ELI WHITNEY ARMORY SITE HAER CT-2

West side of Whitney Avenue to east side of Mill River,
near Armory Street
Hamden, New Haven County, Connecticut

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HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

Historic American Engineering Record
Office of Archeology and Historic Preservation
National Park Service
United States Department of the Interior
Washington, D.C. 20240

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HISTORIC AMERICAN ENGINEERING RECORD

ELI WHITNEY ARMORY SITE
HAER CT-2

Location:	West side of Whitney Avenue to east side of Mill River, near Armory Street Hamden, New Haven County, Connecticut
Date of construction:	1798+
Significance:	Location of the musket factory of Eli Whitney, an important contributor to the development of the American System of Manufacturing. It was here that Whitney attempted a system of production that combined both the functional division of labor and the use of power-driven machinery.
Parts of this report:	1: Site History, by Peter Stott with T. Allan Comp and H. McKelden Smith, March 1975
	2: Report on the Archeological Investigation, by David Starbuck, September 1974
	3: Labor at the Whitney Factory, by H. McKelden Smith with T. Allan Comp, February 1975
	4: New Evidence on the American System, by T. Allan Comp, January 1975

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This report must be read in conjunction with the other HAER material for the Eli Whitney Armory:

	Identification number
Barn	HAER CT-2A
Forge Building	HAER CT-2B
Fuel Storage Shed	HAER CT-2C
Boarding House	HAER CT-2D

Photographs referred to in the following pages can be found by means of the identification numbers above plus a photograph number; for example, photograph number 5 of the barn is designated HAER Photo CT-2A-5. Measured drawings are designated by the identification number plus a sheet number; for example, HAER CT-2A Sheet 3 of 7.

A complete list of all illustrative material for the Eli Whitney Armory is included as Appendix D of Part 1 of this report.

PART 1: SITE HISTORY[1]

Introduction

> No position for a manufactory could be better. From the bleak winds of winter it is completely sheltered by the surrounding hills; to the delightful breezes of summer it is perfectly opened by the valley through which the river flows. No place, perhaps is more healthy; few are more romantic.[2]

In 1821 Timothy Dwight enthusiastically described this small plot of land on the Mill River, naturally suited for early industry, near the seventeenth-century colony of New Haven. Still in use today, it is one of the oldest continuing industrial sites in Connecticut. It was here that Eli Whitney, fresh from his disappointments in the South, built the largest private musket factory in the United States.

The following chapter will be both a physical and an historical description of the site. But as a simple chronology will not serve, it may be useful to briefly outline the organization and contents of the material to follow. Section I includes a brief geological and pre-Whitney description of the site. Section II describes the Whitney land holdings that are pertinent to the factory site, Tracts 10 and 11, but other land holdings related to the site are also mentioned. Much of this information is taken from one of the more important pieces of evidence, the Inventory made in 1826

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1. Acknowledgements are gratefully extended to T. Allan Comp and H. McKelden Smith, from whose research the bulk of the material here presented is abstracted; and to Selma Thomas, whose perspective and editorial criticism proved invaluable.

2. Timothy Dwight, Travels in New England and New York (New Haven, 1821), vol. 2, p. 289.

of Whitney's entire estate.[3] The Inventory is a list both of the land holdings and of the contents (often room by room) of the buildings Whitney owned. Sections III and IV are a two-part history of construction on the site between 1798 and Whitney's death in 1825. The material in these sections generally pertains to the history of the entire site, whereas the material in Sections V-VII (in which the structures themselves are described) relates only to details of the individual buildings.

Throughout its history, the site has been divided by the New Haven Turnpike (now Whitney Avenue), which conveniently separated the site into two categories: "factory" and "domestic." Accordingly, Sections V and VI focus on the factory, and Section VII deals with the domestic buildings. Another division is created by the Mill River, which divides the factory area into east and west. Section V describes the factory buildings first on the east and then on the west side of the river, up to 1860, at which time construction of the dam and other factors imposed radical changes on the site, particularly on the west side. Section VI, which relates a history of the site after 1860, is limited (for reasons explained in that section) to a discussion of the west side of Mill River. Section VII describes the domestic structures west of the turnpike -- the barn, boarding house, and workers' housing.

Section I: Site Description

The two ranges (terminating in Mill Rock and East Rock), through which the Mill River runs to Long Island Sound, are composed of trap rock and granite eruptions through the sandstone bed of the

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3. "An Inventory of the Estate real & personal of Eli Whitney Esq., late of New Haven, deceased, taken by Simeon Baldwin, Elisha Munson & James Carrington," 10 January 1826, Folio 2, Eli Whitney Collection, Historical Manuscripts Division, Yale University Library, hereinafter EWC.

Connecticut River Valley.[4] Between the two ranges runs a short ridge of trap rock, which partially dams the Mill River. William Blake, nineteenth-century historian of Hamden, describing the location of the present dam built in 1860, wrote about this geological feature:

> The foundation of the dam is the top of the nearly vertical trap-dyke which here trends nearly east and west, and forms the connection between Mill Rock and Whitney Peak, the spur of East Rock. It is the same dyke that forms the crest of Mill Rock and has always acted as a natural barrier to the flow of the Mill River, causing Falls at the Crossing. The sandstone above and below the dyke being softer, has worn away faster than the trap, thus leaving the trap rock as the highest portion and so to form a natural dam for the water. This natural dam, and the water power it afforded, with probably but little work, determined the site of Todd's Grist Mill.[5]

Christopher Todd's mill (c.1630) was the earliest and the lowest of the mill seats on Mill River. A six-foot log dam across the river at this point formed a small pond, later known as Sabin's Mill Pond,[6]

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4. The trap rock of these ranges has long been a source of building stone for the New Haven region. Timothy Dwight wrote in 1811 of the trap rock (then called "green stone"), which he noted was "no more conspicuous than in the green stone mountains of New Haven. ... It forms an excellent building stone, and is extensively employed for that purpose in New Haven." In a footnote he adds: "It is worthy of notice that most varieties of trap or green stone rocks, if heated red-hot, plunged into water, and pulverized, become a good substitute for the puzzolana of Italy, in forming a water-proof mortar for the construction of piers, docks, &c." [Timothy Dwight, A Statistical Account of the City of New Haven (New Haven, 1811), pp. 7-8.] For a complete geological description of the area, see James D. Dana, The Four Rocks (New Haven, 1891).

5. William P. Blake, History of the Town of Hamden (New Haven, 1888), p. 100.

6. The Sabin family owned the site prior to 1787 when they sold it to Channey, Edwards, and Hillhouse. [Deed: T. H. Sabin to Charles Channey, Pierpont Edwards, and James Hillhouse, 8 January 1787. Unacc. New Haven Water Company Papers, New Haven Colony Historical Society Library, hereinafter NHWCo.]

which supplied water power for the grindstones.[7] The trap rock dyke effectively prevented the rise of tide water beyond the mill seat. In the middle of the nineteenth century, this tidal flow was eliminated when tide gates were installed downstream. Timothy Dwight, writing in 1821, reported that the river was navigable up to the Whitney site for scows from twenty to thirty tons.[8]

Two additional mill seats on the Mill River were established in this part of Hamden: another grist mill near the site of the present Davis Street Bridge and a paper mill about three hundred yards north of the present Whitneyville Congregational Church. As Whitney and his family later purchased both mill sites, these will be discussed in Section II.

Other mills in the area were reported by Ezra Stiles in his 1761 "Itinerary," in which he sketched a rough map and located, in addition to Todd's mill, three other grist mills, five saw mills, and one combination saw and grist mill.[9] Also, a linseed oil mill, which by 1798 had already been abandoned for twenty years, probably worked in combination with Todd's grist mill.[10]

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7. Two grindstones, possibly from this mill, are still on the site, now by the west end of the dam; they have probably been moved many times since 1798. Legend has it that a seventeenth or eighteenth-century deed contains a reverter clause which would become effective if the stones were removed from the property.

8. Dwight, Travels, vol. 2, p. 289.

9. Franklin B. Dexter, ed., Extracts from the Itineraries and Other Miscellanies of Ezra Stiles (New Haven, 1916). Map, p. 150. (Dexter has inaccurately labeled the Stiles sketch map of the Mill River as "Mt. Carmel Region, in Hamden.")

10. Deed: Charles Channey, Pierpont Edwards, James Hillhouse to Eli Whitney, 17 September 1798. New Haven Colony Historical Society Library, hereinafter NHCHSL.

Section II: Whitney's Land Holdings at His Death in 1825

The inventory taken of Whitney's estate in 1826 by his lawyer and others is the only complete record we have of the contents of both the farm and factory, and by implication, it suggests the activities taking place at Whitney's death. Including the factory and farm lots (which remained distinct at least until after 1825), it listed seventeen tracts of land.[11]

Tract No. 10

The parcel which included the farm was Tract No. 10, a sixty-acre piece of land bounded on the east by the Hartford and New Haven Turnpike (now Whitney Avenue), on the west by Second Quarter Road (now probably Prospect Street), on the north by Mill Rock, and on the south by another plot owned by Whitney. On 17 September 1798 Whitney purchased this land[12] from Captain Daniel Talmage for $2,750.[13] According to the Whitney/Talmage deed, the property at that time included a house, barn, and blacksmith shop. Describing these buildings to his friend Josiah Stebbins four months later, Whitney wrote,

> There are three things called houses on the farm which I bo't of Talmage -- I moved into the best of these (the one which he used to occupy & which is the nearest house to the mill).[14]

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11. This inventory was conducted by three of Whitney's close friends and associates: Simeon Baldwin, his personal lawyer; Elisha Munson, a New Haven merchant; and James Carrington, for many years superintendent at the Whitneyville armory. A transcript of the document is included as Appendix C.

12. He bought one hundred acres from Talmage, but forty acres had been disposed of by 1826.

13. Deed: Daniel Talmage to Eli Whitney, 17 September, 1798, EWC Box 2. The same day he mortgaged the land to James Hillhouse for $1750. [Town of Hamden, Land Records Office, Deeds vol. 4, p. 129.]

14. ALS EW to Josiah Stebbins, 13 January 1799, EWC Box 2. "The buildings," he adds in the same letter, "are miserable."

These structures are evidently the same house, barn, and blacksmith shop that are described in the deed. They are also presumably described twenty-seven years later in the 1826 inventory, which mentions "three old houses," in addition to the farm buildings Whitney built ("new Barn, Five Stone Dwelling Houses, [and] One Stone Store").

The house Whitney moved into is presumably the house with a porch shown in photo CT-2-6 and left of center in photo CT-2-7, since he wrote in the same letter to Stebbins that the new turnpike

> passes directly by my door -- between the house and the mill -- indeed, it cuts off a part of the House and comes hard on my new building which I have erected for my waterworks.[15]

Evidently he set up office in this building as well, and it was still there when he died.[16] He may have lived there until the construction of the boarding house.

The barn mentioned in the Whitney/Talmage deed is referred to only one other time (in a letter of 1811), and it is not shown in any illustration.[17] Presumably it was something less than a barn, perhaps not more than a large shed.

The blacksmith shop that Talmage sold Whitney is less easy to explain. As early as 1801 (if not in 1799), Whitney was using a blacksmith shop in connection with his factory.[18] The only other

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15. ALS EW to Josiah Stebbins, 13 January 1799, EWC Box 2.

16. The inventory lists the contents of the office, the office closet, and "Office Bedroom" (which, from the large number of files stored there, was clearly no longer a bedroom).

17. ALS Philos Blake to his sister Betsy Blake, 26 January 1811, Box 13, Blake Family Collection, Yale Manuscripts.

18. E.g., ALS Philos Blake to Betsy Blake, 7 September 1801, Box 13, Blake Family Collection. It is unlikely that his reference was to the forge building (sometimes erroneously called the blacksmith shop). The earliest date for the construction of the forge building (see Section I11) seems about 1804.

reference to this early building was by Joseph Smith, who, recalling his father's stories about Whitney's factory for a reporter in 1906, mentioned a blacksmith shop "southwest of the filing shop and close to the Farmington Turnpike."[19]

Tract No. 11

Tract No. 11 is the mill site with Todd's mill, evidently the only building on the property (unless the "oil mill" was a distinct structure). The earliest deed for the property among the New Haven Water Company papers is dated 8 January 1787. On that date T. H. Sabin sold the "mill, dam, stream, lands between mill & highway, and right to raise dam" etc. to Charles Channey, Pierpont Edwards, and James Hillhouse for 720 pounds.[20] Eleven years later, on the same day that Whitney purchased the Talmage farm, Channey, Edwards, and Hillhouse sold the mill to Whitney for the same price they paid for it.[21] Whitney mortgaged this property twice: first, on the same day as the purchase, for $2,544, and again a year later for $10,000.[22]

Other Land Holdings

After the initial 1798 purchases, there is a continuous record of land acquisitions through the 1830s. Hartley claimed that this was a deliberate effort to acquire land should Whitney decide to build the mill dam higher.[23] In any case, Whitney very early (1809) bought the third mill seat above tide water, a paper mill,[24] where his son

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19. The Cheshire Hamden Times, 31 May 1906.

20. Deed: T. H. Sabin to Charles Channey, et al., 8 January 1787, NHWCo.

21. Deed: Charles Channey et al. to Eli Whitney, 17 September 1798, NHCHSL.

22. Hamden Land Records, Deeds vol. 4, p. 127 and vol. 4, p. 343.

23. Rachael M. Hartley, History of Hamden, Connecticut, 1786-1936 (Hamden, 1943), p. 149.

24. Deed: Amos Bradley to EW, 12 July 1809, EWC Box 4.
Deed: Silas Hotchkiss et al. to EW, 9 August 1809, NHWCo (two deeds).

later established the Upper Armory for the manufacture of pistols.[25] In 1826 it was listed as Tract No. 12 among the inventoried land of Whitney's estate. It was still referred to as a paper mill as late as 1834.[26]

At what is now the Davis Street Bridge, there was a grist mill, marking the second mill seat above tide water. It was not purchased until 1830, when it was acquired, along with other pieces of land, by Goodrich and Edwards, trustees of the Whitney estate.[27] As noted on the Whiteford map of 1852 (photo CT-2-8), this mill site eventually became "Whitney's Marine Clock Factory."[28]

Other parcels of land held at Whitney's death were seven in New Haven, including two adjacent plots on Wooster Street (probably the site of the old cotton gin factory which burned in 1795) and considerable acreage in salt meadows, then used for haying.[29] The Beers map of 1868 (photo CT-2-9) locates a "Rifle Factory" about a

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25. The factory does not begin to manufacture the Colt pistol until the beginning of 1847 [Hartley, p. 262].

26. Deed: Joel Ford to Goodrich and Edwards, 15 April 1834, NHWCo.

27. Deed: Jesse Gilbert to Goodrich and Edwards, 10 March 1830, EWC Box 9. All these parcels were later turned over to Eli Whitney, Jr., 15 December 1842, for "$1 and divers other causes and considerations." [Deed: Goodrich and Edwards et al. to EW Jr., NHWCo.]

28. The "Marine Clock Factory privilege" was sold by EW Jr. to the water commissioners for $50,000 by the terms of an 1854 contract. [New Haven Water Co., First Annual Report to the Stockholders (New Haven, 1863), p. 21, NHWCo.]

29. A barn and several plots are located in the "New Township." Dwight, in his 1811 account (p. 18) wrote that the city was divided into two parts: the old and new townships, the new lying immediately eastward of the old nine squares. It was "a beautiful tract, bounded on two sides by Mill River and the harbour. The houses here have, within a few years, become numerous." The Barnsville Bridge, also mentioned in the inventory, crossed the Mill River where Grand Street now crosses it.

quarter mile south of the armory on Whitney Avenue. No other reference to these Whitney buildings could be found.

Section 111: History of Construction, 1798-1810

This period roughly covers the execution of the first contract for the United States Government and includes the construction of the original buildings necessary for production of the initial five hundred muskets (delivered in September 1801). The site, at least on the west side of the Mill River, where the first buildings were constructed, seems to have been essentially completed by 1803, when Whitney wrote to Stebbins that the armory had become a "regular establishment ... [progressing] tolerably well."[30]

The date of the contract for ten thousand muskets was 14 June 1798. That summer Whitney visited the Springfield Armory, one of two government armories established in 1794 by Act of Congress. Describing the effect of this trip a year later to Oliver Wolcott, Secretary of the Treasury (and his friend and sponsor), he wrote:

> [I] intended to have done a considerable part of the work in the town of New Haven in the Buildings which I own, and then occupied there -- but after viewing the works at Springfield where the water works are at some distance from the principal Armoury, I relinquished the idea of doing any work in town and determined to do all my work at one spot.[31]

Whitney purchased the site for the factory in September of that year (1798), but some delay forced him to postpone construction until after 1 November. He moved into Talmage's house by the turnpike near the first of October. Though the mill site he found was

> firm and well-founded by nature, ... it was rough and irregular and required considerable expense and some time

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30. ALS EW to Josiah Stebbins, 15 October 1803, EWC Box 3.

31. ALS EW to Oliver Wolcott, 31 May 1799, EWC Box 2.

> to lay the foundation of regular works so as to take the best advantage of the water situation.[32]

To Wolcott (24 October), he complained of the weather -- "Uncommonly severe ... seven snow storms within four weeks" -- and then added, "My principal building, however, is up and covered."[33] To Stebbins (27 November), he was more candid:

> Had it not been for the late snow storm, my building which is 72 feet by 30 and two stories high would have been raised this day -- I have 40 to 50 hands in employ and am almost worn out with fatigue and anxiety.[34]

On 13 January 1799 he wrote again to Stebbins that the weather "occasioned so much delay that I did not complete the raising of my building til the 4th Dec."[35] In February he was writing again to Stebbins about shingles and clapboard, but in March Whitney decided that the cost of shipping was too high, and that he would obtain his lumber locally.

By the end of May, though employing sixty men, Whitney had not yet put the waterworks in operation.[36] Simeon Baldwin, in a testimonial addressed to Wolcott, reported that "a building apparently well calculated for his business is erected & some part of the waterworks are nearly fit for use."[37]

The Cheshire Turnpike (which met the New Haven and Hartford road at a spot just west of the dam) was established in 1800, but there is little documentary evidence of any other activity at the site

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32. ALS EW to Josiah Stebbins, 13 January 1799, EWC Box 2.

33. ALS EW to Oliver Wolcott, 24 October 1798, EWC Box 2.

34. ALS EW to Josiah Stebbins, 27 November 1798, EWC Box 2.

35. ALS EW to Josiah Stebbins, 13 January 1799, EWC Box 2.

36. ALS EW to Oliver Wolcott, 31 May 1799, EWC Box 2.

37. ALS Simeon Baldwin to Oliver Wolcott, 18 June 1799, Box 10, Baldwin Papers, Yale Manuscripts.

in that year.[38]

The first five hundred muskets completed at the factory were shipped on 26 September 1801. Three weeks earlier, ten-year-old Philos Blake, visiting his uncle, had written his now-celebrated description of the factory in a letter to his sister Betsy:

> There is a drilling machine and a boring machine to bore barrels and a screw machine and two great large buildings, one other shop and stocking shop to stocking guns in [sic], a blacksmith shop and a trip hammer shop, and five hundred guns done. I have seen a great many ships since I have been here, and 1 have seen the cannon.[39]

The syntax is a bit awkward here, but it is possible that the correct punctuation would include a colon after "two great large buildings." One was the filing shop (for which he did not know the name), that housed the heavy equipment he described; and the other was the stocking shop. Both "great large buildings" are pictured in the painting by William Giles Munson (photo CT-2-7) and are inventoried in the 1826 description of Whitney's estate; as such they will be discussed among the major factory structures in Section V.

The blacksmith shop mentioned in Philos's description, as we have suggested in Section II, is probably one of the three buildings Whitney bought of Talmage. This would then corroborate Joseph Smith's recollections of a blacksmith shop "southwest of the filing shop and close to the Farmington Turnpike."

The trip hammer shop was a new building, built, according to the 1826 inventory, on the factory side of the turnpike and one and

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38. In February 1801 there was a report of an ice storm which wiped out eleven of Hamden's thirteen bridges (perhaps frequent casualities of heavy winters), tore down Whitney's dam, and did "some damage" to his works. [ALS Rebecca Hillhouse to James Hillhouse, Box 2, Hillhouse Collection, Yale Manuscripts.]

39. With corrected spelling, ALS Philos Blake to Betsy Blake, 7 September 1801, Box 13, Blake Family Collection. The ships and cannon were at the New Haven harbor.

one-half stories in height.[40] This may be the building partially hidden by the trees east of the turnpike in the Munson painting (photo CT-2-7). If so, it stood about where the Heany Industries building now stands (the only factory building still at the site). According to an 1880 engraving (photo CT-2-10), it may have been four bays long by three wide.

By 1803 Whitney seemed relatively satisfied with the state of his works. In March he wrote to Stebbins that though much work remained before he completed the contract, the administration had allowed him the necessary time.

> I have obtained all the time I wished. This has relieved me from a vast load of anxiety which any one must naturally

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40. The phrase in the inventory, "garret store over old trip hammer shop," would seem to imply 1½ stories. "Trip hammer" is a term loosely used and applied to any hammer lifted by a cog and released to fall by gravity to the surface being struck. Of the varieties in common use, a "tilt hammer," delivering light, rapid blows, has a fulcrum in the middle and often a spring to assist the blow. A "forge hammer" (or sometimes "helve hammer") is a heavy, cast-iron hammer with a fulcrum at one end.

    Among Whitney's papers is a sketch for a "perpendicular trip hammer" which, through the use of parallel supports, enables a cog wheel to lift a trip hammer and to let it fall vertically. Joseph Smith described the use of trip hammers for welding barrels: "A flat piece of iron was wound around a wooden rod and welded together by these trip hammers. The rod was withdrawn, and the bore bored smooth." How long trip hammers were used in this building is a matter of speculation. By the 1826 inventory, it was "the old trip hammer shop" [underscoring supplied], and, at least by 1818-1819, it (or a building replacing its function) must have required some water power. Whitney, about that time, had developed a belt-drive system, to reduce the number of distinct motive powers. In a letter to Lee at the Springfield Armory he wrote, "I originated the plan of driving a trip hammer by a belt or strap. ... I believe that a hammer of 500 to 1000 wt. may in most situations be driven by a belt with great advantage -- upon the Principal, a number of hammers, say 8 or 10, may be operated by one wheel with great convenience." [ALS EW to R. Lee, 2 August 1824, EWC Box 8.]

