house. In 1815 he went into business with Bullard to produce looms, shuttles and spools. The new shop was two and a half miles west and was located at a mill privilege previously improved by Abiator Richards, on a ninety acre farm that Bullard had been trying to sell several month earlier. The shuttles they made were sold to Dedham cotton manufactories and were available from hardware merchants in Boston and Providence. The shop also offered "turning of all kinds in iron and wood." When the partnership was dissolved the following year, Bullard continued to operate in the same shop, and continued to advertise turning of all kinds. In 1822 Samuel Ivers bought the shop and its tools to continue the shuttle making business. Jotham Gay, on the other hand, moved back toward the center of town and built a new, larger shop. In later advertisements, he refers to himself as the "agent" of the shuttle company, and when he sold his establishment in 1823, it was called a shuttle making factory. Although such terms did not carry precisely the same meaning as they do today, the fact that Gay began using them immediately after dissolving his partnership, suggests that he was further specializing and intensifying his business. For both Bullard and

Gay, shuttle making was at the intersection of traditional trades and new industry. They were trained in the tradition of wood turning, and applied the same basic techniques to making the new products. At the same time, their customers were new industries, and their methods became increasingly industrial as they applied water power and other techniques to produce large numbers of identical components.[15]

Bobbins, spindles and reeds also came directly from semi-specialized tradesmen. Most of the reeds used in the Boston Manufacturing Company looms were made by Benjamin Wheelden and Benjamin Roberts. Each had a reed making shop in Boston and both made loom reeds out of wood and brass. As with the Dedham shuttle shops, these reed shops grew directly out of a pre-existing trade. The reed shops were part of Boston's long history of musical instrument making, and had begun, and continued, to make reeds for woodwind instruments.[16] Reeds from Wheelden and Roberts were available at hardware stores, but the Boston Manufacturing Company again bought them directly from the producers.

15 Dedham Gazette, 10 March, 1815. Dedham Gazette, 12 May, 1815. Dedham Gazette, 7 July, 1815. Boston Gazette, 8 January, 1816. Dedham Gazette, 20 December, 1816. Independent Chronicle, 23 January, 1819. Village Register 28 June, 1822. Village Register, 27 June, 1823.

16 Columbian Centinel, 3 March, 1821. Christine Merrick Ayars, Christine Merrick Ayars, *Contributions to the Art of Music in America by the Music Industries of Boston, 1640 to 1936* (The H. W. Wilson company, 1937).

In the market of textile machine components, the Boston Manufacturing Company was only one of many textile mills being constructed, and were only one of many customers for the component suppliers. They did not develop close relationships with the suppliers. Beyond being a regular customer, there is no evidence of extensive communication, or special design requests. They were buying parts available off the shelf. Though the parts were integral to the machines in the Boston Manufacturing Company's factory, they were produced externally.

Contract Machines

The Boston Manufacturing Company extended the strategy of purchasing standardized items from external suppliers to include whole machines. The Boston Manufacturing Company machine shop did not build all of the machines in their first factory. While the Waltham shop set up the mill-work and struggled to get their first power loom running, they bought all of the rest of the machines needed to make cloth from Major Luther Metcalf and his son, Luther Metcalf Jr, of Medway, Massachusetts.

Like Dedham, Medway was an old town with a new and rapidly expanding industrial sector. Medway was also on the Charles River, another ten miles past Dedham. Originally part of Medfield, Medway had only moderately fertile soil, but boasted a number of excellent mill sites. The town lay on the main turnpike route, half way between Boston and Providence, and so fell within the expanding sphere of the Providence-centered textile industry. Three cotton mills were built between 1800 and 1813, along with edge tool factories, a bell foundry, and a straw hat factory. The Metcalfs were at the center of this industry. They were investors, organizers and machine builders for all three of the cotton factories.

Major Luther Metcalf Sr was a cabinet maker who was born in Franklin, Massachusetts in 1756. In 1773 he started a large cabinet shop in Medway. In 1805 the elder Metcalf joined several local investors to form the Medway Cotton Manufactory. The younger Luther Metcalf was born in 1788 and trained in his father's cabinet shop, and later joined his father as a major owner and agent for the cotton mill. Luther Metcalf Jr also began a textile machine shop with a Providence trained mechanic named John Blackburn in 1812. In 1815 both Metcalfs, along with Cephus Tayer and Joel Hunt, formed yet another cotton manufactory a few miles from the first.[17] When the Boston Manufacturing Com-

17 William R Bagnall, *Sketches of Manufacturing Establishments in New York City and of Textile Establishments in the Eastern States* ([S.l: s.n.], 1908). Ephriam Orcutt Jameson and George James La Croix, *The History of Medway, Mass., 1713-1885*, 1886.

pany ordered cotton machinery, the Metcalfs were in the midst of building machines for their own mills.

In December 1813, shortly after the Boston Manufacturing Company purchased the Waltham mill privilege, Jackson traveled to Medway to see the Metcalf's factory and to order machines. He ordered five throstle frames (each with thirty spindles), two mules (with one-hundred and ninty-two spindles each), ten carding machines, two winding blocks and four reels. Jackson paid $2276 in advance. A year later, in December 1814, the machines were delivered and joined the newly completed loom in the first manufactory. In total they cost $9254.39.[18] Additionally, Jackson had planned on having Metcalf assemble three machine tools, a roller engine, a cutting engine and a fluting lathe, but canceled the order when Paul Moody found the necessary machines for sale from the Waltham Cotton and Woolen factory.[19]

The Medway-built machines made up the bulk of the machines in the factory when it began producing fabric in 1815. These machines were indirectly descended from the already established Providence industry and were essen-

18 Volume 10, BMC MSS.

19 The Boston Manufacturing Company does not seem to have bought the machines from WC&W. They did receive casting for the machine tools originally ordered from the Metcalfs, but may have assembled them themselves.

tially the same as machines that were being installed throughout New England. The Boston Manufacturing Company depended on a direct material connections to alrady established factories: their machines were physically brought from a factory which itself was within Providence's sphere of influence. Further, these machines appear to have been of common designs, and the shop paid no licensing fees. As with the components, these machines were bought as commodities. The Medway shop was completely independent, and there was little communication involved in their construction. Although the machines were made to order, the Boston Manufacturing Company does not appear to have made any special design requests. Nor did a lasting relationship develop between the two shops. After the Jackson's initial visit, there was no further movement between the shops.

Custom Castings

Not all of the external suppliers operated so independently. The shop had a more intensive and extended relationship with the foundry that made castings. Shepard Leach's iron foundry in Easton, Massachusetts produced a continuous supply of increasingly custom parts. People, patterns and parts moved constantly between Waltham and Easton. Although Leach was organizationally separate, his foundry acted as an integral part of the machine building process and functioned almost as a department of the shop itself.

