AN OUTLINE OF THE DEVELOPMENT OF WOOD MOULDING MACHINERY

by John H. Englund *

The traditional method of producing wooden mouldings by hand with plane, chisel, and gouge is a slow process, requiring in some cases a high level of skill. Given the proper conditions, this can be a pleasant meditative experience as the interaction of tree and joiner through the steel cutting edge creates a surface which is a delight to the hand and eye. However, the pressures of time and money can easily reduce such active contemplation to a monotonous and demeaning task. The joiner, in an effort to increase production and hold down costs, may be forced to work too quickly and with inferior materials, the result being that the work is no longer satisfying and the product ungraceful.

A new class of machinery was developed during the first half of the nineteenth century which, with the help of a few attendants, could duplicate the work of dozens of joiners working with hand planes, and could quickly turn out large volumes of mouldings.of extraordinary low cost and exact profile. The capability of these moulding machines made possible the unprecedented display of wooden ornament which characterizes so much of our nineteenth century architecture. Ironically this ebullient proliferation of architectural woodwork marked the beginning of a long decline of the carpenters' trade. While the low prices made possible for many a new range of architectural expression, the economy of machine production stole from the carpenter much freedom of design. The role of the carpenter was changed during this period, in part as a result of the new technology, from that of a fairly independent builder and designer to that of an installer of factory-made components.

The earliest efforts by Western mechanics to work wood with automatic self-guiding machinery (aside from the much earlier invention of the wind- or water-powered sawmill) seem to have been made during the late eighteenth century. It was at this time in England that Samuel Bentham, brother of Jeremy, first patented a number of machines which embodied many of the principles of modern woodworking machinery.[1] Marc Isambard Brunel and Henry Maudslay were also putting their minds to the problem of shaping wood by machine.[2] The most important of these devices to the later development of moulding machines was a planing machine patented by Bentham in 1793.

In essence, Bentham's machine carried a board to be planed past a cylindrical arrangement of knives which spun at high speed (known today as a

---

* John H. Englund is Coordinator of Interpretation at Old Sturbridge Village and is responsible for woodworking activities. This paper is adapted from an in-process M.Sc. thesis for the Historic Preservation Program at Columbia University.

cutterhead), reducing the board to a uniform thickness and dressing smooth its top surface. His design called for the board to be fixed upon a carriage which was drawn by rack and pinion along ways [tracks] beneath the spinning cutterhead, an arrangement generally analogous to that of sawmills of the time.[3] This design may be the first patented attempt to apply the rotary motion natural to high speed machinery to the problem of dressing the surface of a piece of wood. Samuel Bentham's machine seems, however, not to have seen extensive use in England during the first few decades of the nineteenth century.

Likewise in America, while there are a few references to machines operating upon these principles in the 1820's, it was not until after 1828 that the use of planing machinery began to become widespread. It was in this year that manufacture began of a machine similar to Bentham's, patented by one William Woodworth of Hudson, New York. This patent was developed by the capitalists who owned it into a virtual monopoly which lasted for nearly three decades. After incorporating a few features from several other machines, they had nearly complete control over the production and operation of planing machinery until 1856.[4]

The most important of those features borrowed from other machines by the owners of the Woodworth patent was the feed roll, patented in England by Charles Hammond in 1811, and in the United States by Uri Emmons in 1829.[5] A feed roll is simply a cylinder, often corrugated, mounted so that it bears against the board to be planed and drives it through the machine (Fig. 1). The use of one or more of these feed rolls permits the elimination of the cumbersome carriage and carriage ways. Since the board need be supported only as it passes beneath the feed rolls and the cutterhead, machines equipped with them can be very much more compact than the earlier carriage feed machines. Roll feed machines can also work very much more quickly, and soon became by far the dominant type on this continent.[6]

That these planing machines could have been used with only slight modification to produce mouldings seems evident, yet documentary evidence for such use is rare.[7] Certainly the demand for mouldings generated by the Classical Revival and the later, even more highly decorated styles of the first half of the nineteenth century must have stimulated the construction of machinery to produce them, since during the second quarter of the nineteenth century the planing machines had clearly demonstrated the tremendous economies made possible by their use. It may be that the design and operation of moulding machinery is so similar to that of planing machinery that those sources which go into such detail describing the development of the latter considered a similar account of moulding machinery unnecessary. It should be noted here that even accounts of late nineteenth century machine woodworking, while giving generous space to descriptions of planing machines, often barely mention moulding machines. Only one of these sources goes into much detail at all: Charles R. Tompkins' *History of the Planing Mill*, published in 1889, upon which I have been forced to rely heavily for this outline.