> feel when all is in the power of those in whom they have not the most perfect confidence.[41]

Presumably he had completed or was about to complete what must have seemed the finishing touch to the armory -- a proof house -- which Henry Dearborn (Secretary of War) had requested a few weeks earlier.[42]

There is more evidence of construction in 1804 on the east side of the Mill River. In March of that year Whitney wrote D. Humphries in Boston (evidently an authority on such matters) that he was sending his nephew to consult him "on the position of the building we are about to erect, and especially on the manner of bringing water to it." He was anxious to suggest, however, that cost factors be kept in mind:

> Only such part of the sluiceway should actually be made in stone as might now be indispensible, and that the wooden works could be replaced by more durable materials hereafter.[43]

This is the only evidence of construction during the remainder of the decade, but the letter seems to indicate a water channel of some length or complexity. According to our present understanding of the site, this could only refer to the water power system for the forge building (see Section V). Some doubt about this hypothesis is raised by the evident extravagance (at least in comparison to Whitney's plea for economy) of the stone detailing of the building. Presumably, the hearths in the building would have been supplied from the fuel storage sheds, possibly built at the same time.

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41. ALS EW to Josiah Stebbins, 6 March 1803, EWC Box 3.

42. Dearborn instructed Whitney to build "a proper house for the purpose of proving gun barrels near your manufactory of Arms" not to exceed $200. Dearborn also requested a small brick powder house to contain four or five barrels of powder. [ALS Dearborn to Whitney, 25 February 1803, EWC Box 3.]
Joseph Smith recalled that the proof house and its accompanying powder house were built against East Rock, and we shall consider these buildings, along with the fuel storage sheds also built there, in Section V. However, if this location is accurate (and there is little evidence to suggest that it is not), it is the first definite evidence of buildings constructed on the east side of the Mill River.

43. ALS EW to D. Humphries, 3 March 1804, EWC Box 3.

Section IV: History of Construction, 1811-1825

The period 1811-1825 was one chiefly of consolidation, especially in Whitney's later years.[44] In the 1820s Whitney told his lawyer, Simeon Baldwin, that he was anxious to provide for his two nephews, Eli Whitney Blake and Philos Blake, not through an outright gift, but by repairing the works and thus placing them in a situation where they could earn for themselves.[45]

The buildings constructed during this period were supporting elements to the factory village rather than an expansion of industrial activity. By this time we may presume that the manufacturing buildings had been completed. Repairs on the water-power system were probably made continuously, and major improvements were undertaken on various occasions (particularly in 1820). The barn, boarding house, and five stone dwellings for married employees were also built at this time. So too, if he had not done so before, Whitney now won the praise of his countrymen, culminating in President Monroe's visit to the armory in 1817.[46]

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44. An unidentified document, dated 18 May 1814 [EWC Box 6], raises an unresolved question and a possible exception to this "consolidation:" "E. Whitney, on making his contract for 15,000 muskets, proceeded to erect two new sets of waterworks, which, owing to the severity of the season, were not completed as soon as expected. Has 1,000 muskets finished and the principal parts for 2-3,000 more. His establishment is extensive and founded on the expectation of public patronage, and great losses will ensue to him if this contract is annulled. He therefore solicits that such arrangements will be made as will enable him to proceed." The date of his U. S. Government contract for 15,000 muskets was two years previous -- 12 July 1812.
    In a letter also written on 18 May 1814 to the then Secretary of War, James Monroe, Whitney wrote that with the contract (presumably of 1812) he had built waterworks in Salisbury and Haddam for forging barrels. He added that his establishment had become "much more extensive and complete than that of any other individual in the U. States" so that he could "with certainty manufacture 2,000 muskets a year." [EWC Box 6.]

45. Notes, Simeon Baldwin, 27 January 1823, EWC Box 8.

46. Connecticut Journal, 24 June 1817, p. 3.

Section V: Structures East of the Turnpike, 1798-1860

The Pre-1860 Mill Dams

There is no graphic evidence for the placement of the mill dam on the property Whitney purchased in 1798.[47] It was described as being six feet in height and built of logs: possibly a "solid timber wall, braced by diagonal struts on the downstream face ... [and] protected on the upstream by a heap of rubble stone."[48] According to Baldwin's letter to Wolcott (18 June 1799, already cited), the mill dam was in need of repairs when Whitney took over the site. Presumably the repairs and waterworks were completed during the summer of 1799.

We have already noted (Section III) the flume proposed in 1804, for which Whitney hoped to be spared unnecessary expense. More foundations were laid in the river in August 1813,[49] but the major changes seem to have taken place in the fall of 1820. On 9 September Whitney wrote his brother that two weeks before he had

> commenced taking up my mill dam at the manufactory in order to rebuild it entirely anew, with stone. ... My manufactory is wholly stopped and must remain so till the dam and flumes are rebuilt, which will take, I presume, three weeks longer.[50]

But by 10 November, after ten weeks of arduous work, there still remained about ten days before he expected to begin operation.[51]

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47. See Section I on Todd's grist mill.

48. Carl Condit, American Building Art: The Nineteenth Century (New York, 1960), p. 257. According to Condit, this was usual practice until the middle of the nineteenth century.

49. ALS EW to Josiah Whitney, 29 August 1813, EWC Box 6.

50. ALS EW to Josiah Whitney, 9 September 1820, EWC Box 8.

51. ALS EW to Josiah Whitney, 10 November 1820, EWC Box 8.

The Forge Building

During the past season's project, the forge building was the only early factory building that could be both accurately located and graphically documented. The only manufacturing building to survive beyond 1860, the forge building remained essentially unchanged (at least on the exterior) until destroyed by fire in February 1950. Probably for at least a decade after, parts of its ruined walls remained exposed, a quarry for local residents, until plowed under in the early 1960s.

The excavation just concluded uncovered a whole range of activities from the initial period, when it may well have been a focal building in Whitney's factory, to the post-1860 years, when most of the manufacturing probably took place on the west side of the river, relegating the forge building to lesser tasks. Its power system also saw many changes: from what may have been an open wooden flume, powering (possibly) breast wheels, to the later introduction of a penstock and turbine, installed during the construction of the new dam in 1860. Eventually, the water power was no longer needed, the wheels fell silent, and the raceway gathered silt and rubbish. Finally, probably not long after the property was leased for non-armory uses in 1904, the water channels were filled in and a new concrete floor added to the building.

In his "Reminiscences," published seven years after Whitney's death, Benjamin Silliman began to praise Whitney's craftsmanship by describing the east side works:

> It is necessary only to inspect the work, the flume ways, and the walled borders of the river below, and the canal which he constructed to take the water from the dam to the forging shop, to be satisfied that both genius and taste presided over these useful, although unostentatious constructions.[52]

We have no clear early representations of the forge shop except for two drawings from the Whitney collection (Folio 2), photos CT-2B-4 and CT-2B-5. Both are labeled (undoubtedly by that indefatigable hand that went through all Whitney's sketches after his

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52. Benjamin Silliman, "Reminiscences of the Late Mr. Whitney," American Journal of Science and the Arts, vol. 21, p. 256.

death) "Blacksmith Shop."[53]

We have already examined some possible evidence for construction on the forge in 1804. Some work may have been done in 1813,[54] but there is certain evidence of major work in the fall of 1820, when the dam was relaid. In the summer of 1820, preparing for

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53. It is doubtful that this is a reference to the original blacksmith shop which Whitney bought from Talmage. Both sketches portray a building much more substantial than the "miserable" building Whitney bought. Photo CT-2B-4 is a brief site plan and can, with some imagination, be understood to show the dam, canal, and forge shop. The label may simply be inaccurate, or else done at a much later date when perhaps the building had been converted to a simple blacksmith shop.

    If the elevation (photo CT-2B-5), presumably of the north side, was roughly sketched at a scale of one inch equals ten feet, we have pictured a seventy-five-foot building, two water-level arches at either end with eight-foot spans, and a central door, five feet wide rising six feet from grade to eave. We must presume that the two water channels were not built, but substituted for by the wide central channel uncovered by the excavation. (The foundations, previously thought to represent two buildings, seem on the basis of graphic evidence, to unquestionably represent one building.) Total height of the building above grade is twenty feet. There are also five dormer windows or ventilators, roughly 2-1/2 feet square.

    Unfortunately, almost all the other graphic evidence contradicts this view, chiefly in the ventilators, which in all views (especially photos CT-2-7 and CT-2-11) sit astride the ridge of the roof. In addition, archeological work on the building revealed a single lower raceway cutting through the center of the structure.

    Among the Folio drawings was also one labeled "Plan of a Blacksmith Shop" (photo CT-2B-6), showing the position of six hearths, each with a bellows. Although the width of the building and the placement of one or two of the hearths agrees with the excavated plan of the building, its lack of detail suggests it was little more than a hypothetical plan.

54. 29 August 1813, Whitney wrote his brother Josiah about "some additional works which I propose to add on the opposite side of the river." [EWC Box 6.]

this work, Whitney wrote his nephew from Boston:

> As we cannot, without considerable additional expense, make abutments which will sustain a great lateral pressure, I think it will be best to make a semi-circular arch over the west waterway, in which case the arch will commence below the surface of the water -- perhaps nearly down to the bottom of the channel -- You must be regulated by your own [?] in constructing this arch & will be able to form a more correct judgement after you have taken up the present abutments. I should like to have the underside of the stonework of the arch not come lower down than Eighteen inches below the caps on the flume -- as the water must be drawn off when you commence this work.[55]

The archeological evidence of original double doors and a wide sill in the center of the south wall, directly over the tailrace, raise the possibility that materials were hauled up the river on small barges and unloaded at the forge building. Timothy Dwight's comment, noted earlier, that the river was navigable for scows of twenty to thirty tons, would support this contention, as would an 1830 reference by Eli Whitney Blake to a "Sea Coal Wharf."[56]

In the 1826 inventory the contents of the forge shop included:

> 7 pairs of bellows
> 7 wrought iron anvils

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55. It might be helpful to investigate what form this stone flume took. Howe's 1842 engraving (photo CT-2-11) seems to show the edge of the dam, a large head of water north of the forge shop (with possibly two entrances to the building), an entrance to the headrace at the east end of the dam, and apparently a stone wall or embankment supporting the canal above the river level. Here the very detailed plans quoted above may apply. [ALS EW to E. W. Blake, 1 July 1820, EWC Box 8.]

56. Philos and Eli Whitney Blake, 17 December 1830," Account of Money and other property by them received and expended or worked up," EWC Box 9.

12 anvils for swedging[57]
8 sledges
26 hand hammers
19 sett hammers[58]
7 slide hammers
2 large smith vices
1 set of bayonet forging tools
1 bellows pipe
1 set of tools to make tumblers

and a variety of swedges, dies, and other tools. Trip hammers were evidently not in use, and the water power presumably drove only the bellows.

Although the actual wheel pit for the original water wheel(s) was not located during the excavation, the raceway did contain a section of the penstock and perhaps the turbine. The course of the penstock from the dam face is visible in photo CT-2-12 and shown abandoned in front of the forge building in photos CT-2B-7 and CT-2B-8. The turbine, Blake noted in 1886, was a twenty-four-inch wheel which delivered sixty horsepower.[59]

Later additions to the building included a detached wooden shed of one and one-half stories, three bays wide, with board-and-batten facing, and twenty by thirty feet in plan. Built sometime in the late nineteenth century near the northwest corner of the forge building, the shed was probably demolished when the Acme Wire Company occupied the site in 1904.[60]

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57. A "swedge" or "swage block" is a "block of cast iron with perforations of various shapes and sizes right through it, and grooves of various shapes around its edges. It complements the blacksmith's anvil. The groove can be used for shaping, and the holes can support various tools." [W. K. V. Gale, The Iron & Steel Industry: A Dictionary of Terms (Newton Abbot, England, 1971), p. 205.

58. "Set hammers [are] tools of various shapes and sizes used by the blacksmith. They are fixed in handles and are used where striking direct with the hammer would be impracticable. Sets are held by the smith and struck with a sledge hammer by the striker." [Ibid., p. 182.]

59. Blake, pp. 139-140.

60. See particularly photos CT-2B-7, CT-2-13, and CT-2-15.

Sheds (approximately sixteen by twenty feet) were erected, probably in the same year, against the centers of the north and south walls.[61] Between 1915 and 1918 the southern shed was expanded to sixteen by fifty feet.[62]

Asbestos fibre was woven in the forge building (the "dust" can be seen on the roof in photo CT-2-16), and subsequently a concrete floor was laid by Heany Laboratories, the most recent occupant of the site. According to Robert Smith of East Haven, a long-time employee of Heany, when the company manufactured rubber shock absorbers in the forge building in the 1920s, an upright steam boiler for the vulcanization process stood in one corner.

Fuel Storage Sheds

On the east side of the river beyond the forge building and against the hill, stood a row of small buildings of various uses. According to Silliman, two of these served as fuel storage sheds,

> ... the one for charcoal, and the other for mineral coal; both are finished with great exactness, by selecting smooth natural faces of the trap rock, which are accurately laid in mortar [63] and carefully pointed; the floors are also of firm stone, laid with equal exactness. These store-houses stand by the side of the mountain and at its foot, and by excavating a road in the bank above, the coal carts are driven quite up to the gable end of the building, and their loads are discharged into them simply by tipping up the cart. This notice of these humble buildings is given to show Whitney's exactness in everything.[64]

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61. See photo CT-2-15.

62. See photo CT-2-16.

63. Silliman wrote that in some of the buildings the mortar was "a mixture of iron rust and siliceous and micaceous sand, derived from the grinding of the gun-barrels and other pieces of iron upon the grindstones -- a cement which appears almost as firm as the rocks themselves." [Silliman, p. 257.]

64. Ibid.

Each shed was about twenty-five by twenty-two feet in plan, with a fan light in the front gable and an arched door directly below. They were probably built about the same time as the forge building. They stood at least until 1906, when they were included in the background of a photograph (photo CT-2-17) taken by New Haven photographer Thomas Bronson.

Soon after that 1906 photograph, all the sheds were demolished, except for one (the center shed of photo CT-2-17), which was altered nearly beyond recognition by the addition of a second story, an annex, and new fenestration. Photo CT-2C-2 shows the building at this stage. A heavy stone sill in the upper portion of the rear wall is the only surviving evidence of the fuel storage function the building once served. The concrete bench now there was used in the Heany production of electric transmissions. In the 1940s the wooden second story and annex burned, and the four trap rock walls were covered with a low wooden roof. In 1826 the two sheds contained 5,075 bushels of charcoal, valued at $304.50.

Proof and Powder Houses

Built in 1803 at a cost of $178.75, the proof and powder houses stood on the east side of the river. With regard to the powder house, Dearborn was quite specific: it should be of brick and

> large enough to contain four or five bbls. of powder, which should have no wood attached to it except the door -- A small cone terminating with a stone, covered with a thick coat of paint of spanish brown & oil, which will be the least expensive & most durable -- A door of eighteen inches in width & two feet high will be sufficient, the building need not be more than four feet in diameter either round or square, and the upright walls three feet above the surface and the dome or cone about four feet in height above the upright walls, which walls should be the length and width of a brick in thickness & the cone [,] of the length of a brick in thickness -- the expense of the building should not exceed thirty or forty dollars.[65]

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65. ALS Henry Dearborn to EW, 25 February 1803, EWC Box 3.

Because the buildings are not visible in any of these illustrations, we cannot be certain if the powder house was built to these specifications. Two structures which may qualify are shown in photo CT-2-13 at the southern end of the long row of sheds.[66]

The Foundry

This last building on the east side of the river had the largest single-story floor area of all the factory buildings. The one hundred by sixty-foot building was of wood-frame construction with board-and-batten siding and a monitor roof running nearly its entire length. Projecting from the rectangular plan was a room or shed about ten by twenty feet, which housed the cupola.[67]

We have no dates either for construction or for demolition of the foundry, and it does not appear in the 1828 Munson painting (photo CT-2-7). It may well have been built in conjunction with, or shortly after, the introduction of steel barrels in 1842.[68] It was probably demolished, along with the adjacent row of sheds, soon after 1906.

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66. At this point it might be useful to note the brief cartographic appearence of a road on the Whiteford map of 1852 (photo CT-2-8), running north along the east bank of the Mill River to the factory, where it crosses the river and, according to the map, becomes Armory Street.

67. It is visible in most of the old illustrations (particularly in photo CT-2-16, taken about 1918, after the foundry had been demolished). Local understanding has it that steel production in the cupola furnace (Whitney's attempt at self-sufficiency) was never successful.

68. There is some slim evidence for construction in 1842 in a letter Eli Whitney, Jr. wrote to Thomas Warner, in which he mentioned "pullies for welding hammers, ... [and] stone for the forge." [ALS EW Jr. to Thomas Warner, 29 December 1842, EWC Box 13 (letter book).]

Machine and Filing Shop

On the west side of the river, the earliest site (and perhaps most promising for future excavation) is that of the machine and filing shop, erected 1798-1799 near or on the site of the earlier grist mill. As previously indicated, it was presumably this building that Whitney described as being seventy-two by thirty feet.[69] It was two stories high and joined to the stocking shop by a second-story walkway.

This building housed most of the machinery used at the factory. Smith recalled that after the barrels had been proved across the river, "they were sent to the finishing room. More men worked in the filing shop than in any of the other buildings." He also remembered that men for whom there was no room in the boarding house slept in the attic of this building, and in fact, the inventory of the factory garret shows (aside from four barrels of plaster) ten bedsteads, four straw beds, and a mattress.

The main floors[70] contained major equipment such as the valuable drilling machine (worth $400), a lathe ($25), a nitching machine and milling tools ($75), a screw machine ($100), a stamping machine ($60), a polishing machine for barrels ($22), and a more expensive one listed simply as "polishing machine & wheels $75," in addition to many smaller tools -- vices, clamps, braces, an anvil, "stake and block for cutting files," taps, and dies.

Contents of the "Lower floor of the same building" included a grindstone with "shaft & box," two smaller grindstones and pullies,[71] more vices, a machine and tools for fine boring, and two trip hammers and irons (worth $25).

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69. In all the applicable illustrations (especially photos CT-2-7 and CT-2-11), however, the building is given a marked "T" or "L" form.

70. This may be the upper floor only, if the "Lower floor of the same building" in the inventory is not the basement, but the ground floor.

71. In an excavation for a sewer line several years ago, several grindstones were found in what may have been a dump behind the present Heany Industries building. These stones are now (1974) in the field south of the barn. Similar stones were uncovered during the excavation of the raceway of this building.

Water power was provided by two wrought iron undershot wheels, fourteen feet in diameter and six feet wide.[72] Silliman described them in 1832 as "combining the greatest strength, durability and beauty, with a projective power like that of the fly-wheels in steam engines. They are elegant objects, especially when in motion."[73]

A newspaper account in March 1861 described an explosion on the first of that month which destroyed the main part of the machine and filing shop,

> leaving the southeast corner, in which was a quantity of work in various states, a complete wreck. ... The boiler was situated on the lower floor and about in the center of the shop. The head was blown out in one direction, and the other portions in the opposite, thus riddling the lower story, and bringing down all above.[74]

Stocking Shop

In the two-and-a-half-story wooden stocking shop

> stocks were fitted to the barrels, and here some beautiful work was done. The wood for this stocking was black walnut ... from Pennsylvania.[75]

Joseph Smith also recalled that cotton gins were stored in the basement, although they do not seem to have been there in 1826. Aside from a few (presumably faulty) muskets, the cellar contained four cast-iron forcing pumps (worth $8 apiece) and 1200 pounds of old copper ($192).

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72. Blake, pp. 139-140. On a note from Philos [6 November 1822, EWC Box 8] concerning the poor quality of iron in a recent shipment, Whitney noted the details of construction for two twelve-foot iron water wheels with twenty-four thirty-inch buckets.

73. Silliman, p. 258.

74. News article, March 1861, Dana Scrapbook v. 74, p. 25, NHCHSL.

75. The Cheshire Hamden Times, 31 May 1906.

On the first floor there were evidently two rooms, designated as "north" and "south" in the inventory. The north room was a storage room where musket crates were built. The room contained "2300' pine boards sawed for M. Boxes," 1100 fence pickets, a hay knife, broad axe, crosscut saw, various augers, framed compass saw, three pair of rack and pinion compasses, gauges, chisels, and various other tools.

The south room contained an auger for boring logs, two boxes of bellows nails, forty-five seven-by-nine glass panes, fifty six-by-eight glass panes, considerable quantities of bar iron, Milan and English blistered steel, four cast-iron boxes for case hardening,[76] a leveling instrument for cutting in grindstones, quantities of copper and lead, twenty-nine ground Scovil gun barrels, twenty-five barrels of glue, etc.

The second story seems to have completed the main stocking operation. Here there were in 1826, 869 gun stocks and three bench vices along with four sets of tools for stocking, with benches and stands. Undoubtedly the finished barrels and locks would have come directly from the second floor of the machine and filing shop over the second-story walkway to this room. Presumably power was unnecessary for the stocking operation; in any case it seems to have been unavailable.

In the garret of the same building were four hundred pistol stocks, lumber, bellows parts, some pullies, twenty-seven empty powder casks, eight small grindstones, and a broken crosscut saw. Evidently the space was used for general storage.

There is little evidence of the building's removal. Blake, describing the buildings in 1886, noted that the then-existing armory was "built in 1860 to replace one burned."[77]

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76. Case hardening is the process by which carbon is introduced "into the skin of a soft iron or mild steel. The skin is converted into carbon steel which can then be hardened, but the core, which has not taken up carbon, remains soft." [Gale, p. 40.]
Was the case hardening carried out here? There is a reference in 1808 to a furnace for hardening the ramrods. [ALS EW to Henry Dearborn, 14 June 1808, EWC Box 4.]

77. Blake, p. 143. However, Blake does not mention the explosion in the filing shop, and (although that event did not include a fire) he may be confusing the filing and stocking shops.

Section VI: The Factory After 1860

The Van Slyck steel engraving of 1880 (photo CT-2-10) offers the best general view of the site after 1860. Virtually all of the buildings west of the river were built between 1860 and 1865,[78] and the site remained essentially unchanged until 1904, when the Acme Wire Company leased the site from the New Haven Water Company. Thus the assessment map of the water company property in 1900 (photo CT-2-13) shows a plan which agrees in the main with the 1880 perspective. Photo CT-2-18 illustrates the site photographically about 1920.

Because of the previous buildings on the site, two post-1860 buildings were of particular concern: the 1860 armory and the complex of buildings and sheds next to the dam, which, following the label given by the 1915 site plan (photos CT-2-14 and CT-2-15), we refer to below as the "dam buildings."

The Armory[79]

This one-hundred-by-forty-foot brick structure, two and one-half stories high, was completed in 1861 by builder/architect Richard Treat Merwin and housed (in that year) the activities of two hundred and forty employees.[80] In the twentieth century a monitor roof and several sheds or additions were added (photos CT-2-19 and CT-2-20).

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78. With the exception of the 1888 office building, which was probably built with a trap rock foundation at that date and enlarged some time in the first decade of the twentieth century.

79. This building is frequently referred to by its date alone. The reason is evident in photo CT-2-19, in which "1860" is painted prominently over the door.