Rolling mills could only make shapes with constant cross-sections, and forge-work was limited to forms that could be made by plastic deformation. Foundries could cast almost any shape by creating a wooden pattern, pressing it into sand to form a mold, and pouring molten iron into the mold. Casting was an difficult and expensive process. Like iron smelting, casting required high temperatures that could only be achieved in specially constructed furnaces, which required a large investment to build and maintain. They used large amounts of coal, and most importantly, required a high degree of skill to produce quality castings. The founder had to carefully control the exchange of carbon, phosphorous, sulfur and other alloying elements between the metal, slag and air. Small changes in either the process or in the pig iron had drastic effects on the final castings. At the same time, the method and rate of pouring, the design of the mold and other details of the process could change the cooling rate and thus the metal's crystal structure.[20] Only the most experienced founders could consistently make quality castings.[21] Because of such difficul-

20 At the time, though, the chemical and micro-structural effects were not well understood.

21 Finding quality iron castings was a constant problem. Because cast iron is by its nature brittle failures of cast iron cannons, and building members were spectacular. The US

ties, the Waltham shop did not have its own iron foundry.[22] Instead, they bought castings from two foundries in Bristol County, Massachusetts.

By far the largest and most varied castings came from Shepard Leach's foundry in Easton, Massachusetts. Easton was located in the north eastern corner of Bristol County, twenty-four miles south of Boston, and twenty-two miles north of Providence. It was located in a flat and often marshy part of the county that was rich in bog-iron. It was one of the few places in Massachusetts with a commercially viable source of iron ore and was an early center of American iron-making. By the time Easton was incorporated in 1725 there were already two or three forges in operation. The first iron furnace, used to smelt the bog ore into metal, was built in 1750. In 1776 Eliphet Leonard, the grandson of the first iron-maker in Easton, became the first steel American steel maker. By the early nineteenth century, the town boasted a a large number of forges, foundries, furnaces and rolling mills.[23]

Ordiance Office banned the use of cast iron cannon for a time because of the high failure rate, and much of the early work of the Franklin Institute involved studying the failure of cast iron beams. Robert B. Gordon, *American Iron, 1607-1900*,(Baltimore, M.D.: Johns Hopkins University Press, 1996.).

22 They did build a brass foundry in 1825. In 1830, after the shop moved to Lowell, MA they did construct their own iron foundry, though even then they still relied on external foundries for most of their casting needs.

23 The most well known of these was a string of iron forges operated by the Ames family, which in the mid nineteenth century became the Ames Shovel Company. Duane Hamilton Hurd, *History of Bristol County, Massachusetts* (J. W. Lewis & Co., 1883).

In the early nineteenth century, Shepard Leach was the most prominent iron-maker in Easton. He was born in Easton in 1778. He took over his father's forge and furnaces in 1802. He soon became the proprietor of the Easton Iron Works and continued to buy and expand the many small foundries in the area. In 1823 he owned seven furnaces in Easton. At the time of his death in 1832, his furnaces employed over three-hundred people and he controlled a large portion of New England's iron trade.[24] Leach's foundry provided nearly all of the castings used in the Waltham shop. In 1814 the Boston Manufacturing Company bought nearly ten thousand pounds of castings from Leach. Each year they bought more castings from Leach. In 1815 they bought nearly twenty thousand pounds of castings. They bought large gears and shafts for the factory's mill work, lathe beds, gudgeons for waterwheels and a wide variety of other parts. The shop consistently paid between seven and ten cents per pound, no matter how simple or complicated the parts were. At first most of these castings were for relatively standard parts used in the mill-work and gearing of the shop. They bought large gears, shafts and waterwheel parts that were common to many mills. It seems that little information needed to be

24 James Grant Wilson, *Appleton's Cyclopedia of American Biography*, 1888. Holmes, *On the Death of Godly and Faithful Men: A sermon occasioned by the death of Gen. Shepard Leach, delivered at Easton, Sept. 23, 1832.*

exchanged regarding the specifics. The most complex order in 1814 was for iron work for three machine tools. Even these, though, appear to have been standard items and no special instructions were required.

The Boston Manufacturing Company also bought castings from Charles S. Leonard. In 1816, when the Boston Manufacturing Company bought components from him, Leonard's operation was much smaller than Leach's. In 1825 when a fire destroyed his shop, he had a forge, a trip hammer, a blacksmith's shop and machinery for making rollers for cotton factories.[25] It seems that Leonard had a shop that could do a variety of work, but had partially specialized in producing the heavy, smoothly finished rollers for the the many textile mills being built around New England. Later Leonard and his brother, formed the Matteawan Machinery Company in Matteawan, NY.[26]

Just as the shop depended on the already developed market for components and machines, they also depended on the long established expertise of the Bristol County iron producers. Rather than developing the shop's internal capacity to fabricate these parts, they remained dependent on the external

25 Boston Patriot, 7 December, 1825.

26 David R Meyer, *Networked Machinists: High-Technology Industries in Antebellum America*, Johns Hopkins Studies in the History of Technology (Baltimore: Johns Hopkins University Press, 2006).

source. At the same time, unlike producers of components and machines, Leach's foundry was not creating a finished product that could be simply installed in a machine or factory. They were only performing rough shaping operation. Castings from Leach still had to be finished. Although Leach's foundry was physically and organizationally separate, it was an integral part of the sequence of operations. Later, as the needs of the shop became more complex, the foundry would become an even more integral part of the process. Even at this stage, though, the boundary of the shop was complex.

Employees

Not all of the work to construct the factory was carried out externally. The Boston Manufacturing Company employed full-time machine builders from the beginning. Unlike other factories, which contracted itinerant machinists to construct and install the machines, the Boston Manufacturing Company hired workers as wage employees who were paid by the day or by the week. The full-time employees played a circumscribed, though important, role in the construction of the factory. They concentrated on work that was either experimental, especially constructing the new power loom, or necessarily local, such as installing machines. Wage employees were divided between three basic trades: carpentry, blacksmithing, and machining. The patterns developed in the organization of wage labor at very beginning echoed throughout its history, even as the overall role of the shop expanded.

The basic division of work between trades began even before the construction of the Waltham shop. Almost immediately after the company was incorporated, Jackson and Lowell hired a blacksmith, a whitesmith and a carpenter to help Lowell build a working loom model. All three were established tradespeople, working in Boston. At the time the company had no facilities other than Jackson's loft, and few tools. It is likely that these first three employees used their own tools, and possibly worked in their own spaces. The division of work between the three formed a foundational organization that continued throughout the shop's existence.