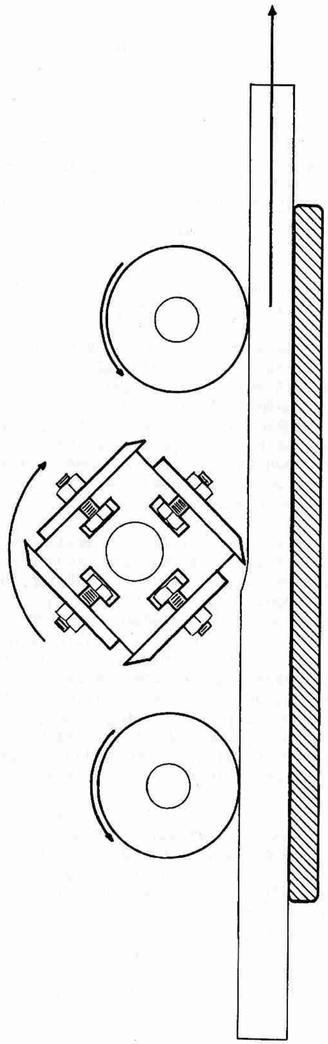


Fig. 1 A schematic drawing of a roll-feed planing machine. Here is the basic mechanism employed by planing machines today, and, with the second feed roll removed, moulding machines as well.

Horizontal Spindle Moulding Machines

Tompkins tells us that the first successful moulding machine built for general use was produced in 1848 by C.B. Rogers & Company of Norwich, Connecticut, along with the associated J.A. Fay & Company of Keene, New Hampshire, and later of Worcester, Massachusetts. This machine was probably fairly representative of the custom built machines which must have existed prior to this time. A wooden frame carried a horizontal cutterhead and a single feed roll above a wooden table which could be adjusted up or down to allow for mouldings of various thickness.[8] This machine, while borrowing a great deal from the Woodworth-type planer, was somewhat different in that it had what was called an overhanging head, which means that the cutterhead was supported by a fixed bearing at only one end. The absence of a fixed bearing at the other end enabled the cutterhead to be easily removed and replaced with another containing knives of a different profile.

Over the next ten years this basic model was the standard machine for the production of mouldings, requiring only a few refinements, the most important of which was the replacement of the wood frame by a more rigid cast iron frame, an innovation which began to appear around 1850.[9] An example of such a machine is H.B. Smith's Moulding Machine #1½. Built mainly of iron and steel, it was equipped with a single horizontal cutter and two edging cutters which ran at 3,000 to 3,500 revolutions per minute. It could handle lumber up to eight by three inches in cross section. In 1858 it cost $400.[10] The biggest problem with the overhanging head moulding machines like this one was that of excessive vibration. In any planing machinery an out-of-balance cutterhead will produce a ripple-surfaced moulding. In the overhanging head machine, where the cutterhead assembly is fastened at only one end rather than two ends, minor imbalances will produce disproportionately large vibrations. Despite the claims of many to the contrary, the flexible wooden frame only aggravated the problem. The arrival of the stiffer iron frame considerably decreased this machine's tendency to produce a rippled surface, but it could not entirely eliminate it.

Vibration became more of a problem as the demand for wider mouldings rose during the third quarter of the century. The response by manufacturers of woodworking machinery was to bring out the so-called inside, or center feed, moulder in the early 1860's. This machine was nearly identical to contemporary planing machines, with a horizontal cutterhead supported by bearings at both ends above a table, over which the lumber to be converted into moulding was forced by overhead feed rolls. C.B. Rogers of Norwich, Connecticut, S.A. Woods of Boston, and C.R. Tompkins of Rochester, New York all brought out twelve-inch-capacity inside moulders in 1864 and 1865.[11] The inside moulder was designed to turn out large volumes of moulding at high speed. It was very much larger and more expensive than the earlier overhanging head moulder. Shops which produced only small volumes of work could not justify the capital investment nor the longer set up time required by these machines; for small shops, therefore, the overhanging head moulding machine remained in use for some time.[12]