80. News clipping, The Daily Morning Journal c.1861, NHWCo.

It was in this building that J. Allen Heany (1877-1946)[81] developed the practical application of asbestos as an insulator for electrical conductors, c.1919.[82] The building was razed in 1949.[83]

The Dam Building

This wooden three-story building is labeled "dam building" in photo CT-2-14. Like the main armory, it was designed by Merwin and completed in 1861. The previous building on the site, the machine and filing shop, had been destroyed in that year, as we have seen, and this new structure with one hundred fifteen windows was completed in sixty days. It is visible left of center in photo CT-2-21. Sometime after 1900 it was expanded to one hundred ten by thirty-four feet. Later additions were built along the building's north wall, and the present concrete foundation testifies to an eastern addition. It had its own boiler and engine rooms behind it (next to the dam) which featured a tall iron stack, prominent in many of the early illustrations (e.g., photo CT-2-22). One edge of the boiler room still remains next to the dam pier, and a wooden plate which supported the roof is still affixed to the dam face. The building was razed between 1924 and 1929.[84]

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81. At the age of sixty-nine on 28 September 1946, John Allen Heany died of cancer. His obituary in The New York Times credited him with the invention of the closed circuit ignition for automobiles. "A veteran of World War One, Mr. Heany received the Franklin Institute medal twice for inventions of lighting systems and the insulation of power lines with asbestos.
"Other of his inventions included lighting systems for railroad cars, high-voltage welding processes, a type of radio tube permitting the use of house current, and thionic [sic] reduction of metals." [The New York Times, 29 September 1946, p. 61.]

82. Rockbestos Products, Inc., The Hourglass, February 1949, p. 1, NHCHSL.

83. News clipping, Dana Scrapbook v. 74, NHCHSL.

84. Determined from the 1924 Sanborn Insurance Map no. 540, with a 1931 correction pasted over (photos CT-2-23 and CT-2-24). The building is visible in the former, not in the latter. The Town of Hamden Assessor's Section Map No. 13 (corrected to 1929) shows the dam building erased.

Section V11: Structures West of the Turnpike, 1798-1860

The Barn

In 1832 Benjamin Silliman described the barn as

> a model of convenience, and even of taste and beauty, and [which] contains many accomodations not usually found in such establishments. 1t was visited and examined by the late President Monroe, during his excursion through the Eastern States, in 1816.[85] 1t is perfectly characteristic of Mr. Whitney, that his attention was directed even to the mangers for the cattle, and to their fastenings. The latter are so contrived, by means of a small weight at the end of the halter, that the animal could always move his head with facility, but could not draw out the rope so as to become entangled in it, nor could he easily waste his hay. The fastenings of the doors, as well as all the other appendages and accommodations are equally ingenious.[86]

The earliest likely reference for the date of the barn[87] is Whitney's 4 June 1815 letter to Stebbins:

> 1n addition to my ordinary business of Manufacturing Arms, 1 shall be occupied this summer in erecting some additional buildings near my manufactory.[88]

Two months later, however, his plans seemed no further advanced. The high price of labor and materials had delayed both delivery and

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85. Monroe's interest in the building may have prompted the commissioning of the measured drawings of the barn (photos CT-2A-15 and CT-2A-16), initialed by Eli Whitney Blake. Presumably these drawings date to the period of EWB's apprenticeship under his uncle, 1818-1825.

86. Silliman, pp. 257-258.

87. The WPA survey of the buildings of Hamden [Dana Scrapbook v. 75, p. 40, NHCHSL] reported the 1816 date to be a "hearsay" date. The Hamden Historical Society's 1816 date is probably based on Hartley's information.

88. ALS EW to Josiah Stebbins, 4 June 1815, EWC Box 7.

payments. Whitney observed that this delay not only occasioned "loss upon loss," but also subjected him to "the most serious embarrassments in meeting ... engagements and proceeding with ... business."[89]

In a letter (now lost) sent to Stebbins in the fall, Whitney evidently asked about timber for new buildings he was planning. The terms were vague, and Stebbins was confused about whether he was referring to framing timber or lighter scantling. Stebbins noted that spruce would be very handsome for scantling, but for the frame, he would prefer hemlock.

> There are not with us many mills in which are sawed plates, sills, and beams for a large house. It may be done in some, but it is preferable to hew the long timbers. ... A next door neighbor of mine, owner of a good sawmill, will saw you timber for a frame, by a [mill?], with or without the long timber, and deliver it at [name of a port] in the Spring. This is a port acceptable and easy for ship navigation. He is an honest, honourable, punctual, and skillful man, and may be relied on for accuracy -- but he cannot promise much spruce. Price, he says is about the same by the thousand, as boards -- but if he selects the proper dimensions, and warrants it excellent, avoiding [rough?] edges, it must be a little more. Boards are 8 or 9 dollars -- variant. He will ask you more than what the same number of thousands of scantling might be provided for, but you will, in my opinion, be a great gainer by it.[90]

Although structurally sound, the barn has undergone some restoration and alteration. About 1950 a new floor was installed, and the facade of the south wing was undoubtedly altered at some time after the Blake drawings. The multi-colored slate roof now on the barn is unusual in the early nineteenth century and probably dates to the latter part of the century.

There is everywhere, as Silliman noted, evidence of careful and ingenious workmanship. For example, in order to achieve an even floor, the floorboards were cut with a gauge line of fixed depth, and then the undersides were adzed or planed across to this gauge line so that they would sit evenly upon the floor joists. The central

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89. ALS EW to John Morten, 12 August 1815, EWC Box 7.

90. ALS Josiah Stebbins to EW, 21 October 1815, EWC Box 7.

bay with doors at either end allows a carriage or wagon to be driven in one door, unloaded, and driven out the other.

From the evidence available it is possible to assign uses to two of the rooms on the barn's main floor. Signs of former whitewash, as well as mortices in ceiling blocks which held stall partitions, indicate that the southeast corner room was probably used as a milking room. In addition to the two yoke of oxen and the bay mare, there were three cows among the stock on the farm in 1826. With the exception of several large items which would have been on the main floor, all farm equipment was catalogued by room; regrettably, nothing is listed for the southeast corner.

"In the Store, N East Corner of Barn" were seven ox yokes, hay poles and hooks, hoes, shovels, axes, stone hammers, flails, pitch forks, four feeding boxes, two cider barrels, three flour barrels, and similar farm equipment. In the cellar of the barn there were two meat blocks and a cleaver, eight iron-bound empty hogsheads, six iron-bound casks of oil, ten old hogsheads, two tuns, eight old barrels, and a large tub.[91] Most of this equipment was probably used for slaughtering. According to local legend, the bars in the basement windows were installed during the Civil War to prevent the escape of prisoners kept there overnight while en route to Newgate Prison.

The Boarding House

On the basis of evidence uncovered so far, there is no clear, convincing date for the construction of the boarding house. Joseph Smith recorded that Whitney, until his marriage to Henrietta Edwards in 1818, "lived with his men in the boarding house."[92] At that time he moved to town, although he still kept his office in the original Talmage house. This presumably establishes a pre-1818 date for the building. Whitney's letter to Stebbins in 1815 (already noted) -- that he would be "occupied ... [that] summer in erecting some additional buildings near ... [his] manufactory" -- could suggest

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91. There are two old barrels still in the cellar.

92. To cloud the issue further, Smith said that the boarding house "stood [past tense] on the site of Whitney Avenue in front of the filtration plant." Presumably this is a reference to the road's pre-1860 alignment. It is nevertheless unlikely that the building has been moved.

this date.[93] However, there is little architectural similarity between the boarding house and the barn, presumably built in the same year.

Another complication is that, though the contents of the boarding house are listed (under the heading "Furniture in the Boarding House"), the building itself is not listed on the inventory, even though the buildings on either side of it -- the "new barn" and "five stone dwelling houses" -- are. According to the 1826 list, the building contained (probably on the first floor) andirons with shovel and tongs, a looking glass, a breakfast table with twelve chairs, a table in the school room,[94] and a table in the south room with probably six additional chairs. Also included were four "kitchen" tables, a chest, and a "tea tray and crockery, etc." Upstairs Whitney owned three candlestands, five bedsteds, and nine cotton sheets.

Stone Stucco Houses

The inventory lists only five houses built for Whitney's married employees. However, Professor Silliman's description of 1832 noted that others were constructed of wood after Whitney's death.[95] Munson pictured nine houses[96] (1828), and Blake, writing in 1886, said that there were

> ten or more dwellings besides the boarding house, erected for the convenience and comfort of the operatives. The village, built by the elder Whitney [the first "Whitneyville"], consisted of six houses of stone, covered with stucco. ... Some of these buildings were removed when the construction

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93. ALS EW to Josiah Stebbins, 4 June 1815, EWC Box 7.

94. According to Howard Stowe, superintendent of the water company's Armory Street plant, the school desks in the barn loft came from the school room in the boarding house. Evidently the school room was used during most of the nineteenth century.

95. Silliman, p. 256. They were, he wrote, "beautifully constructed and arranged upon one plan."

96. The evidence of Munson's painting (photo CT-2-7) is not authoritative, since the painting is believed to have been executed from memory some time later.

> of the high dam rendered a change in the direction of the road necessary.[97]

These buildings were demolished between 1915 and 1917.[98] It had been suggested that one or two of the houses now standing on Armory Street are examples of the later buildings Blake mentions, or that they were built to match them. The evidence in photo CT-2-23 demonstrates that in 1924 there were no buildings on Armory Street between the old pump house and Whitney Avenue.[99]

Regarding the construction date of these buildings, again the record is less than definitive. On 21 October 1817 Whitney wrote to his nephew:

> I have completed the roofs to two of my Buildings, and hope to finish the roofs of all of them before winter sets in -- the stonework is nearly completed & I hope to get up the chimnies.[100]

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97. Blake, p. 143. Photo CT-2-25 shows the present alignment of Whitney Avenue passing through the site of at least two of these houses in 1937. The earlier alignment (c.1860), which Blake mentions, and which is visible in photo CT-2-23, probably removed another two.

98. Unidentified news article, 9 September 1915, Dana Scrapbook v. 74, p. 23, NHCHSL.

99. It was subsequently confirmed by the Assessor's Office of the Town of Hamden, which gives to the houses the following dates: No. 1 Armory Street, 1950; no. 19, 1947; and no. 31, 1940.

100. ALS EW to E. W. Blake, 21 October 1819, EWC Box 7. If we can assume that he does not stucco the houses at the time of construction, then we have also the evidence of his letter from Boston to EWB [1 July 1820, EWC Box 8]: "I think it will be advisable to postpone whitewashing the Houses for some weeks -- till the plastering shall have had time to harden -- till August or September."

One final note relative to these houses: the 1852 map of Hamden (photo CT-2-8) shows a road apparently running up Mill Rock behind these houses. At places, amid the undergrowth, this road is partially visible today.

APPENDIX A -- WATER POWER, 1840-1860

In 1832 Benjamin Silliman described the water power at the armory:

> The great water wheels, which move the machinery of the manufactory, are constructed entirely of wrought iron, combining the greatest strength, durability, and beauty, with projective power like that of the fly-wheels in steam engines. They are elegant objects, especially when in motion.[101]

Despite Professor Silliman's warm praise for the water wheels, by the 1840s, there were serious problems. The younger Whitney by this time occupied both the second and third mill seats. The 1852 map of Hamden (photo CT-2-8) shows that the grist mill site was then occupied by "Whitney's Marine Clock F[actory]," and that the site of the paper mill (which stood as late as 1834) was occupied by "Whitney's Pistol F[actory]." Consequently much of the water power that the main armory depended upon was being used upstream. "I am suffering continually," he wrote in 1852, "from the inconvenience of having 2 armories instead of one. The power being insufficient in the lower factory."[102] In addition, the tide from downstream was backing up against the wheels for two or three feet, necessitating

> frequent stoppage of the works. Efforts were made to add to the effective power of these wheels by raising them 18" and enclosing the bottom portions with side planking so as to form a trough to guide the water. With these changes each wheel gave about 10 HP.[103]

Evidently these changes were insufficient, and in 1846 Whitney successfully petitioned the Connecticut legislature to erect a dyke with gates "to keep out the tide waters."[104] Six years later he was still plagued by water-power problems: "I am much embarrassed by the want of water at the Armory to carry on my works & could now do

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101. Silliman, p. 258.

102. EW Jr. note, 1 July 1852, EWC Box 13 (letter book).

103. Blake, pp. 139-140. Blake went on to refer to "polishing works" evidently run separately "by one little flutter wheel."

104. Private Laws of Connecticut (New Haven, 1857), v. 4, p. 1380.

nothing until October were it not for the upper water power [at the pistol factory]."[105]

Continued efforts throughout this period to improve the supply of water eventually culminated in the 1860 dam.[106] As early as 1853, Whitney was making plans for new water power: "My new factory will cost 3000-3500 dollars probably. ... I hope this will cover expenses on change of water power."[107] Rachael Hartley noted another reason for the construction of the new dam in 1860. "The vibration of the noisy waterfall [presumably as improved in 1820] was then so great as to seriously interfere with the delicate processes involved in the manufacture of firearms."[108] It was said that the noise could be heard in New Haven quite clearly when the wind was right.

On 14 July 1859 the firm of C. McClellan and Son, Eli Whitney, Jr., and the New Haven Water Company signed an agreement[109] concerning the new dam, and the property and rights of the New Haven Water Company. Among the stipulations included were that C. McClellan and Son and Whitney were to construct the works and to furnish all lands and privileges, and, in return for $350,000, would convey to the water company within one year all lands, buildings, privileges, rights, easements, etc., provided that the Whitney Arms Company might use the water above the height of twenty-eight feet in common with the water company.

The McClellans and Whitney would also construct for the water company the "Dam which has been already commenced at the Gun Factory ... to the height of thirty feet from the base line agreed ... ." The top

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105. EW Jr. note, 26 July 1852, EWC Box 13 (Business Diary, Bk. 1).

106. In 1853 the woodwork of the dam then stood fifteen and one-half inches above the stonework of the dam "measured from the top of the perpendicular stonework or face of the dam to the top of the planking." [Deed: Nathaniel Fort to EW Jr., 13 June 1853, NHWCo.] A year later Whitney noted in his business diary (book 1)that on 1 May 1854 the dam and his thirty-five-foot-square building were washed away. [14 June 1854, EWC Box 13.]

107. EW Jr. note, 25 December 1853, EWC Box 13 (Business Diary, Bk. 1).

108. Hartley, p. 279.

109. "Agreement: Charles McClellan, William C. McClellan, Eli Whitney, & New Haven Water Company," NHWCo.

of the dam would be "planked over and an apron ... provided ... sufficient ... to throw the water which may flow over the top of the dam, clear of the dam itself." They would also construct the pump houses and all necessary equipment, and all roads and bridges made necessary by the raising of the water level. Two reservoirs -- a receiving reservoir on the lands of Whitney "near his house" with a capacity of five million gallons, and a distributing reservoir on the lands of James A. Hillhouse holding not less than three million gallons -- were also to be constructed. Two thousand tons of iron pipe were to be furnished by the builders to the water company.

In the New Haven Water Company's First Annual Report of 12 February 1863, the Chief Engineer, Thomas N. Doughty, described in detail the works which had been completed by December 1861. "It must be acknowledged by everyone cognizant of the facts," he wrote, "that the works of the New Haven Water Company have been constructed in a manner which will compare favorably with any other works in the country."110

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110. The First Annual Report of the Board of Directors of the New Haven Water Company to the Stockholders (New Haven, 12 February 1863), NHWCo. Doughty included a detailed description of the pump house and water wheels which pumped water to the receiving reservoir on Sachem's Hill.

APPENDIX B -- THE DAM BUILDINGS

Because of the complicated history of the site, the complex of dam buildings next to the high dam is here treated in greater detail than the buildings previously discussed. Reference should be made to the plan (page 42), to which the following explanation applies.

1. Existing wall. Believed to be the river wall of the first raceway (1798). We assume this wall was also used as the east foundation wall for the milling shop,[111] 1860-c.1905.

2. Partially extant wall. Excavation here demonstrated that this was the west wall of the raceway mentioned above. The machine and filing shop (1798) has been drawn as starting from this wall. This is still to be confirmed.

3. Extant foundation. Dimension (17x34 feet) and position correlate with the 1915 site plan (photo CT-2-14), and thus the wall is believed to be an extension to the principal dam building built c.1861 (see no. 8, below). The extension was probably built by the Acme Wire Company about the time of the demolition of the milling shop, c.1905 (?).

4. Milling shop. Dimensioned (but not located) by William P. Blake as 30x45 feet.[112] This figure agrees substantially with the outline of the building given on the 1900 site plan (photo CT-2-13), and on this basis it is labeled and positioned. It was probably built about the same time as the three-story frame building[113] southwest of the main armory, since, like that building, it is shown in the 1880 engraving (photo CT-2-10) but not in the armory advertisement (photo CT-2-21) of c.1862. In this position the milling operation would have been able to take maximum advantage of the water power --

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111. See photo CT-2-13.

112. Blake, p. 143.

113. The building is shown on the site plan of 1900 (photo CT-2-13), but by 1915, it had gained a considerable addition; the building is labeled (photo CT-2-14): "Stock Room, Factory Office, and Assembly Building B-26."

available through the 36-inch penstock directly behind it from the dam, with its discharge into the old race beneath the building. (The other penstock supplied the turbine in the principal dam building.) The milling shop was one of the casualities of the Acme Wire Company.[114]

5. Machine and filing shop. This building is referred to within the main text (Section V). On the basis of two trap rock walls approximately 30 feet apart (see nos. 6 and 7, below), the north and south lines of this building have been drawn. By hypothesis, the east wall has been drawn at the west line of the race, and the west wall, 72 feet west of that.[115]

6. Extant wall. This short length of trap rock wall is 5 feet 8 inches in height. It may merge with the foundation of the later dam building.

7. Extant wall of varying composition. This construction, of trap rock, brick, and concrete, probably derives from work in 1799,[116] 1860, and 1905 respectively. From the turbine house westward there is no clear datable evidence.

8. Principal dam building. Constructed c.1861, 80x34 feet, three stories in height with 115 windows. A visitor to the factory in 1861 described a tour through it given by its designer and builder, Richard Treat Merwin: "It is composed of wood, three stories high, placed on a substantial stone foundation, measures ninety feet in length, forty-five in breadth, and having one hundred and fifteen windows, which give it a very unique and lively appearence. On viewing the various rooms therein, 1 found the work-benches and everything else designed for business, were all ready for

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114. The building is absent from the 1915 site plan (photo CT-2-14).

115. Through lack of information, the "T" form, visible in several illustrations, has not been included in this analysis. Though this extension was certainly built within Whitney's lifetime (1765-1825), it may possibly postdate the construction of the 72x30-foot rectangle.

116. The wall would not have been exposed at that time, as this tailrace is of late date.

the reception of the numerous workmen who are to commence their operations at the beginning of next week."[117] About 1905 the building was expanded to 110x34 feet with more or less substantial additions and/or sheds built along the north wall of the building. It was demolished between 1924 and 1931.[118]

9. East wall of the dam building. (See no. 8.) Measured out as 10 feet west of the milling shop.[119] Physical evidence is obscured here by a barbed-wire fence and modern fill.

10. North wall of the dam building. (See no. 8.) Except for sheds built against the north wall (see photo CT-2-22), this wall does not essentially change between 1900 and 1915. The lines drawn are projections of the existing foundations (see no. 3).

11. Modern turbine house. Cinder block construction, undoubtedly built when the dam building was demolished (c.1924-1931) while the main 1860 armory (to which a shaft still runs) still stood. The penstock supplying water probably dates at least to the installation of the present turbine, if not to the building of the dam. The interior of the north end of the turbine house bears further investigation, as its construction is a combination of trap rock, brick, and concrete. Possibly this is at least part of the original turbine pit blasted out in 1842 for the first turbine.

12. Boiler room. So labeled and located on the 1915 site plan of the Sentinel Manufacturing Company (photos CT-2-14 and CT-2-15).[120] From the time of its construction (c.1861, along with the principal dam building) and probably until its demolition (c.1924-1931), it featured an iron stack which rose

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117. Letter to the Daily Morning Journal, newspaper clipping c.1861, NHWCo.

118. Determined from photos CT-2-23 and CT-2-24. The building is visible on the former beneath the 1931 correction.

119. Determined from the 1900 site plan (photo CT-2-13).

120. Compare also with photo CT-2-13.

considerably above the level of the dam. One edge of the building still remains attached to the dam abutment; the rest is a cavity in the ground. Still extant is the wooden plate fixed to the face of the dam, which supported one edge of the roof.

13. Engine room. The partition separating this room from the boiler room varies according to whether the site plans of 1900 or 1915 (photos CT-2-13 or CT-2-14) are consulted. One wall is visible on the surface of the ground. Until about 1905 the structure was apparently separate from the dam building itself[121] by about 2-3 feet. It is drawn (10x36 feet) as it is shown on the 1900 site plan. The lines of the post-1905 projection of the dam building are partially determined by the addition of the engine room to the dam building.

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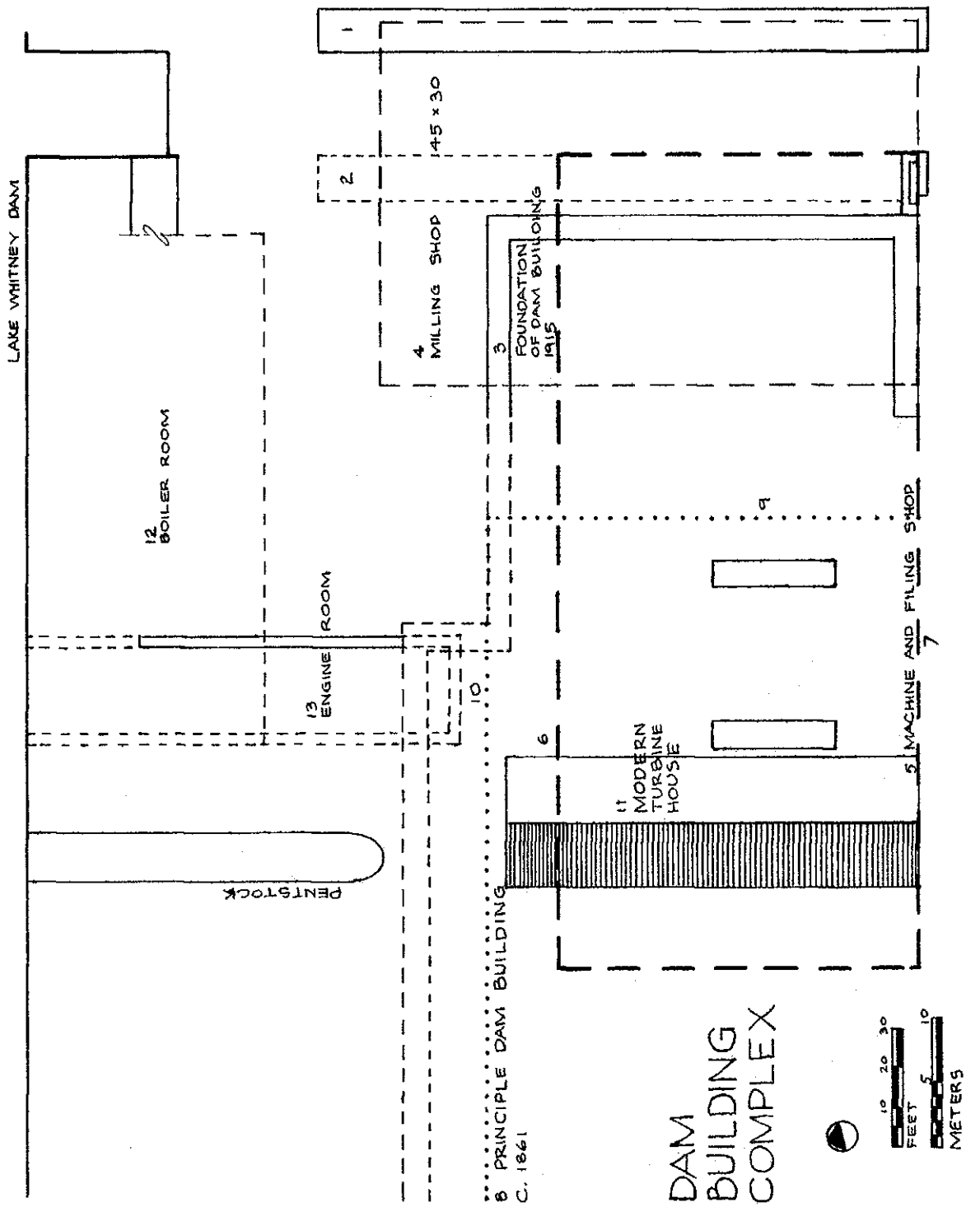
121. Compare the site plans of 1900 and 1915 (photos CT-2-13 and CT-2-14).