One of the first people employed by the Boston Manufacturing Company was a blacksmith named Richard Ferrel. Ferrel appeared in the Boston Directories as a brass founder and metal worker, but the Boston Manufacturing Company hired him to work for a week as a blacksmith. As a blacksmith, Ferrel heated bars of iron to a red hot heat. Once heated he used a variety of hammers, punches, dies, and forms to shape the iron. The key feature to all of this work was that the metal was treated as a plastic substance, and forms were created through bending, upsetting, spreading, folding, and punching.[27] Though even the best blacksmith could achieve only limited precision, complex shapes could be quickly formed. Many of the brackets, bolts, and levers of the loom were made by this process. The Boston Manufacturing Company paid Ferrel $8.75 for the week's work, which equals $1.45 per day.[28] The shop also bought an anvil and a set of blacksmith tools from Ferrell when they first set up their own blacksmith's shop, though there is no evidence whether or not Ferrell himself continued at the shop.

The newly formed Boston Manufacturing Company also hired a whitesmith named Edward P. Hunt. They paid him $51.75 for about thirty days of work. A whitesmith, or brightsmith, was a old term for someone who cold-worked iron.[29] Whitesmiths worked with saws, drills, and, most importantly, files. The resulting work had a bright, white finish.[30] Whitesmiths typically did

27 For a cognitive ethnographic description of blacksmithing, see Janet Dixon Keller and Charles M Keller, *Cognition and Tool Use : the Blacksmith at Work*, Cambridge ;New York, NY, USA :: Cambridge University Press,, 1996).

28 Volume 13, BMC MSS.

29 The term "whitesmith" soon fell out of favor. Later the term returned to describe someone who worked with tin or other "white" metals. Oxford English Dictionary, s.v. "Whitesmith."

30 In contrast to the black oxide that coated a blacksmith's work.

work requiring finer control and more precise measurement than was possible under the blacksmith's hammer. For example, lock-making and gun-lock making were specialized branches of the whitesmith's work. Many products required a combination of hot and cold work and so whitesmiths often worked with blacksmiths. The blacksmith roughly shaped pieces, and the whitesmith refined the shapes, fit pieces together, and constructed multiple-part assemblies. Hunt probably played a similar role at the Boston Manufacturing Company. After Hunt, no other whitesmiths appear in the company records. Instead, cold work was referred to as "finishing," "fitting," "composing," or simply "machining," and the people who carried out such work were generally simply referred to as "machinists." Hunt himself eventually began to refer to himself as a machinist. He did not appear in the Boston Manufacturing Company records after 1813. He remained in Boston, and appears to have operated a machine shop at the intersection of Merrimack and Pitts Street.[31]

The third tradesman listed was a carpenter named M. Spargans. He worked only a few days for a total pay of $3.50. Carpenters were most clearly defined by the fact that they worked in wood. In the early nineteenth century carpen-

31 Boston Directories, 1829, 1830. In 1807 he advertised for a runaway apprentice. New-England Palladium, 16 June, 1807.

ters were one trade within a constellation of woodworking trades, and could be contrasted with more specialized terms, such as barrel-makers, cabinet-makers, or wheel-wrights. They also fell on a continuum of fineness of work. Joiners generally did fine woodwork such as cabinet-making, while framers or house-wrights did very heavy work. Carpenters fell somewhere between. Carpenters in the Boston Manufacturing Company's shop were primary responsible for constructing the heavy wooden frames for the machines. These frames were constructed out of birch, ash and pine, and were often joined with mortise and tenon joints, much as a timber-framed house was. Like the whitesmith and machinist's work, the carpenter's work was subtractive. The carpenter's sharp-edged tools would be familiar to most modern carpenters: saws, chisles, planes and drills.[32] Later powered tools were developed in parallel with powered metalworking tools, but in the early days at the shop, much of the carpenters' work was manual.

Ferrel, Hunt and Spargans only worked for the Boston Manufacturing Company briefly, but their job descriptions would underlie work at the shop for the next decade. The number of people increased, the machines they were

32 For a catalog of traditional carpenter's hand tools see Henry Chapman Mercer, *Ancient Carpenters' Tools: Illustrated and Explained, Together with the Implements of the Lumberman, Joiner and Cabinet-Maker in Use in the Eighteenth Century* (Courier Dover Publications, 2000).

building changed and new tools were introduced, but this basic division between hot worked metal, cold worked metal and woodwork remained.

By late 1813, work in the new Waltham shop began in earnest. The pace of work increased, the number of people increased, and with this the structure of work became more complicated and formalized. The shop began paying regular wages in December of 1813, and over the next five months spent eight-hundred dollars to pay machinists, carpenters and blacksmiths. Over the next year they spent a total of twenty-five hundred dollars on wages.[33] During this period the Boston Manufacturing Company did not track individual machine-makers. Instead management of the shop was left to Paul Moody, who paid the wages himself and was later reimbursed from the company. Whatever records Moody kept to track labor in the shop have not survived. With only about four or five employees, a complex management system would not have been necessary.[34]

The wage employees worked on three main tasks at the shop. All three tasks were necessarily local. First, they continued work on the power loom. Though Lowell appears to have produced a model of the loom by late 1813, the

33 BMC MSS.

34 For details on the size of the shop see chapter 1.

first full sized loom was not completed for another year. During this time, Lowell himself did not play a large role in the process.[35] Instead, Moody took the lead. The basic design was understood, but producing full-scale loom was still a challenge. At this time, design, engineering and construction were not formally separated and communication was informal. It is unlikely that machinists would have been given formal drawing from the designers.[36] It is likely that employees would have worked closely with Moody in an experimental, exploratory, problem-solving mode. The work would have had to have been flexible, as problems arose and as new solutions were developed. This work was not regular or predictable. Nor was it repeating; at first they were building just one loom. Because of the open ended and unpredictable nature of the work these workers were paid for their time, rather than for their output.

The loom was only part of the work performed in the machine shop. Even with parts and machines constructed elsewhere, there was still local work to be done. One of the main tasks was fitting and installing the mill-work that would take power from the river and distribute it to machinery on the factory's four

35 Instead, Lowell devoted his time to lobbying for tariffs in Washington. He was, in fact, traveling when the the loom became operational.

36 Machines were only formally drawn for the patent applications. David J. Jeremy and Polly C. Darnell, *Visual Mechanic Knowledge: The Workshop Drawings of Isaac Ebenezer Markham (1795-1825), New England Textile Mechanic* (American Philosophical Society, 2010).

floors. The castings that came from Easton arrived straight from the sand molds. Machinists still had to refine the rough casting to precise forms: the teeth of gears had to be finely formed and matched, shafts had to be trued, and bearing surfaces had to be fit and polished. Some of the work, especially turning, was done with machine tools, but much of it required hand-work with files. Once the parts were finished, the mill-work was installed in the building. Bearings were bolted to the walls and the frames, wheels and gears installed on shafts and the shafts installed into place.

