The Importance of Research Outside the Library: Watkins Mill, A Case Study

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The author argues that industrial archeology can make significant contributions to the historical record by providing new and detailed information with which we can evaluate and amend previous interpretations in the history of technology, labor, and business, and on the basis of which we can explore new areas in American history, such as the history of the inarticulate, the workers, and others.

To illustrate how artifacts can be used, the author uses a mid-19th-century woolen mill, located in Lawson, Missouri and built in 1861 by Waltus Watkins. The mill holds the finest collection of textile machinery in situ *in North America and thus provides a great deal of information, otherwise unavailable, on the techniques, difficulties, and achievements of Watkins, his suppliers, and his employees.*

Several recent trends in the field of United States history may be seen, in combination, to encourage a more holistic approach to the subject. Exploration of new areas, such as the history of the inarticulate, the new labor history, even the history of technology, aims, by concentrating on topics previously ignored or slighted, to create a more complete and/or accurate picture of the past. A parallel movement toward interdisciplinary approaches suggests the possibility of combining the two trends. Interest in material culture and occasional attention to artifactual evidence on the part of established scholars (often those connected to a museum), raise the possibility that industrial archeology may offer a significant opportunity for some of these new historiographical focuses.

Traditionally, students in standard areas of history such as economics or labor were not prepared for or encouraged in a material approach. Those trained in the use of physical evidence, such as archeologists and historians of architecture and the arts, gave little attention to such subjects as the relationship between industrial structures and machinery, and to the experience of the work force, the development of technology, or other fields related to the industrial past. The value of the artifactual record did not go totally unrecognized:

> The physical things of technology in many ways remain the ultimate source for the history of technology. Preserved products and tools as well as other traces left by these technologies—including railroad cuts and canal segments, razed factories and mine shafts—constitute repositories of information poorly understood by the general historian. . . . The means of technology are physical; the objectives of technology are also physical or material. Three-dimensional physical objects are the expression of technology—in the same way that paintings and sculpture are the expression of the visual arts. They call for the same attention and celebration that is accorded works of art.[1]

It is in such areas, those broadly encompassed by industrial archeology, that I would argue the existence of significant potential for contributions to the historical record.

Before examining the special nature of physical evidence and the types of information it may offer, I should like to point out that (1) the value of written sources and interpretation is not to be slighted. Because of the nature of our evidence (largely documentary, whether interpretive or descriptive), paper sources will remain the historian's primary resource; and (2) artifacts may be misinterpreted, as may other sources; but their continued existence provides us with the opportunity to reassess them. Thus, we can correct our mistakes.

Obviously, our evidence of history remains incomplete and our conclusions about it therefore open to question. Historians have tended to concentrate on highpoints, the dramatic events and changes. This perspective responds to the availability of information and allows scholars to present their view of the relationships between events involved.

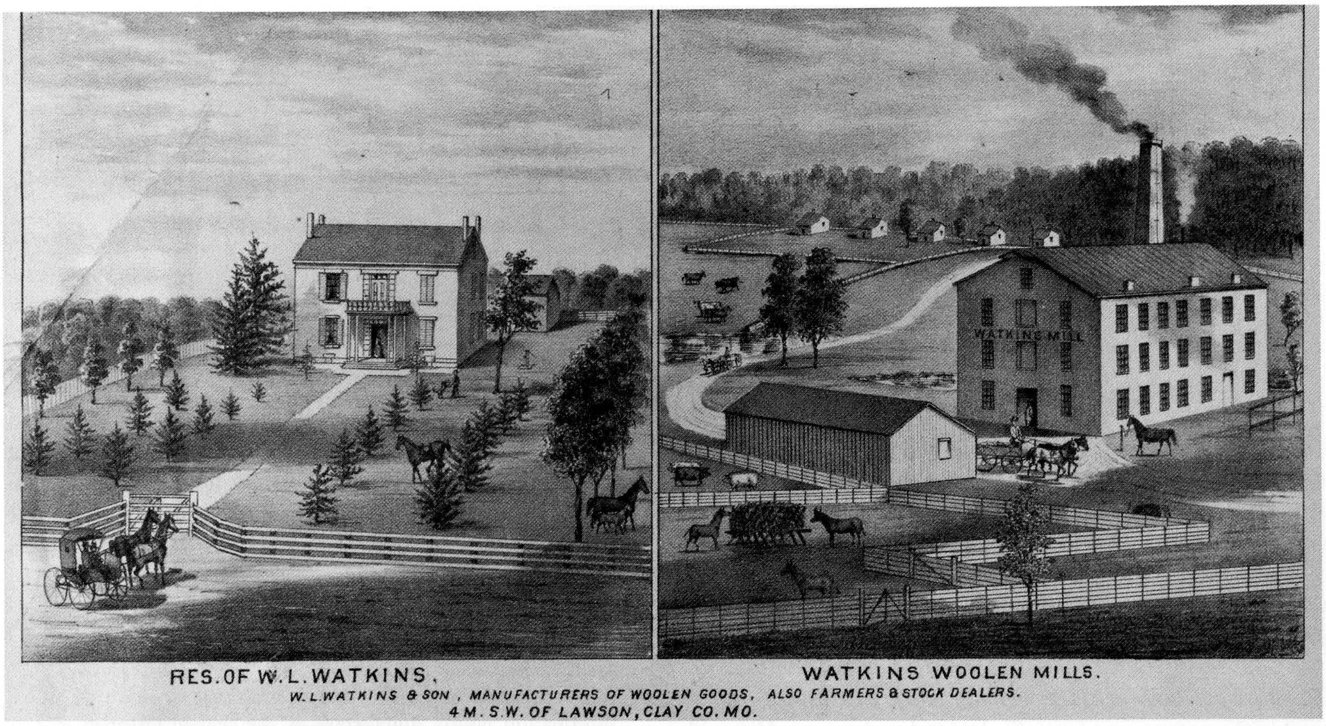

Figure 1. *Contemporary view of Watkins Mill and nearby residence of its founder.*

The dangers of such an approach are as plain as are its advantages and strengths. It accepts the importance assigned by others to the information on which it is based, giving attention to those areas (for example the content of party platforms) where records are extant. By seeking to establish broad interpretations, it moves away from the events which carried historical developments along between the visible and documented peaks. Insofar as its incompleteness permits error to enter, it magnifies the mistakes by the very breadth of conclusion for which it aims. Instead of a vital story of contest, advances and disappointments; of individuals, idiosyncracies and specificity, one often finds only generalized accounts, overall interpretations of cumulative effects, a homogenized history based on sources far removed from the individual instances upon which past developments rested.

The more complete our understanding of any part of history, the greater our ability to generalize without distorting, to present the broad view without misleading. Current attention to the inarticulate, the workers, and others carries with it the implication that these topics have not received sufficient attention, that their relationship to history is not fully appreciated. I will argue that industrial archeology can serve these pursuits, just as it can provide new and detailed information by which to evaluate and amend previous interpretations in the history of technology, labor, and business.