LAKE WHITNEY DAM
1
2
145 x 30
4
MILLING SHOP
3
FOUNDATION OF DAM BUILDING 1915
12
BOILER ROOM
9
13
ENGINE ROOM
10
6
11
MODERN TURBINE HOUSE
5
MACHINE AND FILING SHOP
7
PENTSTOCK
8 PRINCIPLE DAM BUILDING
C. 1861
DAM BUILDING COMPLEX
FEET
METERS

APPENDIX C

An Inventory of the Estate real & personal of Eli Whitney Esq^{r} late of New Haven, deceased, taken by Simeon Baldwin, Elisha Munson & James Carrington, duly appointed & sworn as appraisers.*

Real Estate

Tract No.	1.	A Building Lot containing about one & an half acres, fronting on Elm, Wall, & Orange Streets in New Haven with the Barn thereon standing	Dol. 6000.00
	2.	A House & Lot containing about half of an acre fronting on Chapel Street, bought of James Henry, in which R.S. Skinner now lives	3750.--
	3.	A House & Lot containing about forty rods fronting on Wooster Street in which Warham Bunnel now lives	750.--
	4.	The Lot adjoining containing about sixty rods with the barn on it	350.--
	5.	A Lot containing about one acre and a quarter on the road to Barnsville in the New Township	450.--
	6.	One sixth part of the Distillery on Water Street & of the Lease & appurtenances, under the agency of Col. Moreley	1000
	7.	A tract of Salt meadow near Neck bridge containing five acres & Eighty two rods ..	550
	8.	A Pew No. 11 in the North Church	470
		Slip No. in the Center Church	400

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* Folio 2, Eli Whitney Collection, Yale University Library.

9. A Tract containing Sixty acres, lying North of James A. Hillhouse & wife and between Hartford & New Haven Turnpike & second Quarter road in New Haven.....1800

10. A tract bounded southerly by the above piece of 60 acres, Easterly by Hartford & New Haven Turnpike, Westerly by second quarter road & Joel Fords & Northerly by Cheshire Turnpike, the Mill rock in part & by Stephen Ford & others including all the lands the deceased owned on Mill Rock, the whole about 110 acres.....4426

Buildings on the same, viz.

Three old Houses.....300

New Barn.....1250

Five Stone Dwelling Houses @ 1250 is.....6250

One Stone Store.....1000 8800

11. A Tract including all the lands owned by the deceased, between the Hartford & New Haven Turnpike on the west and East Rock range on the East and between the highway in front of Eli Dickerman on the North and Rock Lane so called on the South, containing about 101 acres including the Blake house.....4300
The Water privileges, Dam, Bridge, Manufacturing and other buildings & appurtenances thereon, as at the time of his Death, exclusive of machinery.....9500

12. A Paper Mill in Hamden, with the Water privileges, vats, engines & other machinery & appurtenances, and all the lands belonging to the deceased near to or adjoining the same, containing about 30 acres lying in Hamden on both sides of the Cheshire Turnpike including the dwelling houses & other buildings thereon.....4500

13. One half of the Millseat privileges & appurtenances, owned by the deceased, Stephen Ford & Jerre Davis, situate between the Gun manufactory & the Paper Mill including half the old Mill & half of the small Dwelling house.....400

14. Several Tracts being the David Potter farm. One tract lying east of the old Highway & North of Wm. Hubbard's farm, containing 27 acres, 1.15 rods with the Buildings thereon.....2550
One tract between the old Highway & the Hartford and New Haven Turnpike about 10 acres 1.27 rods.....475
One tract lying West of said Turnpike & south of Joel Ford & Son about 5 acres, .0.26 rods.....129
One tract in the east Meadow 7 acres. 0.14 rods.....320
One tract of woodland lying North from the Paper Mill containing 22 acres.0.16.....600

15. A Lot lying North of Mill Rock on the plain, containing one acre with a House on it, called the Howel Place.....300

16. A tract of Salt Meadow containing one acre, bought of Jessie Potter, adjoining lands of James Hillhouse, south of factory farm.....40

17. A tract of Salt Meadow and upland in New Haven near Neck Bridge lying easterly of No. 7. now in possession of Lyman Atwater, about 62 acres being part of a Lot formerly owned by John Pierpont..... 325

52,185

Personal Estate viz

112 Shares of Stock in the Eagle Bank in his own name, at the time of his Death then worth 12,000 dol now at this date 0,000
62 do in the name of his Executor then worth 6,200, now.....0,000
5 Shares Stock in Cheshire Turnpike @25.....125
3 do Hartford & New Haven do @15.....45

Stock on the Farm

2 Yoke of Oxen.....@82.50.....165
3 Cows at 17 is 51 Bay Mare 65.....116

Farming Tools viz

1 Left hand Plough 3.50 2 old plough irons 3..... 6.50
1 Large Harrow 10, large scraper 2, small do 5 17--
2 Carts @20 is 40 1 long Cart for Hay 20 60--
1 Stone Draft (except the Wheels) 20

In the Store N East Corner of Barn

3 Ox yokes ironed 7. 3 do not ironed 1.50 ..... 8.50
1 long Yoke .25 Haypoles, Ox basket & hand
Barrow .75 1--
a Lot of Scythe Snaths 3. 2 Bush scythes & snaths 2 5--
1 Cradle & Scythe 1.50 well scoop .75 ..... 2.25
Porthole scoop .67 2 hoes .60 ..... 1.27
2 Hay Hooks & 1 Clever 1.50 Spade .40 ..... 1.90
2 Pick Hoes .75 4 Shovels 1.50 2 Dungforks .60 ..... 2.85
3 Axes & 1 frost axe 2.25 Butte & Wedges .75 ..... 3.--
6 Stonehammers & 1 sledge 4.80
Whippletree & chain 1. sundry Blasting tools .50 ..... 1.50
11 Ox Chains & for Stone 22--
2 Flails .50 3 old rakes .15 ..... .65
1 Very large crowbar 5. 1 large do 2.50 ..... 7.50
3 Common do 6. 3 small Gun barrels .75 ..... 6.75
5 Pitchforks 1.50 Short ladder .25 ..... 1.75
3 Pike Poles .30 Dung hook .30 ..... .60
large Basket & half Bushel .25 2 large Grain tubs .83 .. 1.08
4 Feeding Boxes 1. 2 Cider Bbls .67 3 flour do .25 ..... 1.92
Hay scale Iron bar old screws & beam of wood 7.--

On the ground in front of the factory

1 Large red grindstone 15. 1 Do Burst 5. ..... 20.--
1 Smaller do sold to Col. Mosely 7.--
refuse do around the Cherry tree the whole 15.--
2 containing Cast iron boxes of lead 10.--
3 do square boxes & the lead 3.--

35 Feet of curbstone 2.50 800 Brick 5.....7.50
1 Large Log for a Shaft.....8.--

In the Chaise House

Old 5tick 5ulkey & Harness 10.--
2 5leighs & Harness 15. Axle tree for Chaise 4.....19.--
Old Stick Carriage & irons in the lot.....7.--
2 pair Horsecart wheels old & irons 2.--
Floor plank & boards over barn floor say 3000 feet.....60.--
Old Hhd & live oak Moss in barn store.....3.--

In the Barn Cellar

8 Iron bound empty Hhds.....8.--
6 do Casks with oil say 250 gallons at 40 cts.....100.00
10 old Hhds @ 2/3.33 2 Tierces @ 30 is .60.....3.93
8 old Bbls 2. dols 1 Large Tub .50 2.50
2 Meat Blocks & one Clever.....1.50

Furnature [sic] in the boarding House

1 pair Andirons 4.50 5hovel & tongs 2.--.....6.50
1 Looking Glass.....1.50
12 Chairs 4.50 Breakfast table 3.00.....7.50
1 Table in Schoolroom.....1.00
6 Chairs 2.-- Table in South room 1.--.....3.--
Caster with Bottles 4.--
3 Candlestands 1.50 5 Bedsteads 10.--.....11.50
9 Cotton Sheets 4.50 Kitchen Table. 25 Chest .25.....5.00
2 Kitchen Tables 4 dols. old do...34.....4.34
Tea Tray & crockery old.....1.--

In the factory garret

10 Bedsteads @ 2.00.....20.--
4 5traw Beds 2. dols Mattress 4. dols.....6.--
4 barrels with plaster.....4.--

Under the Office

150	Gun 8arrels burst @ .17 cts.	25.50
12	Tons Scrap iron by estimation @ 35 pr. ton	20.--
	Demijon and say 3 gal. vit. acid	4.--
1	Bbl with 2 gal oil in it	2.50
Say	75 lb White Lead 9.37 50 lb Black Lead 2.00	11.37
1/2	Bbl spruce Yellow 5. State for paint 1.	6.--
	Machinery for grinding paint and apparatus	25.--
680	lbs iron in one inch squares and flat bars @ 5 cts.	34.--
	372) flat 308) 1 in. square	
26	old iron @ 3.50 _____[?]*) removed	
	Old Ramrod Machine @ 4 cts _____[?]*) to	
	Wing Gudgeon @ 5 cts*) Museum [?]	

In the Office closet

1	Elegant prize musket	25
1	Model Musket Charleville	10
1	do Maubeague	10
1	do Philadelphia	10
1	do Queensfusee	10
5	Muskets @ 12 is 60	60
1	Barrel browned	2
		53,838.96

In Office

1	Eprovette	9.--
3	Handsaw iron frames	2.--
1	Large Spatula	.50
	Moulds for Metal Tubes	25.--
2	Ramrod planes, gouges & guages [sic] &c.	2.--
	Bullet moulds 1.50	1.50
10	lb Block tin in scraps @ .18	1.80
110	lbs lead in office & other places @ 6	6.60

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* These items crossed out on original manuscript.

In office Bedroom

1 2/3 Doz. 10 inch rasps @ .17	3.53 1/2	
2 1/12 do Small files @ 8	2.122	
1/3 do 11 inch smooth flat do @28	1.47	
10/12 do 12 inch do @30	3.13	
1/12 do 13 inch do @32	.33	
1 7/12 do 13 inch ruff @26	5.14	
1 2/3 do 12 inch flat do @23	4.79	
2 5/12 do second cut files @24	7.25	
3/4 do 10 inch flats @ 16	1.50	
2 1/2 do Bastards @15	4.68	
2 3/4 do 8 inch do 9/6	3.25	
2 1/2 do 7 inch do 7/6	2.33	
3 1/2 do 9 Inch smooth 22/	9.63	
1 7/12 do 8 do do 20	3.95	
2 do 7 do do 18	4.50	
10/12 do 6 do do 16/	1.67	
5/12 do 10 Inch round 20/	1.04	
10/12 do 10 do Bastard 15/6	1.60	
2 1/2 do 9 do do 10/6	3.83	
3/12 do 8 do smooth 12/	.37	
3/12 do 5 do 4/8	.14	
1 1/3 do whipsaw files 10/6	1.73	
1 2/12 do square 7 inch files 7/6	1.08	
1 1/2 do do do 6	1.12	70.89
1 piece webbing	2.06	
6 gauges .75 - 4 hawksbill chisels	1.75	
2 stamps Connecticut, Carolina	1.50	
18 Plane irons new & old	1.12 1/2	
5 Cannon Locks old brass	.60	
1 Door Lock and Key & 24 catches 1. Trunk handle .25	1.25	
A Lot of Tools in Draw viz 60 Chisels etc.	9.00	
4 Gun Locks solid pans	8.00	
1 do Brass pan bevelled	2.00	
2 do Brass pans	5.00	
6 do do new formed Bridle	16.50	
2 doz. vests at .06 and 5 1/2 gilt coat buttons @ 20	1.22	
1 Paper cast iron Hooks & Eyes	1.00	
3 bunches fine brass wire	.40	51.50

In the Machine & filing shop

	Lathe & Tools appurtenant	25.00	
	Milling Tools & Nitching Machine	75.00	
	Drilling Machine, caps & appurtenances	400.00	
	Shears & appurtenances - old	150.00	
	Do large cast iron - New	200.00	
	Screw Machine & appurtenances	100.00	
	Stamping do & Tools	60.00	
	Large Horse head Shears	40.00	
	Machine for polishing barrels	22.00	
3	Large Stoves & Pipes @ 18	54.00	
	Iron-top-oil table & appurtenances	6.00	
	Breeching Vice & Tools	8.00	
14	Vices at 8 dol.	112.00	
	Turning Wheel	5.00	
	Polishing Machine & Wheels	75.00	
3	Screw Plates, Taps & Dies	30.00	
	Stake & Block for cutting files	5.00	
1	Anvil 10. 2 Stakes in 6 blocks 5.	15.00	
1	Stake without Block	2.00	
6	Iron Braces 18. 12 Vice Clamps 5.	23.00	
3	Hand Vices 2.50 - 3ppr. pliars [sic].75	3.25	
1	Iron mortar & pestle	1.00	
29	Hand Hammers	7.50	
10	Large iron Clamps	15.00	
	Large & other reamers & Taps	5.00	
1	pr Spring Pliars	1.20	
	Spring tongs	.40	
2	Drawers with rimmers etc. to make swedges	18.00	
	other Tools on filers benches	25.00	1483.35

On the lower floor of same building

1	Grindstone & shaft & Box	25.00	
2	Small do & Pullies [sic]	14.00	
3	Vices @ 8 dol	24.00	
	Machine & Tools for fine boring	18.00	
2	Trip Hammers & irons	25.00	106.--

In Garret Store over old trip Hamr Shop

	A Lot of Caps refuse	2.00	
	A large Box of Tools laid aside,several)		
	small Boxes do & on shelf say 500 1b)	30.00	
	Large tray with muzzles	2.50	
	Moulds for casting blanks for		
	Cottin Gins, costly & once valuable	12.00	46.50

In the inner Store under the Stocking Shop

14	Musketts with Bayonets @ 8 dol	112.00	
3	do no Bayonets @ 7	21.00	
6	do condemned @ 5	30.00	
1	Bbl .75 2 do iron bound .75	1.50	
2	Axe helves .25 Demijon & Jug .30	1.05	
4	Cast iron forcing pumps @ 8.	32.00	
1200	1b old Copper @ 16 cts pr 1b	192.00	389.55

ln North room same building below

	Bench Vice 8. Cross cut saw 7.	15.00	
	Hayknife 1.25 Froeiron .50	1.75	
	Broad axe 2. 2 Hatchets 2.	4.00	
	Large Shaving knife .50 Brace & 50 bits 7.	7.50	
16	Augurs different sizes	6.00	
1100	Pickets for fence	25.00	
2300	feet pine boards sawed for M. [usket] Boxes	35.00	
30	Bench & Moulding Tools	20.00	
12	Gouges & Chisels - sizes	6.00	
1	Framed Compass Saw	.75	
3	pr. rack & pinion compasses	2.25	
2	Bevils [sic] 1 wood & 1 iron	1.00	
3	Wood squares	2.75	
1	lron square 1.75 large do wood 1.	2.75	129.75

1n South room

1	Augur for boring logs	6.00	
2	Boxes Bellows nails	1.50	
5	pr large Hinges & hooks unfinished	4.00	
45	Squares 7 by 9 glass	2.00	
50	do 6 by 8 do	1.50	
	A Lot of broken Vices	5.00	
	Bayonet Vice & Stake	7.00	
	Box of old lead say 60 lb.	3.60	30.60
1007	lb rolled iron for bands at 7 1/2¢		75.52
110	lb Square iron bars in bundle at 5¢		5.50
1030	Bar iron for Bayonet Soc at 7¢		72.10
2	Bars English blistered Steel say 60 lb at .16		9.60
1979	lb Nail rods		123.68
	Bunches swivel wire 41.		6.84
208	lb Milan Steel at 10¢		20.80
20	lb Block tin in Bar & in pipes at 20		4.00
29	lb Wrench & Socket at 6		1.44
81	lb Crowley Steel in pieces at 6		4.86
80	lb in 9 Square bars Steel W 71 + at 8¢		6.40
192	lb (6 bars American blistered @ 7)		
	(7 bars from faggots 7)		13.44
107	lb 8 do Sockit iron 7 1/2		8.00
25 1/2	lb in 2 pr bar iron 5		1.37
57	Side Bulls hide Leather 16 at 30¢		17.10
48	lb Leather for Belts in box @ 20		9.60
1	Sheet Russian iron 13 lb at 12 1/2		1.62
	Leveling Instrument for carting in Grindstone Boxes, with 2 spindles	7.00	
1	pr small old scales	1.00	
1	pr Chest Hinges	.25	
4	Cast iron boxes for case hardening	2.50	
	sundry pieces Mahogany over head	6.00	
1	Chaise axle tree do	4.00	
	A sett figure brands no. 10	2.00	
	Copper Tube for hardening rods	3.00	
	Box Emery in the Store	2.00	
5	lb scrap sheet Copper	1.25	
5	lb Sheet Lead	.35	
	Box with Asphaltum	1.00	
	Machine for twisting wipers	1.50	
	pr pincers for Leather	.40	

6	English & 1 pattern _____ [?]	4.50	
1	Bellows pipe	1.50	
29	Scovil Gun Barrels ground	29.00	
	Lot of do not ground	12.00	
73	do condemned some bored + some not bored marked X	5.50	
	Unfinished Steelyards	2.00	
25	lb Glue in Bbls @ 25	6.25	
	Box with scraps bellows leather say 25 lb	5.00	
20	Kegs & old casks	1.20	99.20

In Second Story of Stocking Shop

869	Gun Stocks at .20	173.80	
3	Bench Vices @8	24.00	
1	large Stake & Block	3.00	
	Grind Stone & Frame & Crank	5.00	
4	Set Tools for Stocking with Benches & Stands	40.00	
1	Turning Wheel & Crank	5.00	250.80

In Garret of Stocking Shop

400	Pistol Stocks at 5¢	20.00	
150	lb Cilinder [sic] ring centers	3.00	
2	Piles pine & Bass lumber 10 pating 3	13.00	
1	pr Bellows boards square front etc.	12.00	
2	Common do & irons	20.00	
	Lathe 1. & Whipsaw & broken frame 4	5.00	
2	Pullies & axle 5. Cillinder jointer 2	7.00	
	Shingle jointer Pully & shaft	5.00	
	Bellows Lever & shaft of iron	2.00	
8	Small Grindstones	4.00	
say 600	lb. Sheet iron @.10	60.00	
	Large Crosscut Saw broken	.75	
27	Empty Powder Casks	3.00	154.75
	A large quantity old patterns wood		

In the Forging Shop

7	Pair Bellows without Leather as at his _____[?]	84.00	
7	Anvils of wrought Iron	70.00	
4	do for swedging	22.00	
8	do do of cast iron	85.00	
8	Sledges 10. 26 Hand Hammers 8.	18.00	
13	Sett Hammers	5.50	
7	Slide do	2.50	
2	Smith Vices large	18.00	
1	Set Bayonet forging Tools	50.00	
1	Bellows pipe	1.25	
1	Set of Tools to make Tumblers	25.00	
5	Swedging Vices	50.00	
	Guard plate swedges	15.00	
	Upper jaw do	5.00	
	Heading Stake 5 Heading Tools & Slides	15.00	
	Knee & Slide & Dies for ramrods &c.	11.00	
	Cast iron Shears large & new	200.00	677.25

In Coal Houses

5075	Bushels charcoal @ 6		304.50

In the Lumber Yard

2	piles six sided Brick for paving	18.00	
	a pile of cedar posts & Stakes	2.50	
	a large pile do in S.W. corner	18.00	
	a Lot of Timber, Blocks, Wood, &c., say 10 cords exclusive of posts & rails for fence	20.00	
	Old Lumber in Lot South of Peckham House exclusive of iron	15.00	
	One for Millstones in same field	25.00	
	Oak & pine Lumber near the Bank	4.00	
15	Cedar poles in the road	2.50	105.00

In the old Store in the lumber yard

27	Old windows from Blacksmith shop		7.00
2	T Gudgeon 205 lb at 4¢		8.20
2	tons old Iron at 3.50		140.00
269	lb New in 2 inch & 1 inch bars		13.45

In the White Stone Store

1	Large Cotton Gin with frame)	300.00	
1	do without frame)		
3	Cotton Gin Models	25.00	
	Rumfords Cooking Apparatus	50.00	
1	hhd. by estimate 150 lb piked moss	15.00	
2	Large Boxes old files say 2500 lb at 8¢	200.00	
1	Keg condemned bayonets	10.00	
1	old Brass Kettle say 12 lb	2.00	607.00
537	lb Lock plates old pattern at 5¢	26.85	
73	lb Screw Drivers 10 to pound ?		
	[10¢ pr. lb.]	7.30	
160	lb Wipers unfinished 20 to lb ? 15¢	24.00	
46 1/2	lb Guard Screws 3¢	1.39 1/2	
32	lb small screws milled 3	.99	
31	lb do not milled	.62	
31	lb Hammer pins milled & turned at 4	1.24	
64	lb ramrod heads forged only 4	2.46	
42	lb Heel plate screws forged 2	.84	
No.334	Side pins finished each @ 1.	3.34	79.03

refuse work as sold to Col. Buel

183	Musket Barrels @ 50	91.50
262	do 65	170.30
151	do 73	109.50
413	Bayonets 20	82.60
300	Sets band Springs @2	6.00
55 1/2	lb Lock Work @ 4 is 2.22 1/2 55 1/2	
	rod heads 2 ?	3.33 1/2

59	lb small pins @ 4 is 2.36 -- 14 lb rod Heads @ 2 is .28	2.64	
35	lb Brick pins @ 2-1/2 is 87-1/2 -- 44 guards @ 10 is 4.40	5.27-1/2	
450	But plates @ 4-1/2 is 20.25 -- 406 Rods @ 12-1/2 is 50.75	71.00	
	Side plates .75 144 barrels @ 35 is 50.40	51.15	
10-1/2	lbs Brass pans @ 30 is	3.15	
1778	lb Lock works @ 2 cts is	35.56	
321	Barrels @ .73 is 234.33 broken rods 7.	241.33	
144	Grinding rods & mellow heads @ 2-1/4	3.24	876.58
600	Refuse Stocks @ 5¢	30.00	
200	Barrels @ 10	20.00	
8	Bayonets @ 18 is 15.30 -- 45 do @ 28 is 12.60	27.90	
4	Boxes for packing @ 50	2.00	79.90

as sold Asa Waters

27	Barrels @ 37-1/2	10.12	
1	do @ .65 & 1 @ .50	1.15	
107	do @ 5 is 5.35 -- 462 @ 6 is 27.72	33.07	
2	Boxes for packing @ .50	1.00	45.34

as sold Mr. Downs

3	Barrels @ 1. is 3. -- 2 Locks @ 2. is 4	7.00	
3	do @ .75 is 2.25 -- 6 guards @ 1. is 1. [sic]	3.25	
12	broken rods @ 10 cts	1.20	
24	Side pins .17 cts -- 6 sets bands .75	.92	12.37
		$ 60,047.74-1/2	

In upper loft of Barn Store in New Township
[Tract No. 4?]