The machinery built in Medway also required additional work once it arrived. Each machine was assembled and installed in the factory. Each had to be placed on the factory floor, and attached by leather belts to the line shafts along the ceiling. Once installed, machines required adjustment and fine-tuning before they worked properly and efficiently. Though such work is not often thought of as machinist's work, it was still an important responsibility of the machine shop.

Finishing and installing the machinery and gear-work was work that would have been familiar to any textile machine-builder. Though the Boston Manufacturing Company's factory was larger than most contemporary mills, its design, and the work needed to make it operational was similar. Unlike work on the loom, setting up the factory was a well understood process. Many mills contracted this work to itinerant machinists, but as discussed in the first chapter, the Boston Manufacturing Company insisted on hiring wage machinists. Because the work was a matter of literally building machinery into the building and the landscape, it could not be contracted out, or distributed across space.

Here we see the basic form of the initial geographical organization of the shop's space. What was particular, unpredictable and irregular was done within the shop. Work that was portable or standard to textile mills was done by semi-specialized tradespeople scattered throughout the region. The Boston Manufacturing Company was dependent on the larger landscape of industry for material parts of the process. In many ways, the Boston Manufacturing Company was another mill in the growing list of mill towns, and connected to other locations simply as one place among many.

Expanded Shop

The first factory was completed in early 1815. There was little left for the machine shop to do and work slowed to a halt. Orders for components and castings slowed, and wage payments stopped completely after January of that year. Having fulfilled its purpose, the system developed to build the factory was disbanded. Because employee names were not listed in the records, it is impossible to know what became of the shop's small crew. The stoppage turned out to be temporary. One year later, in March of 1816, work began on a second, larger factory and a third followed soon after. The shop also began to sell machinery to other textile mills, and eventually built all of the machines for the enormous Merrimack Manufacturing Company mill, the first textile mill in Lowell, Massachusetts. As the machines in the first, and eventually the second, factory began to wear out, the shop also constructed new machines to replace them. There was now a constant demand for machinery. The machine shop was expanded to meet the demand. A new two story building was constructed, and new tools were purchased.[37] As work intensified the geographical division of labor developed to build the first factory was not simply scaled-up. Rather, work was reorganized, and the connection between places was transformed. The role of the shop expanded, taking over much of the work had been contracted externally, but at the same time the shop's boundary became more complex, and the division between outside and inside became less demarcated. The shop became less clearly dependent on specific external loca-

37 See Chapter 1

tions. They began to provide components and machines to other places, reversing the relationship with small textile towns. Further, the larger shop size involved a constant turnover of machinists, leading to the shop becoming part of the mobile landscape of machine-building skills.

Some of the older geographical division of labor continued as the shop grew. The Boston Manufacturing Company continued to buy shuttles, spindles, bobbins, and reeds from manufactures like Bullard & Gay, though they began to produce these items within the shop as well.

Shepard Leach continued to produce nearly all the castings for the shop, though his relationship with the shop changed. The total amount of castings ordered from Leach continued to increase. The types of castings also changed. Rather than ordering only common parts used in mill-work, they began to order parts specific to the newly designed Boston Manufacturing Company machines. This required closer communication between Leach and the shop. There was an increasing traffic of people and objects between Easton and Waltham. In 1816 Jackson traveled to the Easton furnace, and in 1817 Thomas Borden, the shop's superintendent, visited the Leach furnace as well. In 1817, a Boston Manufacturing Company machinist named Ephraim Stevens traveled to Easton and spent twenty-one days repairing patterns and working with Leach's founders for an additional fifty-five days producing castings. The major mode of communications between Leach and the shop was the wooden patterns. Leach made castings from patterns developed and sometimes fabricated in Waltham. The patterns were kept in Easton, but were still the property of the Boston Manufacturing Company. Leach occasionally paid the the shop to repair broken patterns. In 1822 Leach paid the Boston Manufacturing Company for the right to make castings from their patterns for two other customers.[38] When the machine shop and all of its furniture were sold to the Locks and Canals Company in 1825, the sale included patterns in Easton.[39] As machine building developed the line between the Easton foundry and the Waltham shop continued to blur. The foundry increasingly acted almost as a department within the shop.

The major change was in the organization of the machine shop. It produced far more machines, and did so with increasing intensity. With this growth, the organization of the shop was elaborated. Rather than a small team of machinists working closely with Moody, the shop was divided into multiple

38 Volumes 13-16, BMC MSS

39 Boott MSS, Massachusetts Historical Society.

parts, with multiple, overlaying organization, payment, and oversight systems. Some workers continued to work for daily wage. These workers were now more formally divided between different projects. Other workers became internal contractors, and were paid for machines completed. In its structure this new organization reproduced the underlying divisions of the older organization, though the geographical distribution changed. Machines and parts that were standardized, and tasks that were easily specified were often carried out by internal contractors, while jobs that required careful oversight, were experimental, or were local, were carried out by wage employees.

Inside Contractors

Technologically stable machines and standardized components were made by machinists who worked within the shop, but who acted as semi-independent agents. Such machinists were called "inside contractors." Inside contracting was a system of labor organization common in a variety of turn of the nineteenth century shops, ranging from machine shops to armories. The contracting system overlapped with other eighteenth and nineteenth century labor organizations methods. Like piece work, workers were paid for completed parts, assemblies, or even whole products. As with the putting out system, inside contractors fell outside much of the disciplinary system of the shop in which they worked. The were often responsible for and sometimes owned their own tools, and even employed assistants and laborers of their own. Sometimes internal contractors even bought materials from the shop.[40]

Inside contract workers and their assistants made up a significant portion of the Boston Manufacturing Company workforce after 1816. In 1816, $5,800, about sixty percent of the total spent of labor, was paid to inside contractors. Over the next decade the amount rose and fell as work at the shop waxed and waned, but overall it increased over this time. In 1818 the shop spent $20,500 on contract labor and in 1824, as the shop built machines for the Merrimack Manufacturing Company, they spent $33,000. Between 1816 and 1824, fifty-six different contractors appeared in the company records. The number varied from year to year, with twenty-five contractors listed in 1816, and thirty-one listed in 1819. An average of twenty-two contractors worked at the shop each year. During this second period of the Boston Manufacturing Company machine shop, there were more contractors than there had been employees

40 John Buttrick, "The Inside Contract System," In *The Journal of Economic History*, Vol 12, No 3 (Summer 1952), 205-221. David Montgomery, "Workers' Control of Machine Production in the Nineteenth Century," In *Labor History*, Volume 17, Issue 4, 1976, 485-509.

when building the first factory.[41]

Not all of the contractors played the same role in the shop. Some worked far more and earned far more money. In the first year, for example, a machinist named William Fowler was paid thirteen hundred dollars, while a carpenter named James Cowan was paid only three dollars. In general, most of the money paid to inside contractors went to a small number of individuals. In 1816, more than half the money went to two people, and two more made another quarter of the total. As the shop grew and the total amount of money spent increased, individual contractors earned more. In 1824 the highest paid contractor, James Derby, made over thirty-five hundred dollars. At the same time, the number of large contractors grew as well. In 1824, the top two people made up only one quarter of the total, but the top eight accounted for the seventy percent of total. The picture, then, is of a small core of steady contractors, supplemented by occasional work by others.