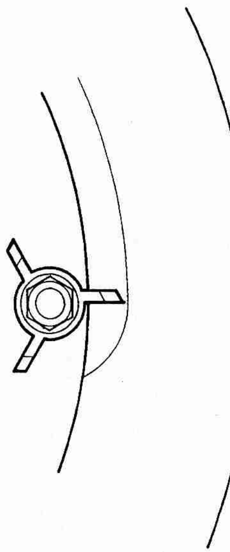
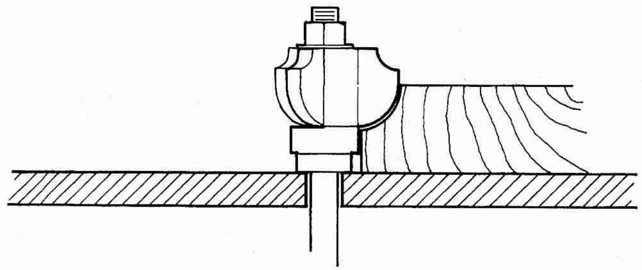


Fig. 2 A vertical spindle shaper cutting a moulding. The collar below the cutter bears against the work, guiding it as the operator feeds it through the machine. The plan illustrates why this arrangement cannot be used to cut inside corners or curves of sharper radius than that of the cutter.



The work of these moulding machines is nearly indistinguishable from that of the hand-held moulding plane. Aside from volume, the capabilities of the hand process and the machine are nearly the same. Rather than striking new forms appearing on wooden buildings as a result of the increasing use of this machinery, there appeared simply a general increase in the use of moulded decoration. While door casing and window trim in Classical Revival buildings were composed primarily of plain boards enlivened by only a few light mouldings, there can be seen on buildings constructed during the following decades a gradual increase in complexity and relief as moulding machines became capable of heavier work.

Moulding machinery does leave a distinctive tool mark on its product which is sometimes visible, this mark being a continuous series of shallow ripples running across the axis of the moulding in question. These ripples are the product of the circular motion of the cutterhead which must of necessity leave the surface cut in a series of shallow arcs. The extent to which these marks are visible is determined by the speed with which the work is fed, and the care taken by the operator to ensure that the knives are all ground to exactly the same shape and size and that the cutterhead is balanced. Their absence does not, however, necessarily mean that a particular moulding was cut by hand. A conscientious carpenter will sand or scrape them away before installing a moulding.

Vertical Spindle Moulding Machines

Aside from machines with horizontal cutterheads there is another major class of moulding machines: those with vertical spindles, the vertical spindle shaper and the router. Andrew Gear of Jamesville, Ohio, patented the vertical spindle shaper (occasionally referred to as the irregular moulding machine) in the United States in 1853. His machine consisted essentially of two vertical spindles which protruded above a horizontal wooden table. Cutters of various profiles could be fastened to the spindles, which revolved in opposite directions at high speed.[13] Only one spindle would, however, be cutting at any one time. There were two different ways to guide work past these cutters. The first was to use an adjustable fence to guide work in just the same fashion as the fence employed to cut lumber on a bench or table saw. To run curved work on this machine, a second arrangement was required, which was to incorporate in the cutterhead, along with the particular knives needed to cut the desired profile, a cylindrical collar which fit around the spindle (see Fig. 2). One portion of the work, then, bore against this collar and served as a guide while the rest was carved to the desired shape. With this collar arrangement, the vertical spindle shaper is not, as the moulding machines are, limited to the production of straight mouldings, or even of circular segments. Surfaces incorporating straight lines, portions of circles, and curves of varying radii can be combined freely and fed through this machine nearly as easily as straight work.

There are two important limitations to this machine. The first is that, as in the overhanging head moulders, the spindles are supported by bearings at only one end. The greater the distance from the bearing, the greater the

misalignment caused by the sidethrust. The resulting vibration makes it very difficult to produce acceptable work wider than two or three inches. The second is that the spindle shaper cannot cut inside curves of smaller radius than the length of the knives mounted in the cutterhead. This means that curves of very small radius, and more importantly, sharp angles must be finished by hand. A casual survey of shaper work will quickly demonstrate that most people designing work to be performed by this machine were careful to avoid this expensive hand work, and that therefore one is much more likely to see brackets and tracery which exhibit inside curves of fairly large radius than sharp angles and sudden changes of direction. Outside curves and corners can of course be as sharp as desired and still be easily cut by this machine.