	A lot of Maple Scantling, Georgia Pine & other Lumber over head	5.00	
473	Feet Clapboards	4.75	

	Maple boards & scantling	2.00	
3	Mohagony Plank 190 feet	30.00	
10	Sticks do 250 feet	40.00	
4	Pattern boxes & 17 refuse Gunstocks	2.00	
1	Cotton gin old fashioned	10.00	
3	Bbls seed Cotton - damaged	2.00	
	Chest & Table .75 Casks, crate etc. 50	1.25	97.00

On lower floor

2235	feet Georgia Pine scantling	65.00	
	Cordage New & old	12.00	
	Refuse Cotton in 2 hhds.	1.00	
	Pistol Stocks estimated at 300 at 5¢	15.00	
945	Gun Stocks in Chamber @ 20	189.00	
3165	do below @20	633.00	915.00

In the Wooster Store in New Township

	Refuse Mahogany in North Garret	5.00
	do South do	20.00
	Maple Lumber	1.00

On second floor

1	Joiners bench 1.50 Pine lumber 1.50	3.00
6	Cotton Machines on frames	150.00
1	Box with cast iron 1. - 3 Jugs .50	1.50
7	Unfinished writing desks with trimmings in office at factory @ 5.	35.00
3	Forms for Cilinders)	
1	do with lever) in West Garret	2.50
75	lb Iron Castings at 1 1/2	1.82
1	Box Bristles - damaged	4.00

In Front Chamber

1	Machine 1. Cask & Box 1.50	2.50
1	Large Lathe & appurtenances	4.00
620	Gun Stocks @20.	124.00
1	Tap for cutting Screws large	1.50
1	Screw plate	3.00

On lower floor

4	Jugs - 4 quire coarse paper & old bedstead	1.00
33	large 33 less & small boxes supposed to contain 66 Cotton gins & frames @25.	1650.00
14	Breast irons)	
75	coupling Boxes) say 667 lb cast iron at 16	10.00
5	Arbors & pullies	3.00

In Kitchen

1	Large Lathe 2.50 Wash Bench 1.	3.50	2025.62
			63,085.37

New Haven Jany 10, 1826

Simeon Baldwin)
Elisha Munson) appraisers under oath
Jas. Carrington)

HABS
CONN,
5-HAM,
3-

PART 2: REPORT ON THE ARCHEOLOGICAL INVESTIGATION

Introduction

The 1974 excavation of selected portions of the Whitney Armory Site in Hamden, Connecticut, was a preliminary effort to answer questions about those Eli Whitney manufacturing processes which had not been adequately covered by contemporary historical sources.* It was believed that archeological excavation, in conjunction with historical research, would be instrumental in locating buildings and exposing diagnostic structures and artifacts within them and in generating new questions and problems for future research.

Since none of those persons involved in the archeological excavation had any previous experience in historical or industrial archeology, the techniques employed throughout most of the field season were those developed by archeologists working on prehistoric sites, i.e., the careful removal of stratigraphical layers by shovel, trowel, and brush with complete records, maps, and photographs to ensure the eventual proper interpretation of all deposits which had been destroyed during removal. Shortly before the termination of the excavation, a backhoe was employed in the rapid excavation of a portion of the site, after which techniques were modified somewhat, in order to expose as large an area as possible, prior to the backfilling of the site. The use of the backhoe will be discussed later in this report.

Plans made during the spring of 1974 had called for the placement of short test trenches through a broad range of deposits and buildings, within both the factory and farm portions of the site. The decision was made by the Project Director early in the summer to concentrate only on three key areas, these being: 1) the 1860 Main Armory Building; 2) the area at the base of the present dam,

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*Historical information in this report is based on Part I.

containing Whitney's 1798 factory building and millrace, as well as a variety of later structures; and 3) Whitney's original Forge Building to which was devoted the greatest attention since its foundation had been but slightly altered by later building activity. All structures were completely below ground, the only exception being portions of the walls of the millrace. The work carried out in these three key areas will be briefly summarized here, whereas the complete records and photographs from these excavations are contained in a set of five volumes which are available for study in the library of the New Haven Colony Historical Society.

Both this present report and all records which are on file from this Project are very preliminary in the sense that little serious effort has been made to analyze and derive interpretations concerning the mass of raw data uncovered during these excavations, nor to rigorously analyze the sizeable body of artifacts which was excavated throughout the Project. For this reason, this report will be principally a descriptive one, with interpretations being far fewer than would be normally expected in an archeological report. It is hoped that eventually a more complete synthesis will be written, incorporating the necessary proportions of both archeology and history, in order to impart a greater cultural significance to the results of this summer's work.

The Main 1860 Armory

A single trench of five 2x2 meter test pits was laid out with an east-west orientation across one corner of the 1860 armory building (built by Eli Whitney, Jr.). The location of the perimeter of this building was already reasonably well-known from existing maps and this trench (termed Trench I) was designed to run from a point within the body of the original 2-1/2-story armory building, across one of its foundation walls and then for a short distance to the west, running underneath a 1-story wooden addition onto the building (added early within the present century).

Excavation revealed that the placement of the building's walls was generally as had been expected, i.e., Trench I exposed a portion of the northwest corner of the 2-1/2-story building, as well as a small stone and concrete pedestal c. 3 meters to the

west, this presumably serving as a roof support within the later addition. Of particular interest was the thickness of the outer foundation wall on the northern side of the building, for on this side towards the dam, the wall was at least twice as thick as on the western side of the building. The original photographs of the main armory had shown a substantial building of brick set upon a stone foundation and the large quantities of bricks found within the fill suitably attested to the ultimate collapse of tbe superstructure into the foundation wben the building was leveled in 1949. Trench 1 had also been designed to include a short portion of an excavation by Professor Richard Ellis and a Yale archeology class which had excavated within the building in the spring of 1972. Slightly over 2 meters at the eastern end of Trench 1 was within the backfill from Ellis' excavation and it was this eastern end of the trench (below the original 1860 building) which contained the great majority of the bricks and artifacts from Trench 1.

The stratigraphy across the trench consisted of rather uniform layers of thick fill with the upper layers being nearly sterile (suggesting that this hard-packed brown earth and gravel had been brought in by dump truck and spread as fill over the entire area in order to create a new land surface over tbe remains of the building and its foundations). Only within the main building's foundations (the east end of Trench 1) was there a significant change in the stratigraphy and here the rubble from the collapsed building extended from c. 1/2 to just over 1-1/2 meters down. However, no layer within the trench contained any appreciable evidence for the making of armaments and the only artifact which would even suggest a connection between this building and the making of guns was a single gun trigger within the rubble at the east end of the trench. No machinery which could be associated with the making of guns was found, nor was there any evidence for a cellar underneath this part of tbe building. Taken as a whole, this trench's artifacts (including much window glass, pieces of iron and nails, coal, slag, bricks, wood, wire, tarpaper, slate roof tiles, an 1856 half dime, a few oyster shells, etc.) included little which dated to the initial construction of the building and even less which would have enabled one to interpret the function(s) of the building, had there not been available historical records.

The Base of the Present Dam

One of the major objectives of the project was to locate the site of Eli Whitney's 1798 factory building which had been the source of the firearms which Whitney supplied under contract to the U. S. Government. Although the trap rock walls of the millrace, which once contained the water wheels powering the factory, still stand, unfortunately there are no remaining walls or structures which are recongizable as pertaining to the factory itself and there are no remaining maps showing the position of the building relative to the millrace. Visible next to the millrace are portions of the foundations of several later buildings and slightly to the north the dam, which now regulates the flow of water from Lake Whitney into the Mill River (replaced Whitney's original 6-foot high dam into 1860). Because the later dam need not have been erected precisely over the site of Whitney's earlier dam, the location of the new dam did not provide any additional clues regarding the location of the factory building.

In testing for the factory's foundations, a grid system (designated Grid 2) was laid out over the area at the base of the present dam. ("Grid 1" had been assigned to a small excavation undertaken by Yale University in the farm portion of this site in late spring, 1974.) The datum point for the grid--NOEO--was arbitrarily placed just north of the southern foundation wall for a 1915 addition onto an 1861 building which had replaced Whitney's earlier building. It was known from historical sources that the 1861 building had been erected in approximately the same area as the 1798 building, but what was not known was whether the foundations or any artifacts from the earlier building were still intact or, alternatively, whether they had been completedly removed by later building activity. An additional problem, of course, was the difficulty in assigning any excavated foundation walls to their proper building period.

Grid 2, Trench S1E4.5

The first testing in this area consisted of a narrow 1 meter wide trench -- Trench S1E4.5 -- placed west to east across the 1798 millrace and running from the eastern edge of the 1915 foundation wall to the western edge of the eastern millrace wall; the total length of the trench was approximately 4-1/2 meters and it also commenced c. 4-1/2 meters east of the datum point. It was hoped that the millrace would have served as a rich depository for factory refuse; additional objectives were to determine the total

depth of the millrace, to learn what its bottom had been lined with, and to find any evidence for the western interior millrace wall also having formed the eastern exterior wall of the 1798 factory building. The results in all cases were inconclusive because the upper layers in the millrace consisted of a multi-colored mixture of several different types of fill. Nearly all the artifacts were relatively recent (glass, wood, animal bones, slate roof tiles, bricks, fragments of iron, wire, tarpaper, ceramic insulators, a single large grinding stone, etc.), whereas the deeper layers contained few artifacts other than broken glass, scraps of wood, and a great many bricks. (Most bricks were unlabeled, but there were several stamped with either: 1) "C. Anness & Son -- No. 1 -- Woodbridge, N.J.," 2) "Boiler No. 1", or 3) "M. D. Valentine & Bro. -- XX - Woodbridge, N.J.".)

Due to the presence of a high water table, it was impossible to excavate below c. 1-1/2 meters, still some distance above the bottom of the millrace, but the occasional fragments of wood at this depth at least suggested that the bottom may once have been lined with wood. At some point after the millrace had fallen into disuse, it had been partially filled with bricks and rubble, after which it had slowly filled with earth until the surface of the debris in its channel was as high or higher than the actual trap rock walls on either side. During the course of the excavation, the surface and eastern side of the western millrace were exposed, but it proved impossible to excavate downwards on the western side of the wall, and so it could not be determined whether the factory building itself had been located on just the other side of the millrace wall. Also, no remnants were found of any of the water wheels which had been used in this channel, although it is, of course, possible that a larger excavation might have been more productive in this regard.

Grid 2, Square N7E0

Square N7E0 was positioned just west of the northwestern corner of the 1915 addition onto the 1861 factory building. It was hoped that if the northern wall of the 1798 building roughly coincided with the northern wall of the later building, this 2-meter-square test pit would either be atop the trap rock foundation for the early wall or else would be slightly inside the factory. However, beneath a thick black layer of topsoil (containing numerous recent artifacts comparable to those in Trench S1E4.5, plus a sizeable number of bullets), the excavation bottomed atop a recent concrete floor in the south and atop randomly positioned stone rubble in the north. Although at least part of this rubble was trap rock and may at one

time have formed a foundation wall, its present lack of any orientation was totally unenlightening. Subsequent removal of many of the rocks failed to reveal more than a few artifacts and limited testing underneath produced only sterile layers of sand.

Grid 2, Square S2E0

Square S2E0 (2x2 meters) was placed partly atop and partly to the north of the southern wall of the 1915 addition, the assumption again being that this would probably be at least partially inside the 1798 factory building. Stratigraphically, this proved to be radically different from either N7E0 or S1E4.5, in that the top layer consisted of a very deep deposit of bricks, recent artifacts, and little earth, with this bottoming atop a thin layer of concrete which had formed the floor for the 1915 building. Removal of the floor and continued excavation revealed portions of one or more trap rock walls underneath, oriented roughly parallel to the trap rock walls of the millrace. Because there were few significant artifacts beneath the concrete floor, none to which a date could be assigned, it was impossible to directly associate this wall(s) with any of the buildings which had been in this area. However, the strong possibility remains that this may have been a part of the first factory's foundations and any further excavations in this area should include continued excavation along the length of this wall to determine its extent and function.

Trenches 4-South and 4-North

Due to the inconclusive nature of the test pits within Grid 2, the decision was made by the Project Director to trench along the western edge of the western millrace wall, looking for any indications that the 1798 factory building had utilized the millrace wall as its own eastern foundation wall. Obviously the location of a substantial trap rock wall running west from the millrace wall was the desired objective, but none was found. (It should be noted that while the historical records fail to state whether the factory wall was also the millrace wall, it is safe to assume that the factory would have been built in very close proximity to the millrace in order to permit the most efficient transmission of power into the factory.)

Trench 4 was laid out as a 1 meter wide trench running along the eastern edge of the foundation wall for the 1915 addition and spanning the narrow space which existed between the edge of the

1915 wall and the western edge of the 1798 millrace wall. Because of the angle formed by the 1915 wall, the magnetic orientation for this trench was c. 34° east of north, making it impractical to incorporate the trench within the Grid 2 layout which had already been established over this part of the site. Because Trench 4 was designed to run the entire length of the millrace wall, this obviously necessitated crossing the already excavated western end of Grid 2, Trench S1E4.5, and this meant dividing Trench 4 into both southern (4-South) and northern (4-North) portions. Trench 4-South ran slightly over 2 meters from the southern edge of Trench S1E4.5 to the southernmost end of the millrace, whereas 4-North ran slightly more than 8 meters from Trench S1E4.5 northwards to a point short of the present dam, ending against a small stone wall (resting atop bricks on the western side of the millrace -- i.e., a comparatively recent wall). Although 4-South was short enough to be excavated as a single unit, Trench 4-North had to be subdivided into 4 test pits (each being 1x2 meters) and these were designated Squares N0E0, N2E0, N4E0, and N6E0.

The excavation of Trench 4 exposed stratigraphy and recent artifacts quite comparable to Trench S1E4.5, as well as a total of 5 additional grinding stones, all in 4-North. It is interesting to note that 3 of these stones were atop the western millrace wall (2 were resting in fill at the bottom of the trench) and that these were aligned in a relatively straight line with the single grinding stone already exposed atop the wall in S1E4.5. At the suggestion of the Project Director, the team did not screen the earth from Trench 4-North for artifacts and consequently few were saved.

Although Trench 4 failed to reveal any portion of the 1798 factory wall, it was impossible to carry out any additional testing for the factory, due to insufficient time remaining. Consequently, it is still unknown whether: 1) the foundations were completely destroyed and removed at some point in the past; 2) the factory was located farther to the north and can eventually be located by testing closer to the base of the present dam; or if 3) some portion of the current excavation was within the factory but simply could not be recognized as such (i.e., in the case of Square S2E0).

The Forge Building

The excavation of Whitney's early forge building (historical records suggest that it may have been constructed as early as 1804) was given a high priority at the start of the field season. Several factors prompted the decision to concentrate principally on this single structure: the building's early date, the reasonably intact nature of the original foundations (it was believed that few major alterations had occurred after its initial construction), and also the accuracy with which the building's location could be predicted. (Portions of the building had remained standing until at least the middle of the present century and its location was well documented both by maps and photographs.) After the Whitney family sold the property, the forge building was used by a series of later industries (this was true for several of the original Whitney buildings). Although the sources of power for the building had changed, as had many of the industrial processes carried out within, it was nevertheless hoped that most of the original foundations had been left unaltered and that a large scale excavation would produce information concerning the activities or processes in the early Whitney works, information which the historical sources could only partially provide. (Refer to HAER drawing of forge building, sheet 1 of 1, to understand the relationship between each of the test trenches and the structures which were exposed within the foundations.)

Prior to excavation, the approximate outline of the forge building was laid out with string markers on the surface of the ground (existing maps showed the outline for the building, but were inadequate in showing the placement of internal structures). The only serious difficulty in excavation would be the removal of a recent, thick layer of concrete laid within the entire building. As the summer progressed, this removal was carried out successively with a sledgehammer, a jackhammer, and finally, with a backhoe which ripped out the concrete in huge chunks.

Excavation was started on the southwestern corner of the foundations, searching both for a forge platform which early sketches had suggested would be in this corner and for a portion of the wall of the tailrace as it curved away from the southern wall of the building before running southwesterly to the Mill River. It was already known that the water coming from the 6-foot dam (north of Whitney's millrace and 1798 factory building) had run through a long flume to the north end of the forge building, passed through the building, and then exited on the south through a stone

tailrace which carried the water back to the Mill River; the details of this process plus any information on the water wheel(s) within the raceway were, of course, largely unknown.

Trench 2

The first two 2x2-meter test pits placed in the southwestern corner of the forge started from a datum of NOEO and were given an east-west orientation. These first pits were placed within "Trench 2" and this designation was maintained, even though continued digging to the north, south, and east of this datum caused this excavation to lose its trench-like character. Initial digging within Trench 2 almost immediately exposed a stone forge platform (precisely where the sketches had placed it) and then expansion of the trench to the south and east exposed a lengthy segment of the southern forge foundation wall, a very broad door threshold in the center of the southern wall, and a short segment of the tailrace wall as it began to curve away from the foundation wall (into which it merged). The surface of the tailrace wall commenced c. 50 cm. below the top of the southern foundation wall and then ran downwards to a total depth of just over 1.70 meters, at which point the wall ended a short distance beneath the current ground water level. Most of the fill within the channel of the tailrace consisted of loose, black cinders and earth (with only occasional patches of other types of fill) and it was within this channel, covered at the bottom with flat (and badly broken) wooden planks and a thick layer of badly decomposed leaves, that most of the artifacts from the forge were found. These artifacts included a great many fragments, of iron, wood, glass, tarpaper, wire, clay pipe stem and bowl fragments, several animal bones, 1914 and 1917 pennies, plus a small cache of at least twelve gun flints found in Square S2EO next to the beginning of the western tailrace wall.

As the southwestern corner of the forge building was being completed, a new set of 2x2-meter squares was commenced in the northwestern corner of the building, the objective being to locate a second stone forge platform. Since the new pits were laid out according to the coordinates of the already established trench, these too were included under the general designation of "Trench 2." As the excavation proceeded, it was decided to expose completely the western side of the forge and consequently the northwestern and southwestern corners of the building were finally joined by continuous test pits. This succeeded in exposing: 1) a stone forge platform in the northwest corner; 2) the entire

western forge foundation wall, with a door threshold in the center (much shorter than that in the southern wall and perhaps distinguishing the main entrance door on the west from a broad "delivery" type entrance on the south, where materials were perhaps loaded and unloaded directly into navigable vessels anchored in the channel of the tailrace); 3) a narrow footing along the western side (especially in N4E0), suggesting that the south wall may have been thickened in order to better withstand the pressure from the water within the tailrace; 4) a large stone footing curving outwards on the west (side of the doorway in Square N4E0), suggesting that extra support had been added here in order to accommodate the increased stress from continual traffic in and out of the building; 5) a sizeable brick-lined drain on two different levels, just south of the forge platform in the northwest corner and designed so that water (?) would fall from a higher to a lower level and then run out through an opening in the western forge wall; 6) a large brick and stone platform just north of the forge platform in the southwest corner, perhaps supporting a bellows or other equipment related to the functioning of the forge platform; 7) only occasional evidence of the original stone floor in the building; and 8) a great many water or drainage pipes along the western, southern, and northern sides of the forge, all presumably added well after the original construction of the building.

The stratigraphy throughout the western side of the forge building was generally quite uniform, there typically being a layer of black topsoil (of variable thickness) over the surface, then a thick layer of concrete underlain by crushed rock, followed by a very thin layer of black charcoal and earth (perhaps derived from the burning of the building in 1950). Below this was a much thicker layer of hard, reddish, brown earth, after which there was only sterile gravel and sand. With the exceptions of the topsoil layer and the deep cinder layer in the tailrace, the layers in the forge contained few artifacts and little that could be associated with the manufacture of armaments.

Subsequent to the introduction of the backhoe, the topmost layers were removed from a broad area on the east side of Trench 2 and then the trench was again expanded, this time to the east. Since the backhoe had removed the topsoil, concrete, and crushed rock layers, it was first necessary to remove the remaining loose earth from atop the forge building. Excavation was then resumed as before, but only within the charcoal and reddish brown earth layers. This permitted the exposure of much of the rest of that part of the forge building which is west of the central raceway (see HAER drawing of forge building, sheet 1 of 1). Given several days more, the excavation of this entire area could have been completed. This

continued excavation within Trench 2 permitted the exposure of a third stone forge platform (this one in the southeast corner, next to the central raceway and with a concrete platform built atop its northeast corner), plus a much smaller stone platform (function undetermined) in the northeastern corner of the building, next to the central raceway.

Probably of even greater significance was the discovery of a rectangular trough in the north-central part of the building, surrounded by a massive stone platform. This central trough contained a hard, thick layer of black grease with scattered metal filings, suggesting the lubrication of heavy gears. The type of machinery which was located here is unknown, but it appears to have been anchored atop both this gearing base and the brick drain to the west, as evidenced by a total of eleven large anchor bolts distributed along the sides of both the trough and drain. Just east of the gearing base was an oval-shaped brick structure with pipes running to the edge of the raceway. However, it can usually be generalized that the scattered brickwork, both here and elsewhere in the building, pertains to relatively late constructions.