Some contractors were local tradespeople who earned only some of their income from the Boston Manufacturing Company. For example, a blacksmith named Daniel Emerson worked at the shop between 1816 and 1818. He forged large numbers of simple parts, such as levers, spindles, and hoops. He also

41 Volume 14-16, BMC MSS.

undertook jobs that would have been common for a village blacksmith, such as mending tools and shoeing horses. Over the course of the three years he was paid about three hundred dollars, which was one tenth of what he would have made as a full-time blacksmith on the shop's payroll.[42] During this time, Emerson also had a blacksmith's shop in Waltham on Main Street. Emerson's other work increased as he became a nationally known wagon maker, and he no longer had to supplement his business with work for the Boston Manufacturing Company. He remained in Waltham, though, and in 1818 built a new house for his family on Main Street, across from his shop.[43]

Many of the inside contractors also earned a portion of their income as wage employees. About half of the contractors between 1817 and 1824 also appear on the payroll. Over the years this type of worker distributed their time differently. In 1817 and 1818 there was a range of how people's time was divided, with some spending little time on payroll, some spending little time contracting, and some dividing their time evenly between the two. During this time such workers spent an average of one hundred days working on the payroll. Benjamin Brooks, for example, began working at Boston Manufacturing

42 Assuming a daily rate of $1.00 per day, for 300 days a year.

43 Melissa Mannon, *Waltham* (Charleston, SC: Arcadia Publishing, 1998).

Company shop in August of 1817, and continued there until 1822. Between 1817 and 1819 he was paid occasionally as a contractor. He filed parts for spinning frames and finished bolts. Over the course of the three years he averaged two hundred dollars a year, which equates roughly to one hundred and thirty days of work each year.[44] During the same time he worked an average of one hundred and twenty days a year as a wage employee. About half of his earnings came from contract work. Over the next few years fewer and fewer contractors appeared on the payroll, and those that did earned a smaller percent of their money from payroll. In 1822, all the workers who appeared on both payroll and as contractors earned less than one third of their income from payroll work. On average they spent just twenty days on the payroll. As contracting became more concentrated into fewer contractors who almost all had several assistants, the liminal position between the two forms of work was largely eliminated.

Others worked full-time as contractors. Such contractors worked at the boundary of the shop. They were physically located in the shop, and used tools and materials in the shop, but they fell outside the regular shop discipline. Their hours were not logged, and the precise way they went about their work

44 Using the average machinist's pay of $1.5 per day.

was not closely monitored. Only their output appears in the company's records. To some extent such contractors were their own bosses. This relationship was similar to that between the shop and the external contractors employed in the earlier period.

The independence of the internal contractors reached an extreme with those who were the highest paid. These contractors were paid for more than a full year's work. For example, In 1816 William Fowler was paid about three times the average yearly income of a machinist, more than even Paul Moody. During the year Fowler completed the iron work on fifty looms, made sixteen rockers for lays, two feed shafts, six toggle pins, among other work. It appears that Fowler had one or two assistants who would have been paid out of Fowler's gross earnings. As the shop grew, more contractors had larger and larger crews of their own. By 1818 the largest contractor, George Brownell, was paid over three thousand dollars for finishing iron work on one hundred and forty-four looms. If Brownell had paid his assistants at an average rate of $1.50 per day, he could have provided full time employment for six other machinists. In 1818 twelve contractors earned enough to employ other machinists. This would account for thirty-seven additional machinists employed by contractors in that year alone. By 1824, sixteen contractors earned enough to employ almost seventy machinists and assistants.[45]

No records from these large inside contractors has survived, so it is impossible to say exactly how many employees they had, who they hired, or how they were organized. With crews of five to seven people, though, such contractors would have operated as small shops unto themselves, or as product divisions within the machine shop. These contractors sometimes bought their materials from the shop. At least some of them also owned their own tools. Such provisions would have further increased their autonomy.

Contractors built many of the standardized machines that previously had been purchased externally. Some relatively simple machines, such as the warping machine,[46] were constructed by single contractors. Warping machines were mostly made of wood, had few moving parts, and required minimal precision. Single carpenters, such as Daniel Smith or Joshua Swan often built almost the entire machine, which cost thirty-five dollars and took about twenty days to build. Other contractors produced large numbers of single components. Most of these were relatively simple parts that were needed in large quantities.

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46 A warping machine prepared the warp for the look. It took yarn off of many spindles and wound it in parallel onto a single wide warp beam,

For example Benjamin Brooks earned two-hundred dollars in 1817 making two-thousand bolts, and James Derby earned eight-hundred dollars in 1819 finishing spindle shafts and lever pins. Others were parts that were particularly time consuming. For example, much of the contracting money went toward finishing the rough cast wheels and gears that arrived at the shop from the foundry. Andrew Harris, for example, earned nearly eight-hundred dollars in 1819 finishing cast-iron and brass wheels. Contractors who did this work were often paid by the number of individual gear teeth they finished.

Other machines, such as looms, spinning machines, and dressing machines, were more complex and were built by several contractors. In these cases the work was typically divided into the woodwork, forging, filing and fitting parts, and composing and assembling. The process of constructing a loom gives a good example of how people, tasks, and time were distributed.

By 1816, the design of the loom had stabilized and had become one of the standardized machines the shop produced. The loom's sub-assemblies were divided between several machinists. Between 1816 and 1818 twelve different contractors worked on looms. Each year between five and eight contractors built looms. Two or three contractors constructed the woodwork for the loom, at a cost of twenty five dollars per loom. One blacksmith forged parts for looms, at a cost of five dollars per loom. And one or two people finished the iron work from the blacksmiths, as well as the cast iron and brass parts from the foundries, at a cost of about twenty dollars per loom. Other parts, such as temples, beams, shuttles and reeds, were made separately and added at the final assembly. Over the years the contractors produced more and more looms; from the thirty looms made in 1816, to more than one hundred and forty-four in 1818. As operations expanded, the underlying organization remained the same, as did the basic steps. The cost of many of the steps remained identical over the period, and did not vary from contractor to contractor.[47]

Other machines such as the bobbin machine, and the eagle frame were made similarly with essentially the same distribution of time, money and people. These machines were all technically stable. They had already been developed, drafted, and, in many cases, patented. Moody could then precisely specify and judge the work to be done by the contractors, and the contractors could predict exactly how much effort each part would take and could plan accordingly.