I will use as case in point a mid-19th-century woolen mill which I studied for the State of Missouri and the Historic American Engineering Record. Built in 1861 by Waltus Watkins, the mill produced yarn and cloth intermittently until about 1900 when it was shut down intact. The building and its contents, a full complement of mid-19th-century machinery, are now part of the Missouri State Park System. The owner's house, and the church and school he established, are also in the park, located in Lawson, northwest Missouri (Figure 1).

This site presents an opportunity which is unique in that it preserves a nearly complete body of physical evidence. It therefore permits discussion of the range of opportunities inherent in artifactual examination. Research there yielded insights into the nature of work, innovation, and business management.

The extent to which Watkins Mill offers a representative picture of rural industry of the day remains to be determined. It does not represent a *typical* opportunity for industrial archeology, for the site is unusual in its completeness. It is convenient for this discussion, however, because it presents the possibilities inherent in industrial archeology and makes the potential for this type of research all the more evident.

The relationship between this operation and general industrial trends may be measured (it is the mill's typicality which has not as yet been adequately determined). Documentary sources inform us that Waltus Watkins started production during a period of expansion and opportunity throughout the industry, that increasingly efficient and comparatively automatic machinery was becoming available, and that continuing efforts to reduce the industry's dependence on skilled labor were meeting with considerable success.

Surviving business records show from whom Watkins bought his equipment and how much he paid for it. A few letters and partial payrolls offer minimal data regarding work in the mill. In the case of most historic businesses there remains still less data, but from such thin resources comes much of our knowledge of industrial history.

In contrast to this meager documentary account stands the mill itself, holding the finest collection of textile machinery *in situ* in North America. All of the mill's carding machines, spinning jacks, twisters and looms remain in place as used and altered. The record thus provided offers a great deal of information, otherwise unavailable, on the techniques, difficulties, and achievements of this rural manufacturer, his suppliers, and his employees. Used in conjunction with traditional sources and other surviving artifacts, the mill offers a vastly more complete picture of its operation than would ordinarily be available. By doing so, it presents a wealth of data to supplement and/or correct previous interpretations of related sites and developments.

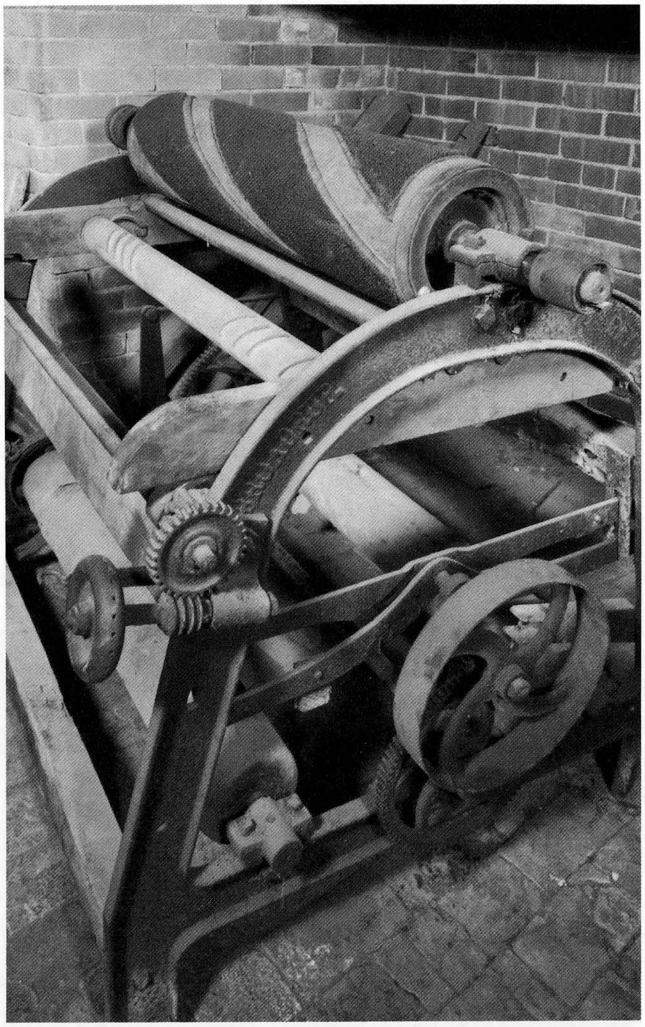

Figure 2. *Cloth stretcher manufactured by Broadrup and Co., Dayton, Ohio. Photos by Jet Lowe for Historic American Engineering Record, 1978, unless otherwise noted.*

The contents of the mill are educational in many ways and on various levels. Regarding the history of textile technology, the most basic type of service they can provide is to introduce one to a previously unseen machine: a cloth-stretcher of an unknown type which removed wrinkles from fulled cloth in preparation for napping, or raising, its surface fibers. It represents a small change in production techniques, perhaps, but one typical of the movement from hand operations to powered techniques which was the basis of industrial production. A discovery such as this, of course, is a rare bonus, one of those unexpected puzzles (it had formerly been unidentified) which offers new information for its solution (Figure 2).

Other machines provide data on developments in areas where conflicting approaches are known but in which our record of developments is surprisingly incomplete, as in the development of the power loom. The earliest looms built in the United States used different techniques to accomplish the beater- or lay-motion which pushes each strand of weft yarn into the previously woven cloth. The Waltham loom of the Boston Associates utilized a cam for this purpose, while the Rhode Island loom, built by William Gilmour, incorporated the crank motion which soon prevailed.

A broadloom at Watkins Mill displays yet another solution to the problem. Built by Alfred Jenks, a respected Philadelphia machine-builder with early Rhode Island experience, this loom utilized a novel technique which fell outside the mainstream of power loom development. Each lay sword (the legs on which the lay pivots) contained an opening shaped like a rounded crescent; an iron disk on a gear-driven shaft turned behind the opening, and a protrusion on the disk revolved in the opening, providing the requisite reciprocal motion. It cannot readily be ascertained whether this technique represented an attempted improvement or simply an effort to avoid a patented motion. In either case, it offered an alternative to both the crank motion of Gilmour's "Scotch" loom and the cam-operated lay of the Boston Associates' loom. It also demonstrates that the debate over the best kind of motion persisted far longer than previously realized and included at least one attempted and effective solution not included in modern discussions. While trade catalogue illustrations partially revealed the existence of such an alternative, it was only the existence of the machine itself which disclosed how it worked (Figures 3, 4, and 5).

Alternative means for accomplishing well-known ends represent one of the more consistently informative aspects of this type of research. The diversity of designs displayed among the power looms, for example, indicates the extent to which innovation continued during this largely unstudied period. While major developments in power-weaving are discussed, for example around 1815, 1840, and 1890, industrial archeology offers the chance to study the developments occurring between those high points which are treated at length in written sources.