Trench 3

Trench 3, consisting of only three 2x2-meter test pits, was commenced part way through the excavation of Trench 2 and represented a departure from the formal trench in that it was orientated c. 81° east of north in order to better follow the top of the southern forge foundation wall (see the HAER drawing). It started along the eastern edge of Trench 2, Square S2E4 and then followed the top of the wall until it reached and partially crossed the raceway running through the center of the forge. This trench was significant because within Trench 3, Square N0E2, the trap rock foundation wall suddenly ended and only deep cinders, capped by a shallow wall of concrete, continued towards the east and north. It was then realized that the central raceway finally had been located. The excavation of Trench 3 was continued as Trench 5, which was so designated after the work of the backhoe.

Trench 7

Although backhoes and other types of power machinery have sporadically been used in archeological sites, they have nearly always been used solely in backfilling deposits or for removing

deep overburden which archeological testing had already shown to be sterile. Rarely in a controlled excavation has a backhoe been employed for the actual excavation of cultural deposits. Shortly before the conclusion of excavations at the Whitney Armory Site, the Project Director decided to use a backhoe for: 1) removing the uppermost layers from atop a major portion of the forge's foundations; 2) trenching around the outside of the building and also (to a much lesser extent) on the north; 3) exposing a significant portion of the top and inner side of the eastern tailrace wall as it curved away from the southern forge foundation wall; 4) removing the shallow concrete wall (found in excavating Trench 3) which joined the southern walls of two separate forge foundations; and then 5) trenching through the raceway from the southern to the northern end of the channel. Those artifacts which were retrieved after being exposed by the backhoe were collectively lumped under the designation "Trench 7."

When viewed from a favorable standpoint, the backhoe was both impressive and amazingly efficient in moving large quantities of earth and in rapidly making it possible to get a general impression of what the entire layout of the forge was like--the HAER drawing of the site adequately demonstrates the point. If the backhoe had not been employed in removing the topsoil and concrete from atop a portion of the foundations, it is certain that fewer test pits would have been excavated and less would now be known about the structures in the foundation on the eastern side of the raceway. After the backhoe completed its work, it was apparent that the forge building consisted of two separate trap rock foundations with the broad channel of the raceway running between the two. Later maps show a single large superstructure spanning both foundations and the raceway, but none of the early evidence suggested such a large structure.

Trench 5

After the backhoe had completed trenching within the central raceway channel, it was noted that the northern end of the channel (where a flume had once carried water into the building) was completely blocked off by a stone wall which connected the two forge foundations (and atop this was a narrow concrete wall, comparable in appearance to the one which had been removed at the southern end of the raceway channel). It further became apparent from the smooth vertical facings at the corners of either forge foundation and from the rather irregular and "crude" appearance of the stone wall, as compared to Whitney's original stonework, that

the northern end of the channel must have been deliberately sealed off at some point after the original construction of the forge building.

In order to learn more about the constructional sequence at this end of the raceway, a narrow trench c. 80 cm. north-south and 3.62 m. east-west was excavated downwards along the southern side of the stone wall and completely bridging the northern end of the raceway. In the center of this trench (termed Trench 5), a sizeable iron pipe was found entering the building at the very bottom of the stone wall, suggesting that the pipe had first been installed with the wall, then being laid down on either side and above it. Although only the upper portion of the pipe could be exposed, due to rapidly rising water at the base of the excavation, a diameter was obtained for the pipe of at least 80 cm., whereas the depth from the top of the stone wall to the surface of the pipe was 1.21 m. Two small openings had been cut in the top of the pipe and through the larger of these it was possible to reach inside to a series of control knobs or handles. It appears that this probably was the pipe which, in the middle and late 19th century, regulated the flow of water to a turbine in the raceway, for the historical records indicate that a turbine and pipe had replaced the successive flumes and water wheels as the principal source of power for the building. Subsequent to the excavation of Trench 6, additional testing in the southwestern corner of Trench 5 succeeded in revealing wooden planks extending nearly to the footing at the base of the northern stone wall. Their significance will be discussed during the description of Trench 6.

Trench 6

A brief attempt was made at the close of the field season to expose either the turbine or the position where it had been located within the raceway. Trench 6 was a hastily dug trench, c. 1-1/2 meters in length, excavated downwards along the western edge of the central raceway channel. Although it failed to produce any direct evidence for a turbine, the side of a wood-lined channel was found along the eastern side of the excavation. A vertical 3x4-inch beam, at least 25 inches high, was first discovered at the north end of Trench 6 and then it was found that this beam had acted as a support for a series of wooden planks (each 2x10 inches) running straight down along the eastern side of the trench. All planks were tightly joined together and formed the western side of a wooden channel at least 40 inches (4 planks) high. (Due to ground water, it was impossible to excavate any deeper.) As was already noted, this discovery prompted further

testing in the southwestern corner of Trench 5 and planks were also found there just below the previous base of excavation and at the same distance (c. 45 cm.) out from the western side of the raceway. Although any additional testing was impossible, it can probably be assumed that there was a similar plank wall on the eastern side of the raceway and the wooden channel which they formed narrowed the raceway, thus increasing the power of the wheel and preventing it from flooding.

Summary and Future Objectives

The results of the 1974 excavation can be briefly summarized as follows: 1) a short trench (Trench 1) was placed within the 1860 main armory and the stratigraphy proved so straightforward that a complete excavation of this building would be quite feasible at some future point; 2) a modest amount of testing (Grid 2, Trenches 4-South, 4-North) was undertaken at the base of the dam and the 1798 millrace and, while Eli Whitney's 1798 factory building was probably not located, we nevertheless have learned enough so that limited additional testing should be capable of locating the foundations (if they have not already been removed). If the foundations can be found, then a complete excavation of the first factory would obviously be extremely desirable; and 3) primary attention was devoted to the armory's original forge building and a major portion of its foundations was exposed (Trenches 2,3,5,6, and 7). Excavation demonstrated that the foundations are sufficiently intact and are so visually impressive that a thorough archeological excavation followed by restoration of the entire structure would easily be worth the considerable time and expense involved. Slightly less than half of the foundations were exposed, but clearly only the complete and careful excavation of the central raceway and the eastern forge foundation can make it possible to adequately understand the function of the forge in its entirety. The forge building, with its impressive stonework, demonstrates, perhaps better than any other structure on the site, the high value which Eli Whitney placed on precision and craftsmanship.

Taken as a whole, the 1974 excavation of selected portions of the Whitney Armory exposed substantial areas within the site, while demonstrating the desirability of continued excavations within a wide range of buildings and areas. Unfortunately, parts of firearms and any other artifacts pertaining directly to the

manufacture of armaments proved to be extremely rare, but this can probably be attributed either to the dumping of worn out tools, defective parts, etc., at some distance from the factory buildings or, more likely, to the melting down and reforging of all scrap metal.

Finally, those areas which were tested represent only a small proportion of the structures which have been erected on this site. Obviously, there are several other factory-related buildings which can and should be tested and, even more importantly, it must be remembered that the factory formed only one portion of Whitney's overall system. Eli Whitney's farm has been only superficially tested (Grid 1 in the spring of 1974) and no work, as yet, has been undertaken in his factory village. Nevertheless, the attainment of a reasonable understanding of the entire complex which Whitney created will require extensive archeological testing in all of these areas and, for all practical purposes, the task has barely begun.

Prepared by David Starbuck
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PART 3: LABOR AT THE WHITNEY FACTORY

Whitney's musket factory offers the historian a remarkable opportunity to study the transition of labor from the agricultural era of the eighteenth century to the industrial era celebrated in America's success at the Crystal Palace. Sun and season were displaced by clocks and production schedules, informal working arrangements by formalized commitments and contracts, the craft artisans by trained industrial workers. Other historians, particularly Felicia J. Deyrup in her Arms Makers of the Connecticut River Valley, have discussed the effects of this transition in the arms industry.[1] This paper concentrates on those aspects of this topic illuminated by the Eli Whitney project and its research, both in manuscript collections and at the factory site.

Before Whitney and twenty-six other arms makers were granted Federal contracts to manufacture 40,000 muskets in 1798, the arms industry was still a craft, relying on highly skilled armorers. Whitney received the largest of the contracts (for 10,000 stands), and he promised to complete it in two years. He was not an inventor of guns, nor did he attempt to design any major part of them (though he did make suggestions). His task was to copy ten thousand times the musket model supplied to him by the Department of War. Whitney had no previous experience in arms making and, although his delivery was delayed, it remains that the organization of his factory and labor force did not include the use of dozens of skilled gunsmiths who worked on individual muskets. Instead, he obtained unskilled workers whom he trained in separate operations in his manufacturing process. His method, though perhaps not a first, clearly anticipated what was later termed the "American System of Manufacture" and it depended heavily on the pre-planned and efficient division, organization, and management of labor and machinery.

Procurement of Workers

Deyrup states that "arms contractors of this period were experienced gunsmiths or blacksmiths, or otherwise closely acquainted with arms manufacture."[2] There were only two exceptions to this among the contractors of 1798, Eli Whitney and Daniel Gilbert of Mansfield, Massachusetts.[3] "Previous to my contract," Whitney wrote to the Secretary of the Treasury, "I had not any experience in the fabrication of arms."[4] And not only was Whitney without experience, his workmen were also. "I did not associate to myself workmen who had been accustomed to their [musket] fabrication. This has, I imagine, been favorable to improvement, but has been productive of some delay, as I have been obliged to instruct myself and all those who are in my employ."[5] Later, in 1813, Whitney wrote to Callendar Irvine that he "did not undertake the manufacture of Arms, relying on the skill or experience of any man or number of men I might employ. All my workmen without an exception were, for a number of years, and have always been almost wholly of my own instructing."[6]

In the beginning, it seems that Whitney employed whoever was available in the vicinity, possibly indicating his decision to rely on the skill of his machines rather than the men he would employ. A 1906 account by the son of one of Whitney's first workers (a Mr. Smith) said that "Whitney, who was immensely popular, prowled around New Haven saying to likely youth 'Follow thou me' and thus securing his workmen."[7] Olmsted, in his Memoir, states that Whitney found it easier to instruct new and inexperienced workmen than to "combat the prejudices of those who had learned the business under a different system."[8] Whitney himself wrote to Henry Dearborn of the inadequacy of some workmen from the Springfield armory who were then working at his factory. They "were not as good workmen as those who had been brought up under my immediate instruction."[9] One way to train workers was through apprenticeship: Philos Blake reported the presence of nine in 1811.[10]

Documents show that there was a considerable exchange of services between armories, some of which seem cooperative for mutual benefit, others were more competitive. As early as August 1798, Eli Whitney expressed concern over the shortage of labor in the area. Apparently, a Mr. Dixon who owned a cotton factory suggested contracting elsewhere for gun parts, and assembling them in New Haven. Whitney protested that: "It would be only an indirect method of procuring that, which they despair of obtaining by direct means. It would fix their general rendezvous here, and afford them, perhaps, a better opportunity of tampering with my

workmen than if their whole business was carried on here."[11] Mr. Dixon's gun factory never materialized. At least in his own lifetime, Whitney was not competing in the same immediate labor pool with other manufacturers of arms.

Special talents in various aspects of production were sometimes exchanged with other armories. Roswell Lee, Superintendent for the Springfield Armory, wrote to Whitney in 1815 that a man requested (named Parsons) would not be permitted to visit New Haven, but that he would send the first hammerman that could be spared.[12] A month later, Ebenezer Whitney was sent. "He is ... recommended as being an excellent workman," wrote Lee, "and I have no doubt but he would answer your purposes."[13] In 1821, Whitney wrote to Lee about obtaining a man to make about 1,500 bayonets.[14] Apparently, the arrangement was satisfactory. Seven months later, Whitney told Roswell Lee that the bayonet forger (Mr. Bates) completed "2,004 bayonets in seventy-two working days."[15] Whitney was pleased with the exchange of labor. "I have done everything in my power to accommodate him and feel much obliged to both you and him for his coming."[16]

Labor "exchanges" between armories were not always this amiable. Whitney complained to Wolcott in 1810 that "several of my workmen on whom I relied at the time I contracted with the State of New York have been induced away to Springfield."[17] In another instance, a foreman for the armorer Nathan Starr, of Middletown, Connecticut, apparently enticed away a workman from New Haven. Whitney filed suit against the workman. Starr, claiming he was unaware of the problem, did not employ Smith, the workman. Whitney told Starr that he considered it "unjust" for workers to leave without reasonable and suitable notice.[18]

Labor Specialization and Factory Mechanization

Whitney's willingness to rely on unskilled labor and to employ workers with special skills like bayonet making or working under the trip hammer evidence his decision to attempt to use machines to replace traditional skills and his success at doing so. He wrote to his close friend, Josiah Stebbins, in 1800, that the work was going slowly, but that "my principal solace arises from the consideration that my machinery and modes of doing the work will certainly answer a better purpose than any heretofore devised."[19] Water supplied the power to run the machinery, and

the "... more exact operations of his machinery [made up for] the want of experience in the workmen... ."[20] In 1801 Whitney again extolled the advantages of machinery to Dearborn. "The machinery not only abridges manual labor but gives a degree of perfection to the work beyond the power of the most skillful workman in the usual method."[21] By 1808 Whitney wrote "... we have improved by practice and experience... ."[22]

In one instance, Whitney explained this problem of lack of skill and its substitution by mechanization, when asked about the possibility of making swords.

> Workmen of skill and experience in carrying on this species [?] of Manufacture in the manner in which it is done in Germany and other parts of Europe, are not to be had in the United States. Hence, a substitute for European skill must be sought in such an application of Mechanics to give all that regularity, accuracy, and finish to the work which is acquired by long and regular Practice and which in fact is the result of the collected experience of Ages... .[23]

According to the Springfield Armory, there were 104 separate operations performed in making a musket, 25 in the barrel alone.[24] Whitney's goal was to reduce as many of their operations as possible to a function that could be performed by machine, thus eliminating the need for and dependence on skilled craftsmen. Denison Olmsted described Whitney's system as follows.

> The several parts of the musket were, under this system, carried along through the various processes of manufacture, in lots of some hundreds or thousands of each. In their various stages of progress, they were made to undergo successive operations by machinery, which not only vastly abridged the labor, but at the same time so fixed and determined their form and dimensions, as to make comparatively little skill necessary in the manual operations. Such were the construction and arrangement of this machinery, that it could be worked by persons of little or no experience, and yet, it performed the work with so much precision, that when, in the later stages of the process, the several parts of the musket came to be put together, they were as readily adapted to each other, as if each had been made for its respective fellow. A lot of these parts passed through the hands of several different workmen successively ... each performing upon them every time some single and simple operation, by machinery or by hand, until they were

> completed. Thus, Mr. Whitney reduced a complex business, embracing many ramifications, almost to a mere succession of simple processes, and was thereby enabled to make a division of the labor among his workmen, on a principle which was not only more extensive, but also altogether more philosophical than that pursued in the English method. In England, the labor of making a musket was divided by making the different workmen the manufacturers of different limbs, while in Mr. Whitney's system, the work was divided with reference to its nature, and several workmen performed different operations on the same limb.[25]

Apparently, the value of workers trained in the operation of this specialized machinery was rather high, probably because of the knowledge of the machine itself. Whitney seemed unwilling to put into operation a barrel-turning machine because he saw no opportunity for "fair compensation for the invention and expense and risque [sic] of the Experiment." Besides, he continued, "the probability is that some person would contract to make barrels and not only take advantage of my invention, but intice [sic] away the workmen whom I had instructed in the use of the machine before I could be half compensated for the expense of making it."[26] It is clear the government recognized the value of Whitney and his new machines. Henry Dearborn, Secretary of War, invited Whitney to take over the Superintendency at Harpers Ferry, requesting that he bring his workmen and machines with him.[27]

The site design, even in the earliest years, reflected the specialization of tasks and the care Whitney lavished on every detail. There was not a single large building where all the workers shared common facilities, but two large buildings designated for specific functions and several smaller specialized structures. One large building was a filing shop and the other was a stocking shop (connected by a second-story bridge), the latter primarily an assembly area. Later on, there was a forge and foundry. Smith's 1906 account refers to the finishing room, suggesting that there were further divisions within buildings, and the 1826 inventory of the armory clearly indicates this room-by-room division.[28]

The architectural examination of the existing buildings at the site did not indicate actual production activity (the only major buildings left were a barn and boarding house), but they do indicate the kind of pre-planned care and attention to detail that one would expect from Whitney. In the barn, for example, the structural pieces were uniform in size and marked for assembly. Flooring was made perfectly level, sills were beveled and undercut to prevent water damage, small stairways folded up when not in use, and the stone foundation was

designed to prevent the individual settling of column bearing points.[29] None of these features have anything to do with Whitney's manufacturing process, but they do indicate the care and attention to detail, so often mentioned in contemporary accounts.

Regarding a hierarchy in the organization of labor at the factory, the research found no complicated structure of rank or chain of command. Whitney lived at the site in a small farmhouse, until he moved to New Haven in 1816.[30] He was constantly involved in the day-to-day operation at the factory, as well as with his other duties as fund raiser, lobbyist, contract seeker, and so forth. In 1799 Whitney wrote to Wolcott of his demanding position:

> I find that my personal attention is more constantly and essentially necessary to every branch of the work than 1 apprehended -- mankind generally are not to be depended on and the best work men 1 can find are incapable of Directing -- lndeed there is no Branch of the work that can proceed well, scarcely for a single hour unless I am present.[31]

ln 1801 he wrote of the necessity of his "personal attention,"[32] but by 1803, it is apparent that Whitney found a superintendent upon whom he could rely, James Carrington, a former inspector of arms.[33]

Contracting

Deyrup writes that "many of the regular contractors undertook parts manufacture, while at the same time, small gunsmiths, who stood no chance of obtaining contracts for complete arms, were in this way able to contribute to the production of military weapons... ."[34] Although subcontracting was not extended (except to previous contract holders) by the government after 1820, and it did not become commonplace in the private sector,[35] Whitney subcontracted much of his work, primarily barrel and bayonet making. For example, Whitney arranged for lra Yale of Wallingford to make 4,000 steel bayonets for fifty cents each.[36] In 1810 Whitney rejected a contract to make barrels, because he did not want to enlarge one branch of the business. lt would have created "unbalanced proportions" at the factory. Furthermore, Whitney complained that wages for "good workmen in that branch" were too high.[37]

Within the factory, workmen sometimes contracted to produce certain parts. Whitney stated that workmen, brought in from time to time to work at the factory, were paid by the day.[38] For example, a man named Parsons was borrowed for two months as a hammerman.[39] In 1821 Isaac Newell's eighteen-month contract with Whitney was running out, and he wrote to Roswell Lee for employment at Springfield.[40] Even without this sort of evidence, it must be presumed that Whitney necessarily subcontracted outside the factory. A report made by Whitney or by an emissary of the Whitney factory reported that there were no facilities for turning stocks, making iron, welding barrels, or milling lumber at Springfield.[41]

Whitney found that the individual skilled laborers with whom he most often contracted created a disruption to his factory system that caused him considerable problems ("embarrassments"). For example, Whitney wrote in 1803 that "one of my workmen on whom I principally depend in doing a particular piece of work has been indisposed for some weeks past -- which has prevented my making up our pattern musket... ."[42] In 1818 Whitney wrote Roswell Lee that "the man who forges my bayonets disappointed me, otherwise these Muskets would have been ready for delivery six months ago."[43]

Conclusion

As a transition between an earlier agrarian society and a later-recognized American System of Manufacture, the Whitney Armory offers a remarkable example. Located in an idyllic rural setting that also boasted good water power and combining both farm and factory, the armory site was a physical expression of its transitional nature. With a labor force that seldom numbered more than forty or fifty men, Whitney had to make a profit in the private sector of the economy, while Springfield and other government armories could depend on the government budget to absorb the costs of mistakes and experiments.[44] That he succeeded at all is notable. That he succeeded in introducing what was by contemporary accounts a "new" system of manufacturing at the same time he managed to make a profit is indicative of the skills of this early industrial entrepreneur.

NOTES

1. Northampton, Mass., 1948.
2. Ibid., p. 43.
3. Ibid.
4. Eli Whitney to Samuel Dexter, 8 January 1801. Eli Whitney Collection, Yale University Library (hereafter cited as EWC).
5. Ibid.
6. Eli Whitney to Callendar Irvine, 25 November 1813, EWC.
7. Cheshire Hamden Times, 31 May 1906.
8. Denison Olmsted, Memoirs of Eli Whitney, Esq. (New Haven, 1846), p. 54. This article first appeared in The American Journal of Science and Arts, vol. 21, no. 2, 1832.
9. Eli Whitney to Henry Dearborn, 14 June 1808, EWC.
10. Philos Blake to Elizabeth Blake, 26 January 1811, Blake Family Collection, Yale University Library.
11. Eli Whitney to Oliver Wolcott, 2 August 1798, EWC.
12. Roswell Lee to Eli Whitney, 8 July 1815, EWC.
13. Roswell Lee to Eli Whitney, 12 August 1815, EWC.
14. Eli Whitney to Roswell Lee, 11 June 1821, EWC.
15. Eli Whitney to Roswell Lee, 25 January 1822, EWC.
16. Ibid.
17. Eli Whitney to Oliver Wolcott, 31 May 1810, EWC.
18. Eli Whitney to Nathan Starr, 8 January 1818, EWC.
19. Eli Whitney to Josiah Stebbens, 26 April 1800, EWC.
20. Timothy Dwight, Travels in New England and New York, vol. 2, (New Haven, 1821), p. 290.

21. Eli Whitney to Henry Dearborn, 27 June 1801, EWC.

22. Eli Whitney to Henry Dearborn, 14 June 1808, EWC.

23. Eli Whitney to Henry Dearborn, 5 November 1807, EWC.

24. Springfield Armory to Department of War, 14 October 1823, EWC.

25. Olmsted, pp. 53-54.

26. Eli Whitney to Roswell Lee, 3 January 1818, EWC.

27. Henry Dearborn to Eli Whitney, 10 December 1806, EWC.

28. Cheshire Hamden Times, 31 May 1906; "Inventory of the Estate ...," 10 January 1826, EWC.

29. The reader should check Part 1 of this report (Site History) and the structural analysis of the Whitney barn, HAER CT-2A, for further information.

30. Cheshire Hamden Times, 31 May 1906.

31. Eli Whitney to Oliver Wolcott, 31 May 1799, EWC.

32. Eli Whitney to Samuel Dexter, 8 January 1801, EWC.

33. Eli Whitney to Major H. Rogers, 31 March 1803, EWC.

34. Deyrup, p. 42.

35. Ibid.

36. Eli Whitney to Ira Yale, 23 March 1821, EWC.

37. Eli Whitney to John Graham, 29 December 1810, EWC.

38. Eli Whitney to Henry Dearborn, 14 June 1808, EWC.

39. Roswell Lee to Eli Whitney, 22 December 1815, EWC.

40. Isaac Newell to Roswell Lee, 23 March 1821, EWC.

41. "Analysis of the Accounts of the United States Armoury at Springfield, Mass.," 1822. Connecticut State Library.