Overall, internal contractors fulfilled many of the roles previously left to

47 BMC MSS

external shops. Rather than being distributed across a wide area, this work was concentrated in the Waltham shop. At the same time though, it was not simply internalized and localized. Though the work was physically located in the shop it was still to varying degrees external. The geographical division was recreated in the newly complicated and gradated boundry of the shop. Work is still divided, but the boundaries between inside and outside become less clearly demarcated.

Payroll

Contractors and their assistants did not make up the whole machine shop. The Boston Manufacturing Company still employed a large number of machinemakers who were paid a daily wage. These "journeymen"worked about forty-thousand person-days between 1817 and 1824.[48] The number of days worked each year varied widely, with nearly ten-thousand person-days recorded in 1818, and only one-thousand listed in 1822. The yearly average was five-thousand person-days. During this period two-hundred and twenty-two different people worked at the shop, with about twenty working at any given time.

The new shop had a new management structure. After 1816, Moody was no

48 This usage of the term "journeyman" follows the original origin of the term. "Journey" means "daily," as in a daily journal, rather than referring to traveling. In the traditional guild system, the term referred to a tradesman who had finished his apprenticeship, and worked for pay until he had an opportunity to open his own establishment.

longer solely concerned with machine-building. He began to act as the Company's agent in Waltham, much as Jackson acted in Boston. As such, he shared responsibilities that had been previously been entirely carried out in Jackson's Boston office. Moody was now responsible for overseeing the Company's many involvements in Waltham, such as the rental properties, the daily operation of the factory as a whole, the construction of the new factory buildings, and the payment of local bills. Most of Moody's former duties within the machine shop were taken over by a shop superintendent named Thomas Borden. There is no evidence of where Borden came from, but it is likely that he was from Fall River, Massachusetts, and might have been trained in that town's metalworking shops and textile mills.[49] There is also no evidence when Thomas Borden arrived but he appears in the earliest payroll records, along with two other Bordens, Isaac and Asa, who might have been close relations. Thomas Borden was listed in the payroll as the supervisor, overseer or superintendent. He was the highest paid workers in the shop. He earned two dollars per day, and worked more days over the period than almost any other employee, consistently working six days a week. Borden, though, was more

49 In 1813, Jackson wrote to a David Borden of Fall River inquiring about machinists for the Boston Manufacturing Company. It is possible that Thomas Borden eventually arrived as a result. In the early nineteenth century there were many Bordens in Fall River, making it impossible to trace individuals. See Chapter 1.

similar to the other machinists than Moody had been. He was not salaried and he lived in the same neighborhood as the other machinists.[50] He was also largely free from the Moody's administrative duties. Though he might have been responsible for keeping the time books, he was not responsible for calculating or distributing wages, or for ordering or paying for materials. Instead, Borden focused on overseeing the work itself.

Thomas Borden was joined in the shop by a small number of other steady employees. Each year ten to fourteen people worked more than ninety percent of the weeks recorded on the payroll. These workers also remained employed by the shop for several years. Each year half of the steady employees had also worked regularly the previous year, and several were at the shop for more than five years. When the machine shop moved to Lowell in 1825, most of these steady employees moved with the shop. Thomas Borden was accompanied by five other employees who worked steadily during the entire period; Isaac Borden, John Dummer, Samuel Ladd, Nathan Oliver, Samuel Oliver, and Jesse Cox. Some were highly paid and, like Thomas Borden, may have acted as supervisors. Isaac Borden and John Dummer, both machinists, were two such workers. Others, though, had much lower pay rates. Samuel Ladd, a carpenter,

50 See Chapter 2.

earned only $1.33 per day, and Samuel Oliver earned only $1.06 per day. Nathan Oliver began at the shop in 1817 earning only $1.08 a day, but his pay increased steadily each year, and by 1820 he earned $1.72 per day, making him one of the highest paid wage employees at the shop. The steady core of the shop had employees from all levels, and from the three main trades represented at the shop.

The steady employees were only about half of the employees at the shop at any given time. Other than the steady employees, the shop was in constant flux. The number of employees varied from week to week, almost every week had an increase or decrease of at least one or two people. These small changes added up to major changes in the number of employees at the shop across the period. Some weeks saw only six employees, while at other times the shop housed more than forty wage workers. Such changes seem to have closely followed the needs of the shop. More employees were hired when there was work to be done, and were let go when work slowed. Unlike contract work, which generally increased over the period, these changes tended to even out over the period. There were not generally more wage employees in 1825, then there were in 1817.

The employees who filled the rest of the shop were temporary employees. A few individuals returned to the shop after not appearing on the payroll for a few weeks, but most did not return. When new positions opened, they were filled by new machinists. There does appear to have been a stable group of temporary employees who stayed in the area waiting for further work at the shop. The result was a constant turnover of machine-builders. Most of the over two-hundred different people who were at the shop during the period worked only a few weeks or months. The average total amount of time worked by each employee was thirty weeks, though many worked less. Some of the temporary employees filled low paying positions. For example, Gustavas Stowell, Amos Carleton, and Alexander Piper, each worked only four weeks, and each earned only eighty cents a day. Not all of the the temporary employees earned low wages or performed unskilled work. Isaac Markham, for example, was a talented machinist from Middleton, Vermont who had built and was the supervisor for a small textile mill in Middleton.[51] Markham arrived at the Boston Manufacturing Company in September of 1820, and worked forty weeks before he left to return to Vermont in December of 1821. Markham earned $1.5 per day.

51 See Chapter 1 for more on Markham.

The changing work force was a fact of daily life in the machine shop. New machinists arrived at the beginning of almost every week, and at the end of every week several departed. The shop was constantly full of new faces. The shop was able to function despite the instability of its workforce. New employees were productive almost from their first day. The short tenures of most employees did not allow time for extensive training, and there is little evidence that employees were promoted while at the shop. Very few saw their wages increase.[52] The shop could function in part because there were enough steady employees distributed throughout the shop to keep the work organized, and in part because the work was simplified enough to be easy to learn. But these factors do not account entirely for the success. Early nineteenth century machine tools were far from the automatic, mass-production machines that would develop later, and much of the work at the Boston Manufacturing Company was still done by hand.

Rather than being de-skilled, the work required an increasingly standard set of skills shared by a large number of semi-itinerant New England machinists. The shop still depended on the industrial landscape; now not simply as a

52 It is more likely that promotions required moving to a new shop, or open their own factories or shops.

source of components, but as a pool of skill and labor. Other historians have discussed the importance of this mobile workforce to the spread and development of machine and tool design[53] but here we see that such interconnections were not just occasional. The movement of people across the landscape was part of the daily working life of machinists at the Boston Manufacturing Company. Further, the organization of work within the shop reflected the requirements of a constantly changing workforce.