Andrew Gear included in his vertical spindle shaper two spindles rather than one. This permitted the operator to switch the timber from one spindle to that spinning in the opposite direction. As a result there was less cutting against the grain and consequent tearing of the surface of long curved work with widely variable grain. Many of the vertical spindle shapers built during the 1850's and early 1860's were equipped with an automatic feed, some with an elaborate system of cams to guide and feed curved work against the cutter.[14]

Refinements of the spindle shaper over the first twenty years of its use were directed at increasing its flexibility. By the late 1860's a single reversible spindle had been introduced to replace the double spindle arrangement. This machine used a new type of cutter, one which could cut while spinning in either direction. Worssam's irregular Moulding & Shaping Machine of 1869 had such a single spindle which could also be raised or lowered, a feature which greatly enhanced its usefulness and flexibility.[15]

The single spindle machine evidently did not possess overwhelming advantages over the twin spindle machine, since even in 1873, years after the introduction of the single spindle, a major manufacturer of woodworking machinery, John Richards, stated that "Shaping machines, with two vertical spindles, have now become standard in American shops...."[16] As late as 1880, both types were still in use.[17] The problem with the single reversible spindle was that of designing a cutter which could work efficiently in both directions. Such cutters could only be, at best, a compromise, and, according to one writer, they worked too slowly and became dull too quickly to perform efficiently. Finally, instead of trying to design a single cutter, manufacturers of these machines produced a cutterhead which could be easily exchanged for an opposite-cutting mate.[18] By 1890, the double spindle machine, except for cases where the change of grain was really severe, as in the production of wheel felloes, was manufactured only in small quantities.[19]

A big advantage of the single spindle machine was that it could be set up in half the time. It may also have been considerably cheaper than its predecessor, having only half as many moving parts. In 1868 Andrew Gear was selling the various sizes of his double spindled machine at prices ranging from 430 to 530 dollars.[20] In 1875, J.H. Blaisdell's Upright Moulding Machine, which employed reversible cutters on a single spindle, sold for only 200 to 250 dollars.[21] Despite their simplicity, these machines were not small. Blaisdell's shapers weighed between 650 and 800 pounds.[22]

Many shaper operators abandonned the originally automatic feed of their machines in favor of hand feed. According to Richards,

> Ten years ago (ca 1860) it was most unusual to find a hand-feeding machine in an American wood shop; whenever the power-feeding machines failed to do what was required, the next resort was hand labor; but of late years, from experience and necessity, there has been a return to first principles, by the use of hand-feeding machines for jobbing, and they are to be found at this time in most large establishments.

The greater flexibility and faster set-up time associated with the hand feed compensated for any loss of speed in the actual cutting of the work if the job was of small volume.[23]

A vertical spindle shaper can be used for a wide variety of tasks. It can, up to a width of two or three inches, duplicate work done by the larger and more expensive center feed and outside feed machines to produce straight mouldings, and can cut mouldings of curved or irregular profile. This machine can also cut mouldings along the edge of wide pieces of wood, such as those which make up a bracket, or other scroll-work. The vertical spindle shaper is, then, within its limitations of size, very much more flexible than either of its larger predecessors.

The inverse of the vertical spindle shaper is the router, often referred to in the nineteenth century as a panelling and recessing machine. Rather than a table with a spindle bearing the cutters coming up from below, the router's cutters work from above the table (Fig. 3). The router can do almost everything that the vertical spindle shaper can, except that because the spindle which bears the cutter head is at the end of what must be a fairly long arm to give sufficient clearance around the table, vibration is even more of a problem, and therefore the router is unsatisfactory for heavy work. The router's unique advantage over any other moulding machine is that the portion of the frame which bears the cutter head is designed to be easily raised or lowered, somewhat like the action of a drill press, usually with a foot-pedal. In some arrangements the table moves vertically and the cutters are stationary.[24]

The router can easily work such areas as the interior edges of perforated scroll-work. The scroll-work is placed on the table, the cutter lowered into position, and, using as a guiding mechanism the same collar arrangement as is employed for irregular work on the spindle shaper, the work is moved against the collar and spinning cutter, and the desired profile cut into the edge of the perforation. This operation can also be performed by the spindle

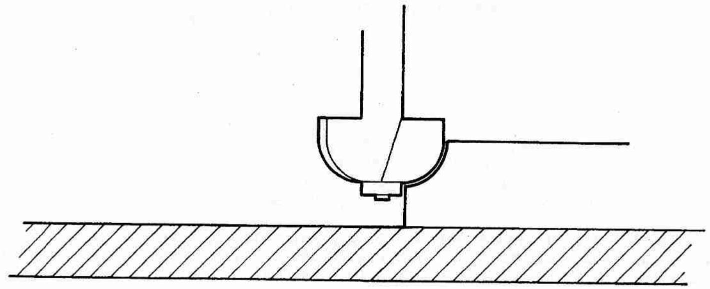
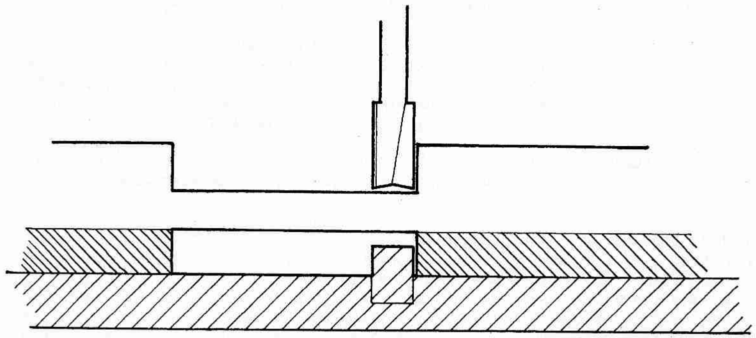


Fig. 3 Cutting a moulding with a router. A collar fixed to the underside of the cutter bears against a portion of the work, and guides it as a cut is made. With this arrangement, outside curves of any radius can be moulded, and inside curves as small as the radius of the cutter.

Fig. 4 Router making a plunge cut. A pin equal in size to the cutter is set in the table, and together with the template fixed to the underside of the work, serves as a guide while the operator lowers the cutter to the correct depth and moves the work/template assembly over the table and pin.



shaper almost as easily by dropping the work over the cutter and cutting it in a similar fashion. The spindle shaper is a little less efficient, though, since the operator must turn off, and wait for the machine to stop running before placing the work on the table or taking it off. This is not necessary with the router because of the pedal arrangement which permits the cutter to be quickly raised out of harm's way between cuts.

The one operation which the router can perform which no other machine can manage as easily or safely is to sink a recess into the face of a board. This operation, the source of the router's other name, the recessing machine, is identical to the previous one, except that instead of using a collar guiding arrangement, a template is fastened to the underside of the work (see Fig. 4). Generally a pin of the same diameter as the cutter is fixed to the table directly beneath the cutter. The template rides against the pin and guides the work as it is moved through the cutter, which must therefore produce a recess identical to that cut in the template. Bringing a spinning cutter down into the face of a board in this way is called making a plunge cut. The same limitations apply to this work as in irregular mouldings cut by the spindle shaper, namely that the router cannot produce inside curves of very small radius, nor can it carve an interior angle. These must be cut by hand.

Unfortunately I have had very little success in my search through the woodworking literature for the origin of this machine. The first reference I have been able to discover to a device operating on the principle of the router is to a machine made by a Pratt of Bond Street (Philadelphia?) in 1845, which was used to carve both stone and wood into decorative Gothic detail. The correspondent describing Pratt's machine for the *Journal of the Franklin Institute* said that,

> We saw, on a recent visit, a small piece of trefoil panelling in stone finished in fifteen minutes, which by ordinary processes would employ a skillful workman a whole day.... In the crockets, finials, bosses, and other solid work, indeed, much has to be done by hand after the mechanical work is finished. The mechanism here only cuts away the larger parts and prepares a ground for the hand of the carver. But in panelling, little or nothing is left to manual skill; all that is requisite is to retouch some of the acuter angles of the tracery.

Unfortunately all that is revealed of the structure of the machine by this account is that the cutters were mounted in a vertical position, and run at high speed by a steam engine.[25]

Contemporary with this machine was a router built for an engraver named Darius Wells of Patterson, New Jersey, in 1845 to carve wooden type. Similar to an old-fashioned dentist's drill, it consisted of a jointed arm over which ran a belt which drove the cutter. The work was stationary, and the cutter was guided over the work by the operator.[26]

In 1847 a related machine, invented by T.B. Jordan was awarded by the English Society of Arts its gold Isis medal for "inventing, arranging, and bringing into successful operation machinery to duplicate any form which the hand of the artist could execute."[27] Both the work and a pattern were fixed to a table which could be moved in any horizontal direction. Above this work was a frame bearing several revolving cutters and a tracer of identical profile, which was fixed over the pattern. By moving the table horizontally, and the cutter-tracer combination vertically, the tracer was made to follow a path over the surface of the pattern, which was simultaneously duplicated by the cutters as they moved through the work.[28] Thus within some limits the Jordan machine could duplicate any carved shape. Like the router it could not carve a sharp inside corner. These details, as in other machines operating on this principle, had to be cut by hand.

Somewhere between the time of these inventions and the 1870's, the modern router was developed. I have been unable to discover exactly when, where, or by whom this was done. It seems to have been a fairly common practice for manufacturers of this machine to combine it with the vertical spindle shaper. A single spindle was mounted in the table which could be lowered out of the way when the router spindle was in use. Likewise in some arrangements the arm bearing the router spindle was hinged so that it could be swung up and out of the way when the table spindle was in operation.

It is really these machines, the spindle shaper and the router, which, of the moulding machines, have had the most revolutionary effect upon the form of nineteenth century wooden architecture. Both of these machines can cut moulded surfaces into pieces of wood of irregular outline, an operation which no earlier device was able to perform easily. In combination with the various scroll saws, they could produce a vocabulary of forms formerly available only to those who could afford to pay for large amounts of hand carving. This capability was exploited for the most part in the creation of the never-ending variety of brackets and barge boards which begin to appear below the roofs of buildings of the Gothic Revival.

The router's ability to make plunge cuts seems to have been little exploited for exterior decoration. One sees a great deal more of this work in furniture and interior panelling. The sort of effects which can be created by the plunge cut can for the most part be created without the use of the router on exterior work, at least, with built up assemblies of smaller pieces, which when painted appear to be a single piece. A frequently encountered interior use of the router is seen in the familiar rosettes found at the corners of window and door casings. Produced simply by lowering a special cutter into the face of a square block of appropriate size, they can be turned out quickly and cheaply, and save the trouble of mitering the corners of the casing.

Gear's spindle shaper was exhibited in New York in 1853 and seems to have been well received. It is likely that because of its simplicity, low cost, and flexibility, it probably became popular rather quickly if, in fact, there were not already a substantial number of unpatented versions in operation. The tremendous capabilities of this little machine were not lost on its promoters. A catalog of 1868, which I cannot resist quoting at length, says in part:

> No machine ever invented or introduced to the public notice is capable of doing so much to benefit the million. Beautiful and graceful forms may now adorn their dwellings as well as the palaces of the rich and great. By it a most classic style of gothic cottage, with its columns ornamented with graceful capitals, cornices supported by brackets, windows and doors arched and ornamented with various forms of cornice, the piazza supplied with tracery, all presenting a rich moulded finish, and surrounded by a new and graceful style of fence, and graced with arbors of corresponding design, can be built at slight expence, thus furnishing to all pleasant and delightful "homes".
>
> This machine, in the work that it does, opens to the architect and designer the whole field of curves. The line of beauty through all the realms of nature, are variations from a true circle like the ellipse and parabola, and are those we most desire to use in designing Ornamental Work. The present improvements meet this great want, and yet the field, open for entirely new operations upon it, as indicated above, is boundless. The results already reached and to be accomplished, will astonish and delight the world!
>
> To Builders: This is the best, and in fact, the only machine for all Varieties of Moulding and Circular Planing to be used in house building. For circular head windows, outside and inside casing, jambs, parting beads and sash, this is the machine most needed and convenient.
>
> Also brackets...., vergeboards, fluted columns, carved caps for the same, lattice work, pilasters of new and elegant designs, mantles and fire fronts, gothic mouldings of the most complicated pattern, tracery and arches for... gothic churches, cottages, arbors and verandas, pew arms, panel work, ellipses, ovals.... It is useless to carry segments of circles to the turner's shop, or keep carvers at work upon gothic moulding. This machine, in such work, has the capacity of thirty first-class mechanics.[29]

Even allowing for the excesses of nineteenth-century advertising copy, it is plain that this simple little machine, along with its companion, the router, had a tremendous impact upon the potential vocabulary of architectural decoration, an impact which can be seen at every turn today. Wherever one sees curved mouldings of this period, whether they be Gothic tracery, Italianate round-headed windows and doors, or the ellipical openings of the Queen Anne, one is looking at the work of one of these machines. In addition, they are the agents responsible for the chamfered or moulded corners of posts, scrollwork, and brackets.

The principles embodied by these four early moulding machines are still those which determine the structure of woodworking machinery today. Consequently it seems that a detailed account of the mechanical particulars of these machines as they evolved through the late nineteenth century and early twentieth century would be of little value to students of architectural decoration. A moulding produced by a machine in 1860 bears the same marks as one produced in 1960. The only point where the presence of machine work can be used as a dating tool, then, is early in the development of this technology.

Unfortunately, planing machinery came into use only gradually over the course of several decades. On this continent, at least, there appears to have been substantial use of custom built planing machines before the advent of generally available commercially produced versions. There is evidence which indicates that the same was true of moulding machines. The presence of machine-made mouldings in a building can therefore only be used in a very general way to determine the chronology of a particular structure.

Market areas for large planing mills may have been extensive. The firm of Hinkle, Guild, & Company of Cincinnati, for example, was in 1862 sending its products to fifteen states and territories.[30] Any attempt to evaluate the work in a given building, then, must take into account a large number of potential sources of materials. It is possible, though, that in isolated regions a direct correlation exists between the establishment of a particular mill, the development of its capabilities, and the appearance of certain types of millwork in local buildings.

It is not enough to know, for example, that the first commercial production of moulding machinery began in 1848, or that the first advertisement for machine-made mouldings appeared in New York City business directories of 1849-50,[31] to be able to say that any machine-made moulding found in New York was manufactured after 1848. There seems to have been some machine work here at an earlier date.[32] Even if more information about this earlier activity were available, there is the possibility that New Yorkers, well connected to the rest of the world, might have purchased machine products from some other center of manufacture.

These problems are not insurmountable, however, and it may very well be that a little careful research in a given locality could turn up sufficient material to help with dating problems in that locality. It seems unlikely, however, that anything better than the broadest generalizations can ever be made for the industry as a whole.

Footnotes

1 *The American Polytechnic Journal* 1 (April 1853): 245-247. Manfred Powis Bale, *Woodworking Machinery, Its Rise, Progress, And Construction With Hints on the Management of Saw Mills And the Economical Conversion of Timber* (London: Crosby, Lockwood, And Son, 1914), p. 74.

Peter Nicholson, *Nicholson's Dictionary of the Science And Practice of Architecture, Building, Carpentry, Etc. From the Earliest Ages to the Present Time with Detailed Estimates, Quantities, Prices, Etc.* (London & New York: London Printing & Publishing Company, Ltd., 1847), p. 303.

John Richards, *A Treatise on the Construction And Operation of Wood-Working Machines Including A History of The Origin And Progress of the Manufacture of Wood-Working Machinery* (London & New York: E. & F.N. Spon, 1872), pp. 3-5.

2 Norman Ball, "Observations on A Contemporary Account of Naval Block-Making Machinery, 1824," *Bulletin*, The Association for Preservation Technology, IX (No. 1, 1977): 74-80.

Op. Cit., Richards, pp. 4-5.

Op. Cit., *American Polytechnic Journal*, pp. 245-247.
Op. Cit., Bale, p. 74.

4 *Op., Cit.*, *American Polytechnic Journal*, pp. 248-251.

Horace Greeley, ed., *Art and Industry As Represented in the Exhibition at The Crystal Palace* (New York: Redfield, 1853): p. 303.

Op. Cit., Richards, p. 18.

C.R. Tompkins, *A History of the Planing Mill, With Practical Suggestions For The Construction, Care, And Management of Wood-Working Machinery* (New York: John Wiley & Sons, 1889), p. 