42. Eli Whitney to N. Terry, 22 September 1803, EWC.

43. Eli Whitney to Roswell Lee, 3 January 1818, EWC.

44. See Eli Whitney to Oliver Wolcott, 31 May 1799; Eli Whitney to Josiah Stebbins, 26 April 1800; Eli Whitney to Callendar Irvine, 4 November 1813; all EWC. See also the manuscript census returns in the Connecticut State Library.

Prepared by H. McKelden Smith
with T. Allan Comp
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PART 4: NEW EVIDENCE ON THE AMERICAN SYSTEM

Eli Whitney was born in Massachusetts in 1765.[1] He was graduated by Yale College in 1792; and one year later, while staying on a South Carolina plantation, he developed a machine for removing the seeds from upland cotton. His cotton gin was a simple machine and easy to copy, so Whitney took out a patent on his invention and then spent the next several years fighting unsuccessfully to maintain his monopoly on gin manufacture. By 1798, his expenditures for travel and court suits brought him close to financial embarrassment and his friends encouraged him to look elsewhere for the fortune he sought.[2]

In the same year, the United States Government decided to contract with private individuals to provide muskets for the army and signed contracts with several experienced armorers to produce a total of about 40,000 muskets. Although Eli Whitney had no previous experience in arms-making, he had acquired a reputation as the inventor of the cotton gin and a number of important friends--some of them Yale classmates--in the government. Drawing on these connections and claiming to have a new system for musket manufacture, Whitney secured a contract to deliver one-fourth of that total within two years. It took him eight years, instead of the promised two, to manufacture the whole 10,000. After 1809, when he completed his contract, he filled orders for the States of New York and Connecticut, and in 1812, the U. S. Government again contracted with him, this time for 15,000 muskets. "Thereafter," says the Concise Dictionary of American Biography, "his unique manufactory yielded him a just reward."[3]

Whitney built his musket factory on the falls of the Mill River, just outside of New Haven, Connecticut. (See Photo CT-2-7.) This factory site still exists, and although most of the original buildings have been destroyed, their archeological remains are still in a relatively undisturbed condition. During the past summer, a team of historians, architects, and archeologists (co-sponsored by the Historic American Engineering Record and the New Haven Colony Historical Society) excavated, recorded, and researched the Whitney musket factory site, quite possibly the last unexamined source on his work. This paper reports the

results of that investigation.

When Whitney first proposed to manufacture 10,000 muskets, he suggested "that machinery, moved by water and adapted to this business would greatly diminish the labor and facilitate the manufacture of this article."[4] One year later, he wrote:

> One of my primary objects is to form the tools [in such a way that they] shall fashion the work and give to every part its just proportion--which when once accomplished will give...uniformity... to the whole. In short, the tools which I contemplate are similar to an engraving on copper plate from which may be taken a great number of impressions perfectly alike.[5]

And, in 1801, he claimed: "My system and plan of operation are, I believe, entirely new and different from those heretofore pursued in this or any other country."[6]

Whitney never described his new method in any detail, but he did welcome visitors to his factory and their reports echo Whitney's claims regarding both the special nature of his process of manufacturing and the uniformity of his product. Edward A. Kendall, in his Travels, published in 1809, reported that "for every part of the musket, he [Whitney] has a mould; and there is said to be so much exactitude in the finishing, that every part of any one musket may be adapted to all the parts of the other."[7] In 1811, Timothy Dwight, President of Yale College, published his Statistical Account of the City of New Haven, in which he described Whitney's armory:

> In this manufactory, muskets are made in a manner which I believe to be singular....[M]achinery, put in motion by water...is used.... The proportions and relative positions of the locks are so exactly alike, and the screws, springs, and other links so nearly similar, that they may be transferred from one lock and adjusted to another, without any material alteration....[8]

Denison Olmstead, a Yale Professor of Natural Philosophy, wrote in 1832 that Whitney's efforts extended "even to the most common tools, all of which received some peculiar modification which improved them in accuracy, or efficacy, or beauty. His machinery, for making the several parts of the musket, was made to operate with the greatest possible degree of uniformity and precision."[9]

Finally, Benjamin Silliman, Yale professor and one of early America's great scientific minds, writing in the same memoir, noted that Whitney's "machinery has great neatness and finish, and its operation evinces a degree of precision and efficiency which gratifies every curious and intelligent observer."[10]

With some of early America's best minds praising the singularity of Whitney's manufacturing process and the uniformity of musket parts produced by that process, one might assume that Eli Whitney would forever hold a firm place in the developmental history of the American System of Manufactures, but this is not the case. As early as 1880, Charles H. Fitch, drawing on his work as Director of the 1880 Census of Manufactures and on interviews with many of the early machine-tool builders, challenged Whitney's contribution and claimed that "in 1815, his methods were still crude, and not markedly in advance of his contemporaries."[11] In response to Whitney's claim to have developed a system different from that "in this or any other country," W. F. Durfee, a mechanical engineer interested in interchangeability, published a collection of French documents in 1894 that clearly demonstrated the manufacture of interchangeable musket locks in France between 1786 and 1807.[12]

In the twentieth century, and especially since the publication of The World of Eli Whitney in 1952, Whitney's contribution to the American System of Manufactures has become the focus of a debate in which the two sides are far apart. Jeannette Mirsky and Allan Nevins, the first authors since Olmstead to have access to the Whitney papers (now deposited in the Yale Manuscripts Library), devote many pages of their biography to a discussion of Whitney as "The Master Manufacturer" and to his central role in "The Birth of the Machine-Tool Industry."[13] Perhaps the most exaggerated praise of Whitney appears recently in the pages of American History Illustrated. Whitney is celebrated as a "pioneer architect of American industry," who found himself at one of "history's crossroads. "His mechanical genius," the article explains, "struck off another great spark [the first was the cotton gin], the concept of mass production and interchangeable parts. No other American had ever done anything like it. The assembly line had been solidly established as the bulwark of American industry and Whitney was "without doubt a Founding Father of Industrial America."[14]

The other side of the debate finds reason to dispute virtually everything claimed by those who would make Whitney a hero. In the most recent interpretative article challenging Whitney's work (1960), Robert Woodbury claimed "The Legend of Eli Whitney and Interchangeable Parts" was "at least partially created by its hero

and uncritically accepted by most of his contemporaries."[15] The opportunity to obtain a contract to manufacture muskets for the Government was not the brave undertaking of a serious inventory, but "new hope for a desperate man!" whose "every source of credit had been exhausted."[16] Whitney's explanations for the delays in delivering the muskets were "unmanly" accounts: he was more a fortune-seeker than a dedicated arms-maker.[17] The muskets Whitney produced were not interchangeable in all their parts!" and Woodbury concludes that "Whitney's claims of originality seem to have been the exact opposite of the truth."[18]

Authors on both sides of the Whitney debate concentrate their efforts on manuscript sources, the most important being the Whitney papers at Yale and the papers on various government officials dealing with private armorers--now deposted in the National Archives. Both sides tend to concentrate on Whitney's early claims, particularly those included in his letters to government officials and then leap several decades to the recognition of the American System of Manufactures as a fully-developed system. Using hindsight and their own definition and concentrating on the interchangeability issue, each side then proves its respective case. More important, none of these historians ever claims to have examined the actual product of Whitney's manufacturing system or the site of his factory. Even Woodbury, for all his denial of the Whitney legend, admits "we really know practically nothing of what Whitney actually had in his manufactory at Mill Rock."[19] If more was to be learned of Eli Whitney and the work he carried on in his musket factory, historians had to examine the product and the process that produced it.

Edwin Battison, Associate Curator of Mechanical and Civil Engineering at the Smithsonian Museum of History and Technology, completed the first half of this task. His detailed analysis of a Whitney musket was published in the Smithsonian Journal of History in 1966.[20]

Battison's manuscript research indicated that Whitney "had the concept of a power-driven, multi-toothed cutting tool."[21] In order to find out just what kinds of tools Whitney actually used in making his early muskets, Battison disassembled a Whitney musket manufactured between 1803 and 1809, closely examining the various pieces for the distinctive marks left by various tools. The results were most interesting. Both the tumbler and the side screws of the musket clearly showed the use of a hollow mill, a thick cylinder with cutting teeth around a central hole at right angles to its axis. Although a relatively simple device and not entirely unknown (the French reports published by Durfee describe

what must have been hollow milling), Whitney's use of hollow milling in musket manufacture is the first in Battison's knowledge in America. Battison also found the marks of a circular saw on the slot or nitch of the large sear screw, indicating Whitney's use of a screw slotting machine in which the work was drawn past the saw to give an even or flat surface to the root or bottom of the screw slot. Here again, although such machines were known to clock makers for almost a century, Whitney was apparently one of the first to use it in American arms manufacture.

Battison was also interested in testing the interchangeability of the Whitney muskets and he actually tried to do so with the few he was able to gather for his research. He found that many of the lock parts in the early musket were marked with a number indicating that they were specially fitted for that particular musket and that virtually none of the finished pieces would easily interchange. Thus, Battison concluded, "Whitney's role as a technical innovator in the development of a workable system of interchangeable parts has been overestimated...."[22]

Despite his negative conclusion regarding Whitney and interchangeability, Battison had discovered the evidence of Whitney's use of two relatively sophisticated machine tools that were apparently new to musket manufacture. The actual site of the Whitney musket factory remained unexamined and the task of the summer project, as defined at the beginning of the summer, was to examine the existing structures and archeological remains at the factory site--along with the Whitney papers at Yale--to learn what we could of Eli Whitney and interchangeable parts. (See HAER CT-2, Sheet 1 of 1 [site plan]; photo CT-2-1 and photo CT-2-3.)

The historians began by reading the entire Whitney collection. It is interesting to note that according to a file maintained by the Yale Manuscripts Library, no one since Mirsky and Nevins has read much beyond the first three boxes and the two folio volumes in the Whitney collection. Researchers have apparently been content to stop their reading at about 1803 and then jump to the extensive inventory taken of Whitney's estate in 1826, ignoring all the correspondence of the two intervening decades.[23] The collection includes sixteen boxes of letters, accounts, notes, and photostats of government documents on Whitney from the National Archives, as well as two folio volumes containing Whitney's first contract, the inventory of his estate, and a large number of unattributed drawings. The historians also examined all other collections at Yale with materials on Whitney, the unaccessioned papers of the New Haven Water Company (deposited at the NHCHSL), the company that has owned the factory site since 1860, and materials in

several other collections, both private and public. Finally, they visited the Winchester Gun Museum, in order to examine the Whitney musket used in the Battison study. In addition, the archeologists and architects involved with the project were unsuited by training to interpret the materials they were finding or recording, and the historians had to provide both direction and interpretation for the entire project. This work included artifact identification, advice on the preparation of measured drawings of the existing buildings, and the graphic research necessary to locate archeological remains not visible on the surface.

Archeological excavation started in an area that had been experimentally excavated the previous summer and it was assumed that the stone foundations discovered then were those of Whitney's 1798 factory buildings. (See photo CT-2-5.) Soon after the dig started, the historians found maps and other sources indicating that the foundations were not those of the 1798 factory. The building was, instead, the 1860 armory building erected by Eli Whitney, Jr., to replace the original factory buildings which were destroyed in a boiler explosion earlier that same year.[24] (See photo CT-2-10.) It was decided to close this first trench and move on to more promising areas, but two things had been learned. First, there was a thick layer of fill covering the site and this would seriously retard our progress during the summer, if it were to be excavated layer by layer. Second, there were surprisingly few of the smaller artifacts one expects in such areas. Aside from a lot of bricks (from the demolished 1860 building), a few oyster shells and one half-dime, the archeologists uncovered nothing of identifiable significance.

The second of the three trenches opened during the summer excavated a large part of Whitney's forge building on the east side of the river. Built sometime between 1804 and 1815 and relegated to a position of little importance about 1850, the interior furnishings of the structure were covered by a concrete slab in the early 1900s and the building was not destroyed until 1950, when a fire gutted the building and the owners knocked down the stone walls as a safety precaution.[25] At the start of the summer, there were no visible indications of the building, although we did have several photographs of the building with its Palladian window over the front door. (See photo CT-2B-8.) The historians brought their graphic research data to the site and then laid out what proved to be the exact location of the building.

The concrete slab on the interior of the building, sometimes fourteen inches thick, proved to be more than the archeologists could handle with their hand methods. They first tried a sledge hammer and then a self-powered jack hammer, but the work was still hard and slow. With the summer rapidly coming to an end, a backhoe was brought to the forge site to remove the slab and its overburden of fill. The first pit uncovered the curved side of a stone raceway exactly where the historians thought it should be and then opened a forge platform on the interior of the building that corresponded to a sketch in the Whitney papers. (See photo CT-2B-6.) Excavation continued along the front and south side of the building, revealing more of the close-fitted and heavy stone work of the race and also discovering another forge platform, again indicated in the Whitney sketch. After the backhoe removed the slab and the fill over the slab, the excavation uncovered one more forge platform, two large machinery bases, one with a brick drain to the exterior of the building and the other with a large grease-filled pit, and several smaller configurations of stone-work which could not be interpreted. (See photo CT-2B-1.) While the excavation opened an area that may span the entire nineteenth century, it is quite possible that some of the remains discovered here may date from Whitney's original construction of the building. The correspondence of the forge platforms to the Whitney sketch and the manuscript evidence indicating that the building was little used after the 1850s all suggest that the evidence here uncovered is part of Whitney's early manufacturing process.

The water power system of the forge building was particularly interesting, but the end of the summer and a consequent halt in the work made full investigation impossible. Maps of the site showed a single building with a raceway (assumed to be a tailrace) along its south side. Excavation discovered two separate foundations, each of equal size, with a large raceway running between the two. (See HAER drawing of forge building, sheet 1 of 1.) The earlier waterwheels, renewed by Whitney about 1820, were replaced by a turbine in 1860, but it was clear that this turbine is still in place within the race, although it could not be completely excavated. In addition, heavy wooden walls installed in the race by Whitney's nephews and successors about 1830 to narrow the water channel and prevent flooding of the wheel were still in the race and intact.[26] Most interesting for the historians was the clear confirmation of one important early description of the Whitney site. Silliman's 1832 memoir claimed "it is only necessary to inspect the work, and the flume ways, and the walled borders of the river below, and the canal which he [Whitney] constructed, to take the water from the dam to the forging shop, to be satisfied that both genius and taste presided over these

useful, although unostentatious constructions."[27] "Genius and taste" may be difficult to prove, but most of the details Silliman mentioned are still in existence and confirm the authority of his account. (See photo CT-2B-2.) As in the first trench, the number of small artifacts was quite limited. With the exception of one pair of forge tongs and a small group of musket flints found in the raceway, it was the foundations and layout of the building that were the most important discoveries, not the smaller artifacts we hoped for.

The last trench opened by the archeologists was the most difficult to locate, but it promised to be the most important as well. Whitney's first factory buildings, erected in 1798 and 1799 on the west side of the Mill River, stood until destroyed by a boiler explosion in 1860. Research established that these early buildings were followed by a succession of nine different structures on the same general site, each leaving its mark and each partially altering what had existed previously. Excavation on this site was a kind of random sampling, a familiar archeological technique, and the topography of the area made a backhoe impossible. The excavation started during the last quarter of the summer with a limited crew and the results were equally limited, though promising.

The original six-foot-high mill dam (which pre-dated the Whitney works) was replaced by a thirty-foot-high dam in 1860, but the raceway for Whitney's waterworks appears in the Munson painting and more clearly in the Howe illustration of 1842.[28] By clearing away some brush near where we thought the raceway might be, we uncovered what appeared to be the capstones for the race. (See photo CT-2-2.) Further archeological work confirmed this as the raceway and, in addition, turned up several grindstones possibly used in the early factory. With time running out near the end of the summer, an attempt was made to excavate along the inside wall of the race in hopes of finding the abutting walls of the 1798 factory building, but to no avail. We know the size of the race and that the stone construction techniques were those of the 1798 period and that its bottom was lined with wood. We also know that the race was in use until about 1860 when it was replaced by iron penstocks carrying water to turbines. The race was apparently left open and abandoned and the penstock pipes were thrown into it when they were discarded after the turn of the twentieth century. (See photo CT-2-4.) We do not know exactly where the race started (its upper end probably destroyed by construction of the new dam in 1860) and we do not know where within the race the early water wheel was located. Random trenching within the interjor of what we assumed to be tbe early factory proved unenlightening and further conclusions will have to await a complete excavation of the entire area including the raceway.

The two architects working with the project prepared measured drawings of the three existing buildings at the site, as well as a site plan and the drawing of the forge excavation. They also assisted in interpreting early maps and photographs of the site and in locating the archeological remains of the demolished factory and forge buildings, and they prepared a structural analysis of the large barn Whitney built. The buildings all date to the early years of Whitney's activity at the site. A small fuel storage shed was probably constructed with the forge building about 1804. A large barn located on the west side of Whitney Avenue was built about 1815. The last building, a boarding house north of the barn, was impossible to date precisely, but structural techniques suggest it was constructed early in the nineteenth century and it was certainly in use well before Whitney's death in 1825.[29]

The fuel storage shed (two were originally built, one for charcoal and the other for mineral coal) was near the forge building and actually cut into the foot of East Rock, a mountain that marked the eastern border of the factory site. (See photo CT-2C-1.) Research conducted before the summer started suggested that this building was a carpenter's shed. It was not until after the measured drawings were completed that the historians were able to establish that the building was the fuel shed visible in the Munson painting and, by 1974, in much altered condition. One early photograph of the building showed a completely different facade on the shed and the earlier one had a small Palladian window to match the one on the forge building. (See photo CT-2-17.) By the time the summer ended, it was clear that the present facade and roof were of recent construction, but that the remaining three walls were original. (See HAER drawings of Fuel Storage Sheds, sheets 1 and 2.)

As just mentioned, the building had been cut into the hillside to its rear and the architects also found a small roadway leading up to the back of the building at about gable height. In Silliman's description of the factory, he mentions this roadway and states that the road made it possible to drive coal and charcoal carts up to the back of the building and dump them directly into its interior, thus saving the labor of unloading the carts into the front of the shed.[30] A heavy door sill at ceiling height in the back wall of this building and the overgrown roadway are now all that remain.

The boarding house is of undistinguished construction, although its interior panelling corresponds to that of the barn, but it does serve as an existing reminder that Whitney built not only a

factory, but an entire factory village including the boarding house, five stone houses (now demolished), and garrets over several of the manufacturing buildings. (See HAER drawing of Boarding House, sheet 1 of 1.) As early as 1800, the census listed twenty-two men, two women, and two boys as residents of the Whitney household.[31] He maintained a work force of between forty and fifty men throughout the period and Whitney continued to live at the factory until 1818 when he moved into New Haven with his new bride.[32] (See photos CT-2D-1 and CT-2D-2.)

The barn received the most architectural attention because it is the largest existing and unexamined three-dimensional Whitney document. (See HAER drawing of the barn, sheets 1-7.) In addition, the manuscript collection at Yale contains several letters to Whitney answering his questions regarding shingles, scantling, and framing timbers for this building and the historians were anxious to examine a building to which Whitney had apparently given some thought.[33] Completed about 1815, the building attracted considerable attention. Silliman said it was "a model of convenience, and even of taste and beauty and contains many accommodations, not usually found in such establishments" going on to describe cattle mangers and their fastenings, hooks for the doors at either end, and other "appendages and accommodations."[34] Two years after Whitney built the barn, it was visited by President Monroe on his tour of the eastern states.[35]

Our examination of the barn discovered several of the details mentioned by Silliman, including the cattle halters, long heavy hooks for the large doors at both ends of the barn, and a carefully rounded stairway to ease entry and exit. (See photo CT-2A-11.) The architects also recorded several more important structural elements in the barn, elements that make it clear that Whitney did spend some thought on the construction of the building. Within the stone masonry foundation walls of the barn, the interior columns supporting the roof and the floor loads do not rest on individual piers, as was common practice, but on walls which are perpendicular to and attached to the foundation walls. Because these interior walls evenly distribute the column loads, they minimize the chance of any single column bearing point settling in a manner different from the others and thus maintain the rigidity and weight distribution of the timber frame. The straight roof peak--now one hundred sixty years old-- demonstrates the integrity of the barn's foundation.[36] (See photo CT-2A-2.)

The structure above the foundation is impressive for its simplicity of construction and economy of materials. All structural members are repetitive and were pre-cut to very close

tolerances. (See photo CT-2A-5.) All of the timber was milled or sawn in comparatively small (none of the timbers are larger than eight inches in cross section) and uniform sizes and each joint or connection was pre-marked for assembly. (Common practice at the time would use heavy hand-hewn timbers with each connection fitted at the time of construction.) Connections in the Whitney barn ~~was~~ were mortised and pegged, which was common, but more important, these connections are kept in a single plane, thus reducing the complexity of the joints and eliminating any need for different sized members. (See photo CT-2A-10.)

Other features of the barn reinforce the impression of careful planning and attention to detail. The main horizontal beams are continuous timbers 43 feet long and 7-1/2 inches square, and both the great length and small cross section are unusual. (See photo CT-2A-8.) The thick floor boards in the barn were cut along their bottom edge with a depth gauge and then adzed or planed across their width at each point where they rested on a supporting joist, thus making the floor above perfectly level. (See photo CT-2A-14.) A small stairway leading from the main floor to the hay loft could be folded up when not in use. (See photo CT-2A-12.) In several parts of the barn, interior panelling was carefully planed on one edge to break the monotony of a flat wall, a technique also used in the boarding house. (See photo CT-2A-6.) The sill plate, exposed to both weather and rain water running down the exterior timber sheathing, was tapered and then undercut on its bottom edge to prevent water from seeping onto or under the plate. (See photo CT-2A-13.) Finally, the architectural ornament on the front of the barn is unusual in structures of this type and duplicates the same architectural theme noted earlier on the forge building and fuel shed. (See photo CT-2A-1.) After viewing all these features, the Curator of Technology at Old Sturbridge Village claimed that he felt like he was walking around the inside of a fine cabinet instead of a barn, so meticulous was the workmanship and attention to detail.[37]

The architectural and historical aspects of the Whitney project were completed last summer: the archeological excavation will continue next summer and must, therefore, be judged in that context. Did the project uncover any "New Evidence on the American System of Manufactures," a goal developed before the project actually started? The answer is a tentative "no": tentative because the project did lead to a significant reevaluation of its approach to the problem of Eli Whitney and interchangeability, negative because the material uncovered at the site served only to supplement and to confirm information

in the manuscript collections rather than add new material.