Payroll employees were divided into the same trades listed in the first shop's first years. Most of the workers were listed as machinists, blacksmiths, or carpenters. There was also a small number of millwrights and casters listed. The shop was not evenly divided between the three trades. Of the two-hundred and twenty-four people listed, only twenty-two were blacksmiths, eleven were carpenters, four were millwrights, and three were casters. The overwhelming majority of the payroll employees were listed as machinists. Looking at the total number of each, though, is misleading. Although there were many more individual machinists, the people from other trades often remained at the shop longer, so on a given week, there was still a larger percentage of car-

53 David R Meyer, *Networked Machinists: High-Technology Industries in Antebellum America* (Baltimore: Johns Hopkins University Press, 2006).

penters and blacksmiths. The steady workers were evenly divided between the three trades.

Over time the number of people listed as anything other than machinist decreased. In 1818 there were five blacksmiths, six carpenters, two millwrights, and two casters. By 1822 there was only one blacksmith, one carpenter, and no millwrights or casters, and in 1823 only machinists were listed. Some of this change could be accounted for by the changing needs of the shop. A millwright for example, would only have been needed when work was being done on a water wheel or power train. Blacksmiths and carpenters, though, were needed as much as before. As we saw in the previous chapter, the shop still bought significant amounts of wood and bar iron, and still consumed large amounts of coal. The essential tasks would have remained the same. Rather, the classification of workers changed. Employees were less clearly divided between the various trades then they had been. This can be seen in the manner in which individuals switch classifications. Most of the carpenters and blacksmiths also appear as machinists. Some switched from year to year, or even from month to month. Some switched for a few weeks before switching back. Carpenters, though, were never listed as blacksmiths, or vise versa. This suggests that the category of "machinist" was wide enough to include at least some of the activities of people who were otherwise carpenters or blacksmiths. It appears that machinists at this time were as much classified by the fact that they made machines, as by the tools and techniques they used. As Jackson's original job advertisement listed, the shop was made up mostly of "people expert in the construction of machines," rather than simply operators of lathes, drills, files, chisels, or hammers.

Divisions of the trades may still have been prevalent on the shop floor. And it is likely that their work spaces would have remained separate, as flammable wood dust was best kept far from the smith's fires. But as far as the people who organized the shop were concerned, such divisions did not exist. As mentioned in the first chapter, the blacksmith's shop was mentioned separately, but mostly because it was a separate building. Once in operation costs, materials, and labor were not reckoned separately.[54] Neither were there separate overseers or foremen for carpenters or blacksmiths. Whatever divisions existed operated informally on the shop floor.

Instead, the shop was organized by projects. Each day of work from each

54 Such a division would have been easy for the managers to imagine. After all, the costs of operating the factory itself was consistently divided between carding, spinning, dressing, and weaving.

machinist was charged to a different internal account. Some of these accounts tracked the costs of special projects that were completed in a few weeks, such as building patent models, constructing forcing pumps, or making a newly invented regulator. Other projects were on-going and remained important for months or years. These included work on gearing, repairing old machines, and constructing and installing new machines. The amount of work done in each of these categories varied as the needs of the shop and factory changed. So, between 1817 and 1819, when the factory was building two new buildings, gearing appeared as an important part of the work schedule. After 1820, as the first factory and machines aged, repair work became important.[55]

The division of work into these different projects was certainly of importance to the bookkeepers in the Boston office, and allowed them to track the expenses of different parts of the operation closely, but these divisions do not appear to have been just accounting idealizations. They appear to have also governed employees' day-to-day work. While most employees worked on several projects during their tenure at the shop, they were not continuously shuffled between projects. Each week, an employee generally only worked on one or two projects, and were consistently assigned to the same set of projects for

55 BMC MSS

many weeks in a row. These projects formed stable, though gradually shifting, associations within the shop.

By the end of the period, the shop looked as if it has become vertically integrated, with more and more of the process being undertaken within the walls of the shop. By looking more closely at the layers of organization, it is possible to see that the physical walls of the shop, and the legal boundaries of the firm are a shifting part of a larger system that extends throughout the region. External entities acted as part of the shop, while workers located within the Waltham shop acted as external entities. Further, at the very core of the shop, the wage workers were a constantly shifting selection of workers circulating among a wide range of shops, creating a tightly connected system of shared skills and experience. Even at the very core of the work of building machines, one finds a layered and complex operation of place, space, and landscape.

Epilogue: The Business of Place-Making

By the 1820s the Boston Manufacturing Company was one of the most successful manufacturing ventures in the country. The factory was larger and produced more fabric than almost any other. The company was also profitable, paying regular dividends to its investors from its first year of existence. Even during the economic panics of 1819 and 1825, when many new textile concerns failed, the Boston Manufacturing Company continued to be successful enough to expand.

In many ways the Boston Manufacturing Company's Machine shop was even more successful and unique than the textile factory. During its first decade, the shop grew to be one the largest machine-building operations in the country. It occupied a larger building, and employed more people, than many textile factories. Perhaps more significantly, the machine shop was a profitable entity in its own right. Unlike machine shops at most other factories, the Boston Manufacturing Company's shop was not limited to repairing and replacing the factory's own machines. The shop also sold textile machines to mills across the country. The Boston Manufacturing Company's machine shop was important as one of the first entities to regularly produce industrial capital goods.

As this dissertation has examined, the success of the machine- and factory-building at the Boston Manufacturing Company was linked to the company's relationship with place. The work of building the factory and the machines that filled it transformed the site, landscape, and regional networks. Through this work, the company's machinists and managers produced and re-produced an interconnected collection of places that made the factory possible. Ultimately, the Boston Manufacturing Company's machine shop created more than single factory in a single location. Through the process they helped create a world in which building more factories became easier and less risky. The methods of building sites, of transforming landscapes, of gathering materials, and of managing skill and work could in the construction of other kinds of mills in other parts of New England. Even mills with no direct connection to the Boston Manufacturing Company, its owners, managers, or workers, would have found the process of creating their own factories easier.

For the Boston Manufacturing Company, its machine shop, and New England industry as a whole, the 1820s marks only the beginning of the story. The textile production part of the Boston Manufacturing Company would grow and expand in Waltham for more than a century, surviving until 1930. The machine shop became one of the central organizing forces in the next chapter of New England industry. The shop's machinists and mechanics went on to build Lowell, Massachusetts, an industrial city that would soon set new a standard for the size and intensity of American industry. The shop eventually became the Saco-Lowell Company, and for most of the twentieth century, was one the three largest textile machine companies in the country , finally closing its last production facility in 2000. Throughout the shop's long history, the methods and ways of working that were developed in Waltham during the first decade were elaborated and extended, so that factory and machine building became industrialized and regularize to the same extent as the the production of fabric itself was.