A factor as central as the picker-motion, which sends the shuttle back and forth across the loom, requires up to 70 percent of the loom's power and essentially determines the rate at which it produces cloth, appears at Watkins Mill in numerous configurations. Present are the Stearns parallel picker motion, invented in 1859, which would become standard, and the bat-wing drive, also used throughout the industry. These are exceptions here, however; several less effective techniques predominated.

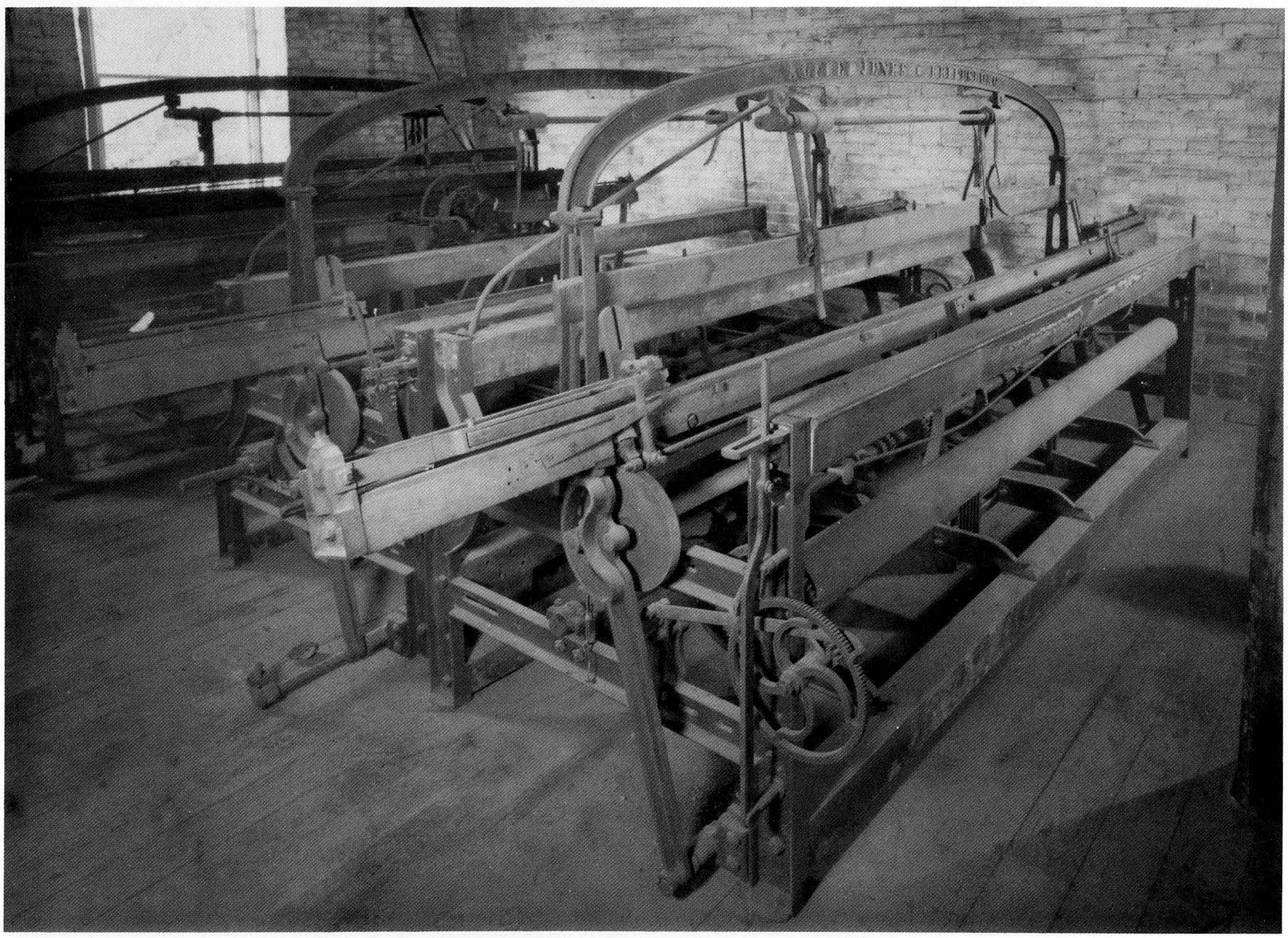

Figure 3. *Broadloom marked Alfred Jenks, of Bridesburg, Penn., with lay motion at center of the scene.*

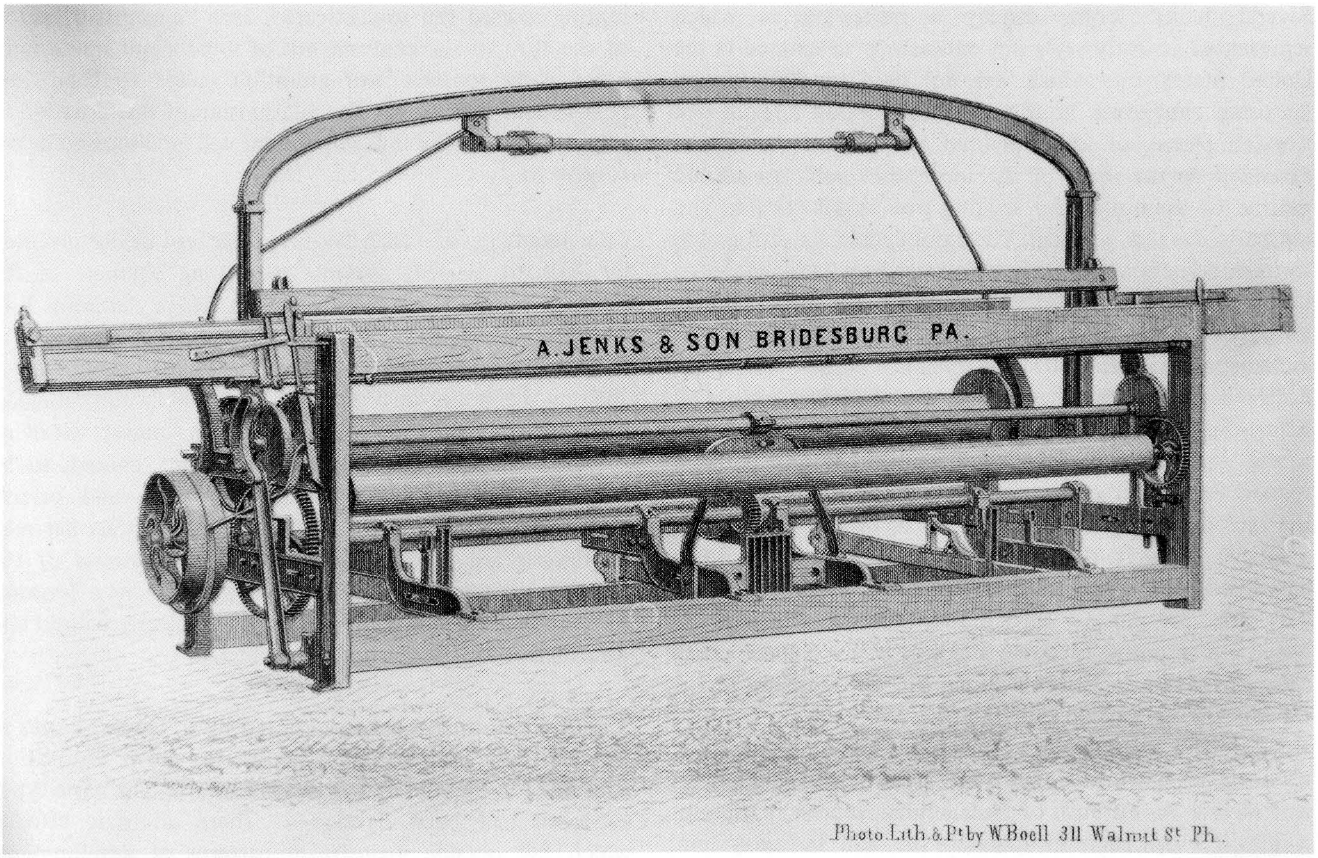

Figure 4. *A Jenks and Son broadloom. The lay motion is partially visible, at left, while the picker motion is omitted altogether. From* Descriptive Catalogue of Machines Built by the Bridesburg Company *(Bridesburg, Penn., 1867). Courtesy Merrimack Valley Textile Museum.*

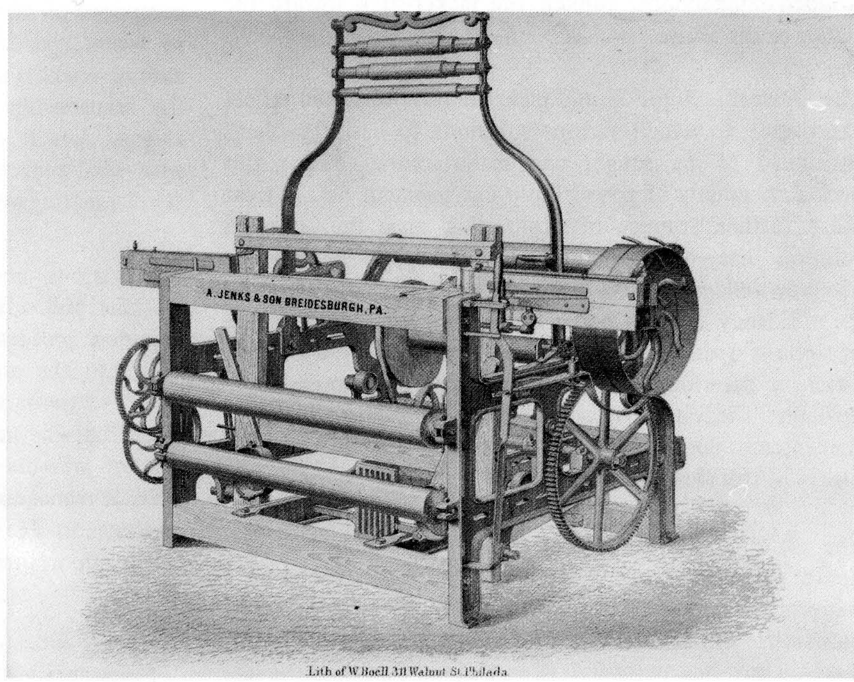

Figure 5. *A plain loom. The leather strip from the picker stick to picker is omitted. These lithographs (c1867) represent a selective and interpretive view of the machines. From* Descriptive Catalogue of Machines Built by the Bridesburg Company *(Bridesburg, Penn., 1867). Courtesy Merrimack Valley Textile Museum.*

Several Jenks' looms display a picker-motion which represented an early style not extensively developed in the United States, one which was not used by other manufacturing companies in this or later periods. Treadle-like wooden pieces, or arms, pivoted at the back beam and extended to the front of the loom. Pick-balls transferred motion to these arms by striking iron ridges set into and bolted to the tops of them. The front end of the arm passed through a leather strap attached to an iron wheel mounted on an iron bar connected to the lay and holding a wooden lever, or picker-stick. A leather strap ran from the picker-stick to a rawhide pick hammer, which slid on an iron rod behind the shuttle box into which it extended. When the pick-ball drove the arm down, it pulled on the wheel, and thus the picker-stick yanked the pick hammer toward the center of the loom, sending the shuttle across the race plate on the lay to the shuttle box on the far side; a length of weft was left in the shed. Although Jenks advertised that looms of this type could run at speeds of 130 picks per minute, their motion was less efficient, less exact, more prone to error, and less easily adjusted than others available in Watkins' time. The combination of the Stearns picker motion and the ball and shoe or bat-wing style of drive, as represented at Watkins Mill on looms made by both the Stafford Company of Readville, Massachusetts and Merrill A. Furbush of Philadelphia, represent superior solutions which came to dominate the field. In this system, a ball struck the curved shoe, twisting the square shaft on the side of which it was mounted and, through iron and wooden connections, yanked the picker-stick toward the center of the loom.

The unusual lay-motion and picker-motion observed reflect the degree to which various solutions to basic problems continued to be sought and manufactured during this period. Accounts of power loom development do not treat these further avenues of exploration once the accepted solution has been discovered. The large number of machine-builders in this period, and their apparent desire for efficiency and distinctiveness, kept a considerable range of options open to manufacturers, making the work of the latter in determining what machinery to purchase more difficult. The variety of solutions would seem to highlight the intense competitiveness of the machine-building industry at this time, as well.

The net effect of this diversity, caused in part by Watkins' desire to produce a variety of materials, is chaos, a weaveroom where 17 looms of seven basic types reveal numerous means for accomplishing the desired ends. Take-up motions, pattern devices, stop motions and the like leading toward the sophisticated, even "automatic" looms of the turn of the century, but of insufficient importance individually to have had attention called to them, are present and significant. The relationship of this situation to other aspects of the mill's operation will be discussed below (Figure 6).

Coincidentally, one such feature, a pattern device invented by Richard Garsed, presents a striking example of the research value of industrial artifacts. When Anthony F.C. Wallace cites Garsed's work, particularly this invention, in *Rockdale,* he discusses Garsed's intellectual activity.[2] Finding the device in Watkins Mill puts the invention in the context of utilized improvements in power weaving, identifies it as a development important enough to be manufactured—and not by the inventor alone—and corrects a misinterpretation of its operation. The contrast between its description in *Rockdale*, and in the *Journal of the Franklin Institute* in 1847, and its presence in a Missouri mill supplied by another manufacturer is clearly helpful and informative to a researcher in the field.[3]

The diversity of designs represented by the power looms at Watkins Mill indicates the degree to which innovation continued during the mid-19th century after the basic types of loom had been developed. These alternate efforts, which fall outside mainstream patterns of development, would otherwise have remained unknown, lost amid the plethora of patented inventions. The patent record, composed of many tens of thousands of inventions related to looms, paradoxically loses value because of its very extensiveness. Furthermore, one cannot determine from it the relationship of a patented concept to technological change: was it made? used? and if so, how extensively? with what success? The patent record seems most useful in supplementing evidence gathered from other sources.

The various and continuing attempts discoverable at Watkins Mill whereby machine-builders sought to revolve common problems represent something more than excursion into the arcane. These efforts record an important aspect of the industrial history of the period. They present the activity of inventors and machine-builders, the occupation of weavers and loom-fixers, and a challenge to the skills of management, as well. Nathan Rosenberg and Walter Vincenti, in *The Britannia Bridge,* recently called attention to the importance and potential of this sort of study:

> It is . . .difficult to liberate ourselves from the confining perspectives of the present. It is deceptively easy to evaluate

the significance of individual technological improvements in terms of their contribution to that ongoing stream that directly flowed into visible, present-day technologies. If this approach is not successfully resisted (and it usually is not), technological history then becomes the celebration of a series of such success stories. In fact, as we have argued, there was a vast accretion to the stock of technical knowledge and much growth in technical expertise as a result of efforts expended in the development of specific technologies that for a variety of reasons were discarded or bypassed in the later onward rush of industrial development. It is therefore likely to be seriously misleading to write technological history in terms of developments that have survived in present practice. If we are concerned, as we believe it is necessary to be, with the collective learning process underlying industrial societies, then we must recognize that the success and survival of individual technologies do not provide an adequate guide to the sources and the growth of industrial skills.

If this view is correct, our understanding of the historical growth of technological knowledge and skills may be vastly expanded by identifying and studying other specific events that, even though they eventually proved to be commercial failures or experienced only short productive lives, made important contributions to technological knowledge.[4]

Artifactual evidence offers one of the best and often the only way to discover these "anonymous" developments, essentially non-written and not written of. This attribute also begins to suggest ways in which the artifactural record can speak to historians of labor.

Information of the type found in Watkins Mill represents a valuable resource for the student of labor history and should prove indispensable to the "new labor historians" who pursue the subject from the bottom up, starting with the workers rather than their institutions. This orientation toward the work experience requires, I believe, an understanding of the work done, the machines used, and the operatives' relationship to them. Such understanding is often impossible without the kind of concrete knowledge offered by artifacts. As in the above quotation, E.P. Thompson applies the lesson to labor, objecting to an approach which "reads history in the light of subsequent preoccupations, and not as in fact it occurred. Only the

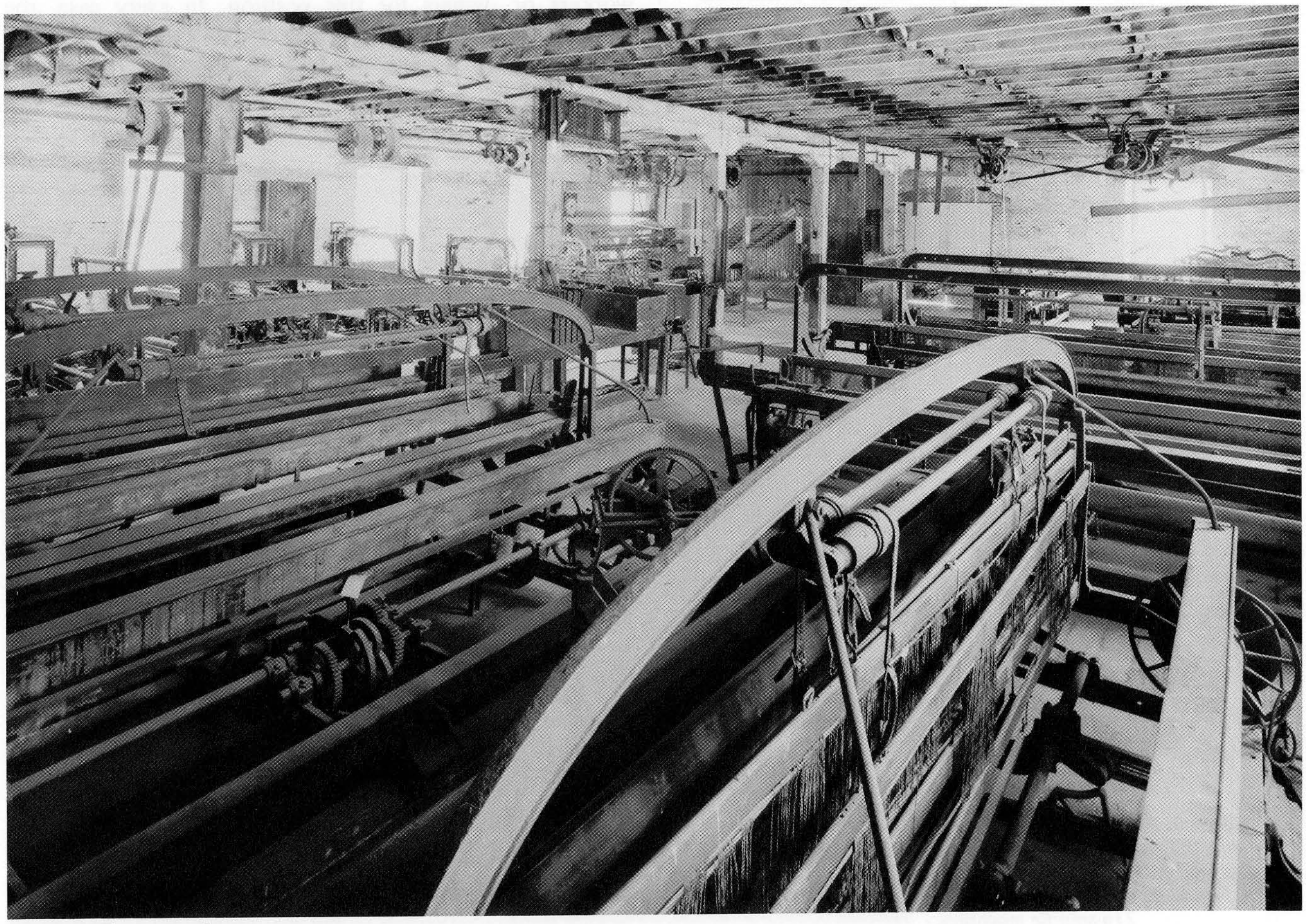

Figure 6. *The weaver loom.*

successful (in the sense of those whose aspirations anticipated subsequent evolution) are remembered. The blind alleys, the lost causes, and the losers themselves are forgotten."[5] The potential achievement of artifactually oriented study in conjunction with this new labor history is an exciting but as yet undeveloped possibility.

Labor historians now strive to understand and appreciate the experiences of working-class men and women who left few traces in the record transmitted by the publications of the upper class. These people have long been seen as an inarticulate mass because of their lack of participation in, or access to, the written record of 19th-century culture. Wallace points out that artifactual research offers a direct road to a part of their experience:

> The work of the mechanician was, in large part, intellectual work. This was true in spite of the fact that he dealt with tangible objects and physical processes, not with symbols, and that some of what he did was done with dirty hands. The thinking of the mechanician in designing, building and repairing tools and machinery had to be primarily visual and tactile, however, and this set it apart from those intellectual traditions that depended upon language, whether spoken or written. The product of the mechanician's thinking was a physical object, which virtually had to be seen to be understood; descriptions of machines, even in technical language, are notoriously ambiguous and extremely difficult to write, even with the aid of drawings and models.[6]

Artifacts preserve the record of the activity, over a period of years, of both local residents and their Eastern suppliers.

The industrial building itself can inform us about the experience of working there. For example, it is widely known that mulespinners walked many miles as they spent their days following the long carriages of whirling spindles back and forth across the floor, but the knowledge is somehow more impressive after one sees the floor boards worn down, even worn through, by these workers. Brick walls pitted by errant and potentially dangerous shuttles offer similar reinforcement. And the hole worn through the floor by the operator of a yarn hanker while he or she worked, one foot strapped to a treadle, supported by a crutch (its length indicating a small person), offers that famous "mute testimony" about the nature of this little-known job. The presence of a powered hanker patented in 1882 and probably the latest machine purchased for the mill suggests a limit to the tolerance of workers or owners for this position. In every case, the closer one comes to experiential data, the better one's comprehension of the meaning of the work experience (Figure 7).

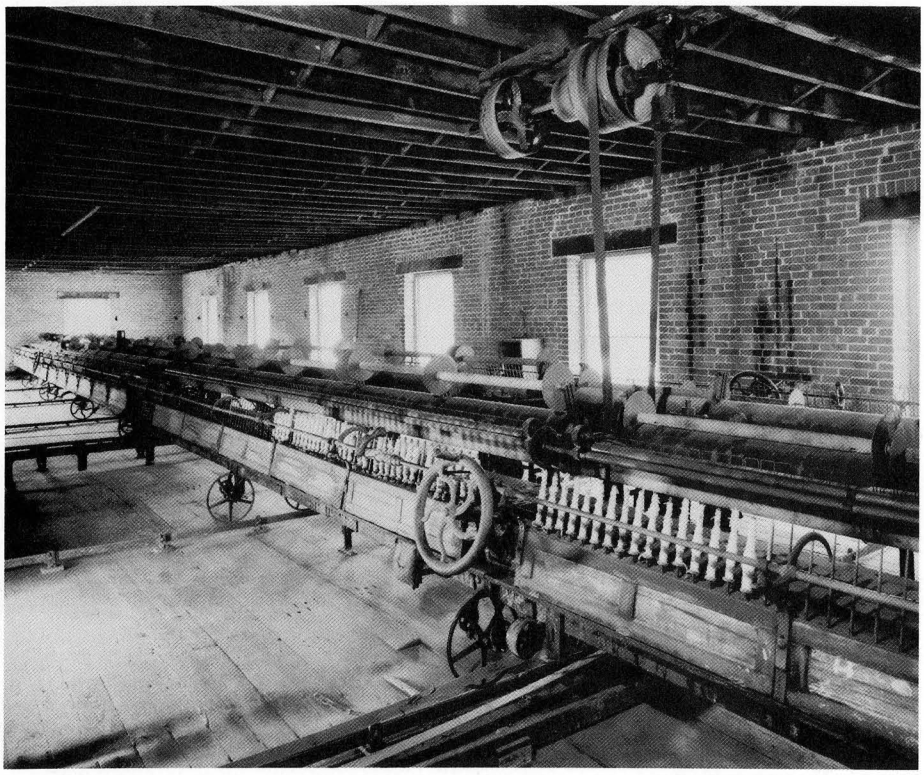

Figure 7. *Four spinning jacks, two facing the viewer, at which spinners walked for miles daily while skillfully and laboriously operating the 216-spindle machines.*

The weaveroom, once again, offers excellent examples of the ways physical evidence can add to our knowledge. The variety of looms there likely would have taxed the workers in ways which an establishment producing less various materials would not have. Apparently the workers not only met the challenge but, with only a primitive shop, managed to overcome the limitations presented by some looms and to adapt them to take advantage of superior techniques displayed by others. For example, they completely rebuilt several of Jenk's picker-motions, described above, replacing them with an improvised copy of a superior design on another loom. Unknown loom-fixers coped with a wide variety of mechanisms, a situation unlike that of more typical mills utilizing looms of a particular type to produce a more limited range of goods. Wear patterns in the floorboards show where weavers moved while tending, apparently, one or two looms apiece. Thus, the physical evidence reflects the workers' day-to-day operations and displays their ability to alter the equipment (Figure 8).

The woolen industry requires a high level of skill in a number of positions, more than required by the often-discussed cotton industry. Machines accomplished a good deal of the work, but their direction and control remained largely and literally in the workers' hands. Watkins did little to overcome his reliance on worker skill. His operation, therefore, conflicts with expectations based on better-known enterprises.

The most basic of textile innovations, those which made possible the operation of increasing numbers of machines by a given number of employees, are almost entirely lacking. Stop-motions available from the earliest part of the century are not found on Watkins' looms. Card feeds such as the Bramwell and Apperly, available at or near the time of the operation's founding, are not present despite the increase in quality they (at least the latter) offered at low cost and with less labor and less skill. Despite a 50-year international effort to eliminate mulespinners or to overcome their control of production, Watkins did not purchase the automatic machines or attachments which offered increased production and consistency and diminished reliance on, and cost of, these skilled workers.

Because he did not purchase this equipment, skilled help was required at practically every machine in the building. Workers could easily determine the pace and quality of production, thus removing a large part of the operation from direct control by management.

Watkins, for reasons which must be sought in further research, does not seem to have had the type of relationship with his workers that general sources would lead one to expect. Whether he tolerated a high level of independence without discomfiture, hired unusually dependent and untroublesome help, or whether the rural location and part-time employment in his agricultural operations somehow altered the equation has not been determined. Still, it seems that he must have had cheap labor and tolerated a decline, relative to other mills, in the quality of his product,

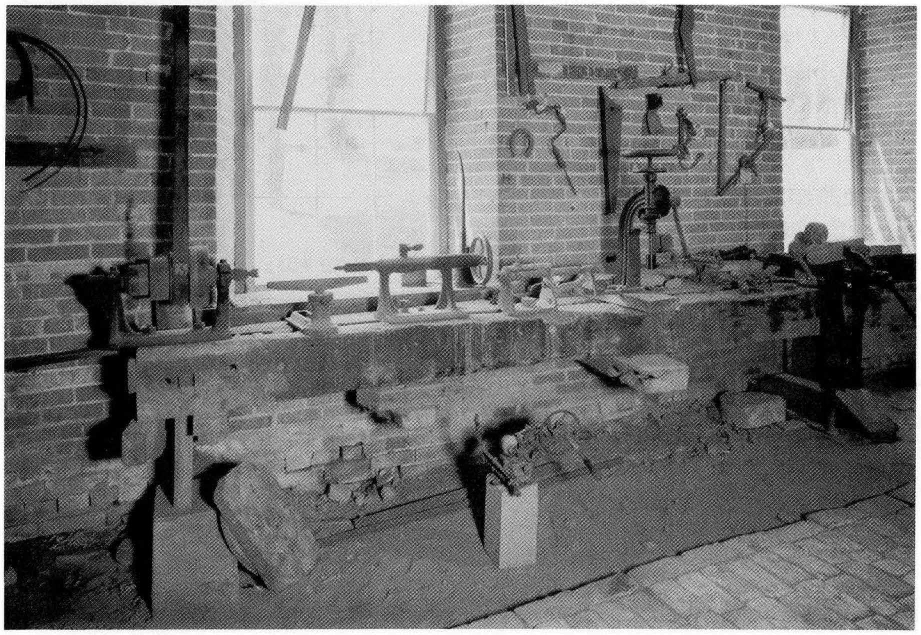

Figure 8. *Shop with wood lathe, bench-mounted hand-powered blacksmith's drill, and blacksmith's vise.*

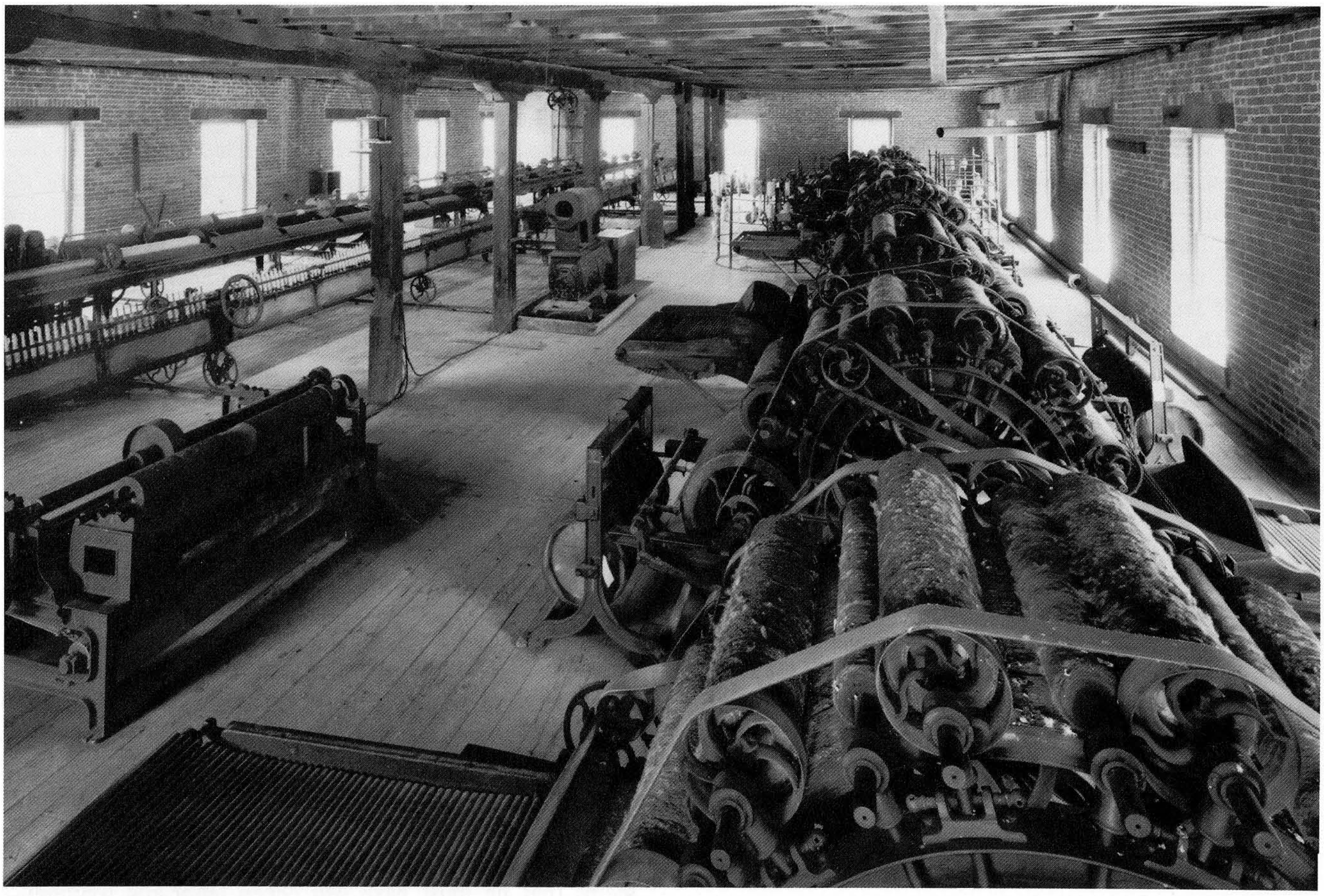

Figure 9. *Carding and spinning room. Note joisted floor above.*

for most of the labor-saving devices of this period increased cloth quality at the same time they reduced production costs.

The elucidation provided by the evidence of the structure and its contents for the operation's business history is equally informative and surprising. Various aspects of the scene violate common assumptions about a mill. No artificial evidence of lighting exists, so the mill cannot have operated for the long hours associated with maximizing profit from investment. The limited hours of operation also presumably limited the skill of the workers Watkins could attract by reducing their opportunity to earn. Most remarkably, Watkins failed, in constructing his mill, to utilize the knowledge of slow-burn construction design and techniques which had been developed in the East beginning in the 1820s. Watkins' ignorance of, or willingness to ignore, these features despite the high fire danger in textile mills must indicate an effect of his relative isolation (Figure 9).

Fire insurance companies in the East would have objected

Figure 10. *Modern view of the restored mill, 1978.*

to the dark and dangerous workspace under the peaked roof, the location of the picker and steam engine within or attached to the main structure, the excessive flammability of flooring laid on joists (rather than planking on timbers), the absence of a water-tight barrier between floors, the lack of a sprinkler system with a cistern to operate it until pumps could be turned on, the omission of a stair-tower, and the use of tied-in floors. Flooring systems bolted through the walls provided strength and rigidity, but in case of fire the collapsing floors pulled the walls in on top of them; floors which could fall free from the rest of the structure created the possibility of rebuilding within standing walls.

Locating the staircases within the building rather than in a stair-tower on the end or side not only added to fire dangers but also meant that moving machines and materials in and out of the building or through it impeded production. In a fire, employees could exit through a stair-tower, opening the fire-proof doors only as necessary, thus shutting off the draft which would otherwise feed the flames. Wool, yarn, cloth and machinery could travel vertically without interfering with other operations. A water cistern could be placed in the tower above the top floor of the mill. The lack of such a tower compounded already serious flow problems and contributed to the factory's uninsurability.

The physical evidence also shows that Watkins lacked foresight and planning in other areas related to cloth production. The spinning jacks he added left so little room that a person could scarcely pass between the two pairs. This rendered the repeated tasks of bringing fresh jack spools of roving and removing the 216 filled bobbins several times a day awkward and difficult. Elsewhere mills were often designed to accept specific equipment; lacking that degree of foresight, Watkins could have avoided the problem by ordering slightly smaller versions of these machines. Instead he aggravated the existing flow problems.

The machines also greatly expand the meaning of the documentary records of the business. The record tells us that Watkins bought two spinning jacks from Jenks, then two from Furbush and Gage, another Philadelphia area manufacturer. But we cannot appreciate the contrasts between the two sets of contemporaneous machines until we see them. While all four machines performed the same functions, the Jenks pair utilized a crude system of weights and levers to initiate various actions, provided no power for the carriage return, offered limited adjustment for producing different counts of yarn, and was not up to current standards when purchased. The Furbush and Gage machines, on the other hand, displayed recently patented features, demonstrated improved systems of timing for various motions, exhibited precise operation through clutches and gears, more solid construction, precise adjustment, and smooth, more positive and more easily duplicable actions. Without these artifacts, these contrasts could not be appreciated, nor their part in the developing spinning technology of the period be known.

Similarly, the presence on two sets of cards of successive condensing systems, a five-roll rub on one and a seven-roll rub on another, might in some cases be discoverable from business records, but there would be no way of understanding that what sounds like a small improvement actually indicates a striking contrast between a primitive attempt to build such a machine and a later and vastly more successful and effective effort; in fact, the quality of production of the two cards must have offered a significant contrast. As the earliest version of this important development known, the five-roll rub also enables us to push a thorough understanding of this mechanism's development back to a time nearer its invention, in contrast to the later and more sophisticated embodiments which survive elsewhere.

As in the area of the sciences, where the ultimate test of a phenomena is the ability to experience it, to measure it, to test it, history based on artifacts proceeds from the specific, the concrete, the measurable, avoiding in part the potential unreliability of secondary sources or otherwise indirect information about physical objects and working conditions. While artifactual sources are as susceptible to misuse as any others, they do, by their indisputable existence, provide a concrete basis for interpretation, an unarguable example of parts of the industrial process.

Machinery also yields to efforts to understand its construction, operation, and usefulness in a direct way with which plans, drawings, or other indirect and two-dimensional data cannot compete. Artifacts offer different information from written sources, information of value to a variety of disciplines: they record the creative process of the mechanician, the construction techniques of the builder, the decisions of the mill-owner, the adaptations by workers, and the durability of the machine and its parts.

Instead of directing research into a concentration on the most striking moments in the history of textile technology, such as the introduction of the power loom, the fancy loom, or the automatic loom, which secondary materials must, the artifacts can provide information on run-of-the-mill developments (pun intended) which directly reflect the experience of the "inarticulate." Not only is an element of precision thereby added, but the story becomes more complete as well. The type of machines people ran becomes clear, as do their efforts to alter or maintain them, to avoid obsolescence by adapting an improved picker motion, for example, instead of replacing expensive broadlooms, the type of effort which would otherwise be unrecorded.

Alterations in machinery perforce alter the work experience, but without direct evidence neither factor could be recognized. Study of technology from the ground up, as the new labor history aims to do, provides a new and essential aspect to both discussions which would otherwise be missing.

Interpretation becomes more precise in numerous other ways, as well. Company names and style changes displayed in castings help date specific pieces. They often enable us to identify second-hand or out-moded machinery and to compare actual purchases with alternate choices known to have been available. Machinery offers valuable information on the relationship between what was ordered and what was received. Thus an order for a jack, card, or loom could represent a primitive or advanced machine, a current or archaic model, which the machine identifies. The order gives its cost and date of installation.

Furthermore, the quality of equipment helps identify its potential in ways that standard descriptions, such as "a two set mill" fail to do. The number of card sets is significant, but so is their age, size, quality, and associated machinery. The careful study of remains adds important information to any discussion of the operation or to any theory based upon it.

Instead of reliance on generalities or secondary sources, these artifacts present hard evidence which may disrupt current theories and assumptions based on less complete or incorrect information. Beliefs about machinery, conditions, products, and industrial development are challenged by this approach. It must be recognized that mills differed, as did plain looms, spinning jacks, and other factors whose existence we cannot ignore, but whose testimony conflicts with accepted dogma based on generalized interpretations. Dealing with specific examples, rather than general developments, forces one to confront inconvenient or unclear facts such as the willingness to ignore labor-saving devices, including some once present and allowed to fall into disuse. Trade catalogues, patents, employers' and historians' testimony may all lead to an expectation not borne out by this evidence, but the specific case must be dealt with, and historical accounts perhaps reshaped to accommodate it.

By challenging our expectations, artifacts inject new life into old questions, help develop new questions and provide answers not otherwise available. Their challenge cannot be ignored once their potential is admitted, even if it requires a further expertise of the historian:

> As Eugene S. Ferguson put it, 'The historian should consider looking at artifacts to be so much a part of his trade that he will, over the years, develop a keen critical sense regarding the authenticity and significance of the artifacts and restorations that he sees. To be used effectively, the artifacts must mean something to the historian directly, not once removed through the mind and eyes of a curator.'[7]

Such examinations can help provide a meeting ground for scholars of different disciplines and at the same time challenge the accepted interpretations of the fields. By presenting as many questions as answers, artifacts, not only in Watkins Mill, but by the tens of thousands in collections and by the thousands more available or still waiting to be found, offer a store of information we can no longer afford to ignore. To truly understand our technology and the working conditions and products it created, we must begin to examine the closest thing to primary evidence available, the artifacts which bring us closer than anything but a time machine to the history they record. By improving our understanding of the past they will make our generalizations concerning it more truthful.

Notes

1. Brooke Hindle, *Technology in Early America* (Chapel Hill, N.C.: University of North Carolina Press, 1966), p. 10.
2. Anthony F.C. Wallace, *Rockdale: The Growth of an American Village in the Early Industrial Revolution. An account of the coming of the machines, the making of a new way of life in the mill hamlets, the triumph of evangelical capitalists over socialists and infidels, and the transformation of the workers into Christian soldiers in a cotton-manufacturing district in Pennsylvania in the years before and during the Civil War* (New York: Alfred A. Knopf, 1978), pp. 198-200.
3. *Journal of the Franklin Institute* 3rd series, 14 (1847):170-171.
4. Nathan Rosenberg and Walter G. Vincenti, *The Britannia Bridge: The Generation and Diffusion of Technological Knowledge* (Cambridge, Massachusetts: The MIT Press, 1978), pp. 68-69.
5. E.P. Thompson, *The Making of the English Working Class* (London: Victor Gollancy Ltd., 1964), p. 12. Thompson draws briefly on this approach in citing architectural evidence regarding weavers' lives in the 18th century (p. 270).
6. Wallace, *Rockdale* (note 2), p. 237. I was reminded of this passage by the comments of Cyril Stanley Smith after delivering another version of this paper at the 1979 meeting of the Society for the History of Technology.
7. Hindle, *Technology in Early America* (note 1), p. 15.