The archeological excavation and the architectural recording did not uncover any milling machines or muskets marked "interchangeable." In fact, the almost complete absence of any small tools, musket parts, or other similar artifacts was a particularly disappointing aspect of the summer's work. The project uncovered one-half of Whitney's forge building and, while it is fairly certain that the hearth bases and other stonework date to the early years of the site, there was not sufficient material--or perhaps historical expertise--to confidently interpret the exact function of the excavated stonework. The project located the raceway for Whitney's first factory buildings, but it did not succeed in finding the buildings themselves, buildings that may hold the real keys to understanding Whitney's manufacturing process. Future excavation at the site, including the other half of the forge building, the area where the first factory building should be, the raceways on both sides of the Mill River, and the peripheral areas possibly used as factory dumps may be enlightening. But it must be admitted that the past summer's archeology served to do little other than to confirm the historian's calculations regarding the placement of various buildings and to reveal the stone raceway described in the accounts of Silliman and others.

The architectural recording of the barn, boarding house, and fuel storage shed again confirmed the early manuscript accounts and the structural and functional elements of the barn indicate an ingenious and meticulous designer. But there is little direct connection between Whitney's barn and his manufacturing process and the literature on Whitney is not in need of more tenuous hypotheses drawn from equally tenuous assumptions.

On a more positive note, the historians were able to complete a detailed history of the physical site beginning with the construction of a seventeenth-century grist mill and concluding with the Heany Industries plant, still in operation. That research suggests that shortly before 1820, the Whitney armory was in poor condition. Whitney laid plans for extensive repairs, but, although he completed work on a new dam and raceways, the armory itself was never renovated.[38] Thus, those who cite the inventory of the armory taken in 1826 are using a document that only establishes the declining state of the armory that year. It is not a document that can reliably indicate the relative progressiveness of Whitney's manufacturing system in its earlier and more important developmental stages.

The most complete accounts of Whitney's manufacturing process and his factory are contained in the early descriptions of Kendall, Dwight, Olmsted, and Silliman, and the project was able, on several occasions, to confirm parts of these descriptions with archeological and architectural investigation. This physical confirmation--and the position of intellectual respect these men held in early America--makes it difficult to accept Robert Woodbury's suggestion that Whitney's claims were "uncritically accepted." Moreover, Whitney constantly invited those with whom he was dealing to visit his armory and his visitors included many of those in decision-making position in the government.[39] If Whitney was indeed consciously creating his own legend with little basis in reality, it is difficult to believe that so many bright men could have been so thoroughly misled. It is easier to believe that Whitney was, in his own context, doing just what he and others said he was doing.

The importance of judging Whitney in his own context provides the focus for a second conclusion regarding the summer project and Eli Whitney. The project started off looking for evidence of interchangeability and it is now apparent that this was the wrong question. It is true that Whitney wrote often of uniformity in his musket pieces and claimed his machines would produce musket parts like a copper engraving produces prints. What few have recognized since then is that even the printed results of a copper engraving are only approximately alike within their own context. None of the early accounts claim full interchangeability for Whitney's musket parts; they claim only that the various parts were easily adjusted to different muskets without material alteration.[40] Edwin Battison tested the interchangeability of a few Whitney muskets and found that the parts would not easily interchange. Other scholars have examined other government arms and it is clear that interchangeability was never fully achieved on any of them during most of the first half of the nineteenth century. The pistols of Simeon North do not interchange;[41] the muskets of Harpers Ferry and Springfield do not interchange before 1842.[42] Even the Colt revolver of the 1850s does not fully interchange and we should note that this was the revolver that impressed the British at the Crystal Palace with its American System of Manufacture.[43]

Interchangeability is, thus, a moot point. It was not the interchangeability of his final product--for which Whitney has been both praised and condemned--but the manufacturing process he employed to create that product that historians must know more about if they are to evaluate Whitney fairly.

Olmsted's description of Whitney's methods remains the most complete account available and it is worth quoting:

> The several parts of the musket were, under this system, carried along through the various processes of manufacture, in lots of some hundreds or thousands of each. In their various stages of progress, they were made to undergo successive operations by machinery, which not only vastly abridged the labor, but at the same time so fixed and determined their form and dimensions, as to make comparatively little skill necessary in the manual operations. Such were the construction and arrangement of this machinery, that it could be worked by persons of little or no experience, and yet, it performed the work with so much precision, that when, in the later stages of the process, the several parts of the musket came to be put together, they were as readily adapted to each other, as if each had been made for its respective fellow. A lot of these parts passed through the hands of several different workmen successively...each performing upon them every time some single and simple operation, by machinery or by hand, until they were completed. Thus, Mr. Whitney reduced a complex business, embracing many ramifications, almost to a mere succession of simple processes, and was thereby enabled to make a division of the labor among his workmen, on a principle which was not only more extensive, but also altogether more philosophical than that pursued in the English method. In England, the labor of making a musket was divided by making the different workmen the manufacturers of different limbs, while in Mr. Whitney's system, the work was divided with reference to its nature, and several workmen performed different operations on the same limb.[44]

This account--and it is echoed in Whitney's letters and in other's descriptions--makes it clear that it was not interchangeability that impressed Whitney's contemporaries, it was his division of labor according to the kind of task performed and the machines he developed to perform these

tasks, thus making it possible to employ unskilled workers rather than skilled armorers.[45]

This functional division of labor and the use of unskilled labor to operate machines producing uniform pieces is the basic conceptual innovation of the American System. Interchangeability, attributable to an increasing sophistication of machine tools and manufacturing processes, is a later result of this innovation, not an innovation in itself.

If we are to believe contemporary accounts--and the work this summer adds to the reasons for doing so--then Eli Whitney played a significant early role in the development and spread of this system. If we do not accept contemporary accounts (a rather serious historical judgement, considering the authors of those accounts), or if these accounts must be substantiated by physical evidence, then historians must turn to the only evidence available and only still partially examined--the Whitney factory. The work of this past summer provides a first look at the kinds of evidence and the difficulties of interpretation that will have to be dealt with if this is to be accomplished. It is to be hoped that the excavation of this coming summer, building on the efforts of the summer past, will provide "New Evidence on the American System of Manufacture."

NOTES

1. I am grateful to Charles K. Hyde, Selma Thomas, Lewis Hunter, and Eugene Ferguson for their criticism and assistance.

2. Solomon Williams to Eli Whitney, 2 May 1798, Eli Whitney Collection, Yale University Library (hereafter cited as EWC). Williams told Whitney to "strike some new invention which will astonish the world and command all their Purse Strings."

3. Concise Dictionary of American Biography (New York, 1964), p. 1197.

4. Eli Whitney to Oliver Wolcott, 1 May 1798, EWC.

5. Eli Whitney to Oliver Wolcott, 30 July 1799, EWC.

6. Eli Whitney to Henry Dearborn, 27 June 1801, EWC.

7. Edward Augustus Kendall, Travels Through the Northern Parts of the United States in the Years 1807 and 1808 (New York, 1809), pp. 251-2.

8. Timothy Dwight, A Statistical Account of the City of New Haven (New Haven, 1811), pp. 31-2.

9. Denison Olmsted, Memoir of Eli Whitney, Esq. (New Haven,1846), p. 50. This article first appeared in The American Journal of Science and Arts, v. 21, no. 2, 1832.

10. Benjamin Silliman, "Reminiscences of the Late Mr. Whitney," in Ibid., p. 67.

11. Charles H. Fitch, "The Rise of a Mechanical Ideal," Magazine of American History, v. 9, no.6, June 1884, pp. 516-18.

12. W.F. Durfee, "The First Systematic Attempt at Interchangeability in Firearms," Cassier's Magazine, v. 5, no. 30, April 1894, pp. 469-77. See also his "The History and Modern Development of the Art of Interchangeable Construction in Mechanism," Transactions of the American Society of Mechanical Engineers, v. 14, 1893, pp. 1225-57.

13. Mirsky and Nevins, The World of Eli Whitney (New York, 1952), pp. 177-89, 223-43. See also Constance Green, Eli Whitney and the Birth of American Technology (Boston, 1956), pp. 119-43.

14. Brother C. Edward, "Eli Whitney: Embattled Inventor," American History Illustrated, v. 8, no. 10, February 1974, pp. 5-9, 44-7.

15. Robert S. Woodbury, "The Legend of Eli Whitney and Interchangeable Parts," Technology and Culture, v. 1, no. 3, Summer 1960, p. 235.

16. Ibid., pp. 236-7.

17. Ibid., pp. 240-1.

18. Ibid., p. 250.

19. Ibid.

20. Edwin A. Battison, "Eli Whitney and the Milling Machine," The Smithsonian Journal of History, v. 1, no. 2, Summer 1966, pp. 9-34. See also his "A New Look at the 'Whitney' Milling Machine," Technology and Culture, v. 14, no. 4, October 1973, pp. 592-8.

21. Ibid., p. 21.

22. Ibid., p. 23.

23. Yale keeps a card file on the users of each of its manuscript collections and which parts of each collection the individual examined.

24. Daily Morning Journal, news clipping, no date (c.1861), New Haven Water Company Papers, New Haven Colony Historical Society Library (unaccessioned). All information on the development of the site is drawn from Part 1 of this report (Site History) prepared by the project historians.

25. See Part 1: Site History, Section V.

26. Ibid.

27. Silliman, "Reminiscences," p. 68.

28. William Giles Munson, "The Eli Whitney Gun Factory, 1826-28," Yale University Art Gallery, Mabel Brady Garvin Collection (HAER Photo CT-2-7). "Whitney's Armory Near New Haven, Ct.," from Henry Howe, Memoirs of the Most Eminent American Mechanics (New York, 1842), p. 124 (photo CT-2-11).

29. Eli Whitney to Josiah Stebbins, 4 June 1815, EWC, mentions that he would "be occupied ... in erecting some additional buildings near [his] manufactory" and the 1826 Inventory of the Estate, EWC, lists the contents of the boarding house.

30. Silliman, "Reminiscences," pp. 68-9.

31. Census of the United States (1800), "Photostat of the Original Returns of the Assistant Marshals," Connecticut State Library.

32. See Eli Whitney to Oliver Wolcott, 31 May 1799; Eli Whitney to Josiah Stebbins, 26 April 1800; Eli Whitney to Callendar Irvine, 4 November 1813; all EWC. See also manuscript census reports, Connecticut State Library.

33. Part 1: Site History, Section VII. Eli Whitney to Josiah Stebbins, 4 June 1815; Eli Whitney to John Morten, 12 August 1815; Josiah Stebbins to Eli Whitney, 21 October 1815, EWC.

34. Silliman, "Reminiscences," p. 69.

35. Connecticut Journal, 24 June 1817, p. 3. See also ibid.

36. Most of the structural analysis presented here is included in data book CT-2A on the Whitney barn.

37. Four members of the Old Sturbridge Village Research Department spent a day inspecting the Whitney site. I am grateful to them for several suggestions.

38. On 18 May 1814 Whitney wrote to the then Secretary of War James Monroe that his armory was "much more extensive and complete than that of any other individual in the U. States." Thereafter, things apparently went downhill. See Eli Whitney to Josiah Whitney, 9 September 1820 and 10 November 1820 regarding extensive repairs and Eli Whitney to Simeon Baldwin, 27 January 1823, about his desire to put the works in repair before turning them over to his nephews. See also Part 1.

39. Virtually every letter Whitney wrote to a government official includes an invitation to visit. See Eli Whitney to Hezekiah Rogers, 17 August 1807, and Eli Whitney to Henry Dearborn, 14 June 1808, as examples. Olmsted's Memoir reports on the personal visit of "the Secretary" (presumably Wolcott) p. 48.

40. See the Dwight and Kendall descriptions previously cited.

41. The North contract of 1813 was the first government contract to specify interchangeability. North's next contract, signed in 1816, dropped that specification. See fn 43.

42. Joseph Wickham Roe, English and American Tool Builders (New Haven, 1916), p. 160. Eli Whitney Jr. was the first to produce this musket with a steel barrel.

43. Robert Howard, Curator at the Hagley Museum, is working on an article of firearms manufacture in the nineteenth century and generously shared his findings with me. See fn 16 in Paul Uselding, "Elisha K. Root, Forging, and the American System," Technology and Culture, v. 15, no. 4, October 1974, p. 549 and also Eugene S. Ferguson, "Expositions of Technology, 1851-1900," in Melvin Kranzberg and Carroll Pursell, Technology and Western Civilization, v. 1 (New York, 1967), pp. 711-12.

44. Olmsted, Memoir, pp. 53-4.

45. Whitney and the early descriptions consistently maintained that his work force was unskilled in arms manufacture. See Eli Whitney to Oliver Wolcott, 12 July 1798; Eli Whitney to Samuel Dexter, 8 January 1801; Eli Whitney to Henry Dearborn, 5 November 1807; Eli Whitney to Callendar Irvine, 25 November 1813; and Dwight, Statistical Account, pp. 58-9. This is not to say that Whitney did not depend on a few skilled workers. See Eli Whitney to N. Terry, 22 September 1803, "one of my workmen on whom I principally depend in doing a particular piece of work;" Eli Whitney to Oliver Wolcott, 31 May 1810, a delay due to workmen "induced away to Springfield;" Roswell Lee to Eli Whitney, 20 June 1815, regarding a hammerman requested by Whitney. All in EWC.

Prepared by T. Allan Comp
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BIBLIOGRAPHY

Manuscript Collections

Connecticut State Library

"Analysis of the accounts of the United States armoury at Springfield, Mass., showing cost of manufacturing muskets, with objections by the legal representatives of Eli Whitney estate on allowances made by the Springfield armoury under a contract with Eli Whitney for 1822." 1829.

United States Bureau of the Census. Original manufacturing and population returns for New Haven County, Connecticut for the years 1800-1880.

Hamden Historical Society

Certificate of [Musket] Manufacture, Luther Sage, 12 August 1816.

New Haven Colony Historical Society Library

Dana Collection
New Haven Water Company papers (unaccessioned)
Miscellaneous

Yale University Library

Baldwin Family Collection
Benjamin Silliman Collection
Betts Collection
Blake Family Collection
David Daggett Collection
Dwight Family Collection
Eliot Family Collection
Eli Whitney Collection (This collection also contains copies of materials in the National Archives relating to Whitney.)
Hillhouse Family Collection
Munson Family Collection
Stokes Autograph Collection
Whitney Arms Company Collection

Newspapers

Cheshire Hamden Times, 16 May 1906
Columbian Register, 15 January 1825
Connecticut Journal, 24 June 1817, 11 January 1825

Published Works

Barber, John Warner. Connecticut Historical Collections. New Haven, 1836.

Battison, Edwin. A. "Eli Whitney and the Milling Machine." Smithsonian Journal of History 1 (1966):9-34.

———. "A New Look at the 'Whitney' Milling Machine." Technology and Culture 14 (1973):592-98.

Bidwell, Percy Wells. Rural Economy in New England at the Beginning of the Nineteenth Century. New Haven, 1916.

Blake, William P. History of the Town of Hamden, Connecticut. New Haven, 1888.

———. "Sketch of the Life of Eli Whitney, the Inventor of the Cotton Gin." New Haven Colony Historical Society Papers, vol. 5. New York, 1894.

Clark, Victor S. History of Manufactures in the United States, vol. 1. 3 vols. 1868. Reprint. New York, 1967.

Connecticut. Report of the Secretary of State Relative to Certain Branches of Industry. Conn. House of Representatives. Doc. 26, May Session, 1839. Hartford, 1839.

———. Statistics of the Condition and Products of Certain Branches of Industry in Connecticut for the Year Ending October 1, 1845. Hartford, 1846.

Dana, James D. The Four Rocks. New Haven, 1891.

Deyrup, Felicia Johnson. Arms Makers of the Connecticut Valley: A Regional Study of the Economic Development of the Small Arms Industry, 1798-1870. Smith College Studies in History, vol. 33. Northampton, 1948.

Durfee, W.F. "The First Systematic Attempt at Interchangeability in Firearms." Cassier's Magazine 30 (1894):469-77.

_____. "The History and Modern Development of the Art of Interchangeable Construction in Mechanism." American Society of Mechanical Engineers. Transactions 14 (1893).

Dwight, Timothy. A Statistical Account of the City of New Haven. New Haven, 1811.

_____. Travels in New England and New York. 4 vols. New Haven, 1821.

Ferguson, Eugene S. "Expositions of Technology, 1851-1900." Technology and Western Civilization, edited by Melvin Kranzberg and Carroll Pursell, vol. 1. New York, 1967.

Fitch, Charles H. "Report on Manufactures of Interchangeable Mechanism." Tenth Census of the United States: 1880, volume on Manufactures, pp. 617-704. Washington, D. C., 1883.

_____. "The Rise of a Mechanical Ideal." Magazine of American History 11 (1884):516-27.

Fuller, Claud E. The Whitney Firearms. Huntington, W. Va., 1946.

Fuller, Grace Pierpont. An Introduction to the History of Connecticut as a Manufacturing State. Smith College Studies in History, vol. 1. Northampton, 1915.

Gale W. K. V. The Iron and Steel Industry: A Dictionary of Terms. Newton Abbot, England, 1971.

Green, Constance. Eli Whitney and the Birth of American Technology.

Hammond, M. B. "Correspondence of Eli Whitney Relative to the Invention of the Cotton Gin." American Historical Review 3 (1897):90-109.

Hartley, Rachael M. The History of Hamden, Connecticut, 1786-1936. Hamden, Connecticut, 1943.

Howe, Henry. Memoirs of the Most Eminent American Mechanics. New York, 1844.

Hubbard, Guy. "Development of Machine Tools in New England." American Machinist 60 (1924):205-209.

Jefferson, Thomas. Writings. Edited by H. A. Washington, vol. 1. 9 vols. New York, 1853-1855.

Kendall, Edward Augustus. Travels through the Northern Parts of the United States in the Years 1807 and 1808. 3 vols. New York, 1809.

Kraus, Michael. "Scientific Relations between Europe and America in the Eighteenth Century." Scientific Monthly 55 (Sept. 1942).

Macdonald, Robert R. "Eli Whitney and the Development of American Technology." Discovery 8 (1973):83-92.

Mirsky, Jeannette and Nevins, Allan. The World of Eli Whitney. New York, 1952.

Mitchell, S. A. and Ames, H. A Narrative of a Tour of Observation Made During the Summer of 1817 by James Monroe. Philadelphia, 1818.

Morse, Jarvis Means. A Neglected Period of Connecticut's History, 1818-1850. New Haven, 1933.

North, S. N. D. and North, Ralph H. Simeon North, First Official Pistol Maker of the United States. Concord, New Hampshire, 1913.

Norton, Gen. Charles B. American Inventions and Improvements in Breech-Loading Small Arms. Springfield, Massachusetts. 1880.

Olmsted, Denison. "Memoir of the Life of Eli Whitney, Esq., Inventor of the Cotton Gin." American Journal of Science and Arts 21 (1832):201-254. Reprint. New Haven, 1846.

Osborn, Norris Galpin. History of Connecticut in Monographic Form. 5 vols. New York, 1925.

Osterweis, Rollin Gustav. Three Centuries of New Haven, 1638-1938. New Haven, 1953

Pease, John C. and Niles, John M. A Gazetteer of the States of Connecticut and Rhode Island. Hartford, 1819.

Porter, Dwight. "Report on the Water Power of the Region Tributary to Long Island Sound." Tenth Census of the United States: 1880, vol. 16, pp. 161-333. Washington, D. C., 1885.

Potter, Alonzo. The Principles of Science, Applied to the Domestic and Mechanical Arts, and to Manufactures and Agriculture. Vol. 21 in "The School Library" published under the sanction of the Board of Education of the State of Massachusetts. Boston, 1840.

Prince, Campbell. "Eli Whitney." The Peterson Magazine. November 1897, pp. 1133-36.

Roe, Joseph Wickham. English and American Tool Builders. New Haven, 1916.

_____. "Machine Tools in America." Journal of the Franklin Institute 225 (1938):499-511.

_____. "Interchangeable Manufacture in American Industry." Transcript of an address given 14 November 1939 to the Newcomen Society meeting, held in Montgomery, Alabama, Montgomery, 1939.

Sawyer, John E. "The Social Basis of the American System of Manufacturing." Journal of Economic History 14 (1954):361-79.

Silliman, Benjamin. "Reminiscences of the Late Mr. Whitney." The American Journal of Science and Arts 21 (1832):255-65. Reprint. New Haven, 1846.

Smith, Merritt Roe. "From Craftsman to Mechanic: The Harpers Ferry Experience, 1798-1854." Technological Innovation and the Decorative Arts, edited by Ian M. G. Quinby and Polly Ann Earl. Charlottesville, Virginia, 1974.

_____. "John H. Hall, Simeon North, and the Milling Machine: The Nature of Innovation Among Antebellum Arms Makers." Technology and Culture 14 (1973):573-91.

Stiles, Ezra. Extracts from the Itineraries and Other Miscellanies of Ezra Stiles. Edited by Franklin Bowditch Dexter. New Haven, 1916.

———. The Literary Diary of Ezra Stiles. Edited by F. B. Dexter. 3 vols. New York, 1901.

United States Bureau of the Census. Fourth Census of the United States: 1820. Digest of Accounts of Manufacturing Establishments in the United States, and of their Manufactures. 1823.

———. Sixth Census of the United States: 1840. Aggregate Value and Produce and Number of Persons Employed in Mines, Agriculture, Commerce, Manufacture, &c. 1841.

———. Eighth Census of the United States: 1860. Manufactures of the United States in 1860. 1865.

———. Ninth Census of the United States: 1870. The Statistics of the Wealth and Industry of the United States. vol. 3, 1872.

———. Tenth Census of the United States: 1880. Report on the Manufactures of the United States. vol. 2, 1883.

———. Tenth Census of the United States: 1880. Reports on the Water Power of the United States. vols. 16, 17, 1883.

———. Eleventh Census of the United States: 1890. Report on the Manufacturing Industries of the United States. vol. 6, 3 parts, 1895.

United States Senate. Message of the President of the United States, Communicating a Digest of the Statistics of Manufactures According to the Returns of Seventh Census. Executive Document No. 39, 35th Cong., 2d Sess.

United States Treasury. Documents Relative to the Manufactures of the United States: 1833. 2 vols. Reprint. New York, 1969.

Uselding, Paul. "Elisha K. Root, Forging, and the American System." Technology and Culture 15 (1974):543-68.

Waldo, S. Putnam. The Tour of James Monroe, President of the United States, Through the Northern and Eastern States in 1817. Hartford, 1820.

Woodbury, Robert S. "The Legend of Eli Whitney and Interchangeable Parts." Technology and Culture 1 (1960):235-53.

ADDENDUM TO:
ELI WHITNEY ARMORY
West of Whitney Avenue, Armory Street Vicinity
Hamden
New Haven County
Connecticut

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HAER CONN,5-HAM,3-

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