In 1820, Patrick Tracy Jackson, and the other organizers of the Boston Manufacturing Company saw that while the potential market for their machine-made fabric was apparently endless, the possibilities at the Waltham site were not. The ten foot drop of the falls, the crowded situation along the Charles River, and the relative density of the town, all contributed to limiting potential growth at the site. To grow, the investors would have to find a new location. In 1820, Paul Moody found a place on the Merrimack River that seemed to offer unbounded potential for the construction of water powered textile mills.[1] Located twenty-five miles north of Boston, in East Chelmsford, the Pawtucket Falls offered a thirty foot drop, enough for even Jackson's ambitious plans. In addition to the falls, East Chelmsford also had a transportation canal that was first built by Newburyport investors in 1792 to provide a way to bring lumber and other goods around the falls on their way to Newburyport. By 1820, the canal was falling into disuse and disrepair. In 1821, Jackson and his associates purchased the Proprietors of the Locks and Canals Company, who operated the canal, along with four-hundred acres. In the same year the Merrimack Manufacturing Company was incorporated with nine individual stock holders and a total of $600,000 in capital, and the land and canals were transferred to the new company for development. Within three years, the Merrimack Manufacturing Company had completed three mills, each larger than the Waltham factory, and were continuing to build more. They were soon joined by the Hamilton Manufacturing Company, the second of nine textile companies to

1 Most accounts of the "discovery" of Pawtucket Falls are derived from Nathan Appleton's memoirs. It is likely that Appleton overstated both the difficulty in finding a site, and its undeveloped quality. East Chelmsford was already home to several small mills, as well as both power and transportation canals. Jackson would have been well aware of this site, being a major stock holder in the Locks and Canals Company in East Chelmsford. Appleton, Robert Weible, "More of a place than represented to have been: East Chelmsford, 1775-1821." in The Continuing Revolution: A History of Lowell, MA. 1-38.

be built between 1824 and 1836. In 1824, East Chelmsford received a town charter and officially became the town of Lowell, Massachusetts. This was only the beginning of the astonishing growth of one of the first industrial cities in the United States. There were 300,000 spindles, and 13,000 employees by 1848. The city's factories were said to produce two hundred miles of yard-wide cloth every day.[2]

One of the most striking features of this new industrial city was the rapidity with which it was built. New mills were almost always under construction, new machinery was constantly being produced, and the water power system was constantly being improved and expanded. The large amount of available power from the falls provided the conditions for the possibility of such rapid expansion, but its success relied on the careful management of the process of place-building.

An elaborate and formal place-building system in Lowell developed over the first five years. At first control of the land, water power, and textile produc-

2 *Hand-Book for the Visitor to Lowell* (Lowell, MA, 1848), 7. Quoted in Patrick Malone, *Waterpower in Lowell: Engineering and Industry in Nineteenth-Century America* (Baltimore: Johns Hopkins Press, 2009). For the early development of Lowell see, Arthur Louis Eno, *Cotton Was King: a History of Lowell, Massachusetts* (New Hampshire Pub. Co., 1976). George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969). Robert Weible, Ed. *The Continuing Revolution: a History of Lowell, Massachusetts* (Lowell Historical Society, 1991).

tion was combined in the Merrimack Manufacturing Company. The machines for the first mill, though, were constructed in Waltham by the Boston Manufacturing Company's machine shop. In 1823, the process had begun of moving the tools, patterns and most of the machinists to Lowell, to become part of the Merrimack Manufacturing Company. Soon the company's managers realized that the scale of operations that were possible in Lowell exceeded what could be organized by a single entity. In 1824, the Merrimack Manufacturing Company decided to allow other companies to begin operation in Lowell. The Hamilton Manufacturing Company was the first. They contracted with the Merrimack Manufacturing Company for the construction of two factories, with a total of 7,168 spindles. They also purchased land from the Merrimack Manufacturing Company, and paid an annual rental fee of $300 for the use of water from the canal. Over the next few years additional companies had factories constructed on the Lowell canals.

Soon the construction of mills and machines, and the maintenance of the canal system became a major organizational challenge. The company's organizers decided to separate those tasks from textile production. To that end, they reconstituted the Proprietors of the Locks and Canals Company, and transferred the land, canals, and machine shop to the revitalized company.[3] Although the Locks and Canals Company shared many investors and even managers with the Merrimack Manufacturing Company, the organizational separation made growth in Lowell simpler than it might otherwise have been. The Locks and Canals Company constructed new mills for all of the first companies that started in Lowell. They also constructed and updated machinery for the mills.

One of the most important functions the company played was in maintaining the canals. Each company, including the Merrimack Manufacturing Company, rented use of the water from the Locks and Canals Company. Over the next twenty years, the company developed one of the most complex water power systems in the country, and developed many innovative ways to control, measure and understand the use of the water.[4]

During this period the machine shop also greatly expanded its operation as it produced a surprising variety of products. The shop produced machinery for customers outside of Lowell. They sold machinery to factories in New Hamp-

3 George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969).

4 Patrick Malone, *Waterpower in Lowell: Engineering and Industry in Nineteenth-Century America* (Baltimore: Johns Hopkins Press, 2009).

shire, Maine, Vermont, Ohio, Louisiana, and even St. Petersburg, Russia.[5] They also produced many cotton gins for customers in the southern United States. In the 1830s and 40s the company made woolen machinery, steam boilers, and even machine tools. One of the most notable diversifications was into the new field of steam locomotive engines. The Locks and Canals Company began producing engines for the Boston and Lowell Railroad, which was yet another P.T. Jackson led enterprise. The shop hired a West Point trained engineer named George Whistler to supervise a locomotive-building department, and were soon selling locomotives to railroads all along the east coast. At the time the machine shop in Lowell was one of about six places in the country capable of building steam locomotives, and was briefly one of the largest producers.[6] As more specialized machine shops of all kinds developed across the country, the Locks and Canals Company shop could compete in so many different product lines, and eventually focused once again on textile machines.

The Boston Manufacturing Company and its Waltham factory were direct the source of and model for the Lowell mills, and through those mills directly influenced textile mills across the region. The company's financial and techni-

5 George Sweet Gibb, *The Saco-Lowell Shops: Textile Machinery Building in New England, 1813-1949* (Russell & Russell, 1969), 91.

6 *Ibid,* 92-97.

cal success have earned it a place in American business and industrial history, but perhaps even more important were the lessons in place-building learned along the way. From the first uncertain steps that Jackson, Lowell, Moody and the machinists they employed made, to the efficient and elaborate machine- and factory-building enterprise that constructed Lowell, Massachusetts, the Boston Manufacturing Company's machine shop made more than a new factory. They made a new way of making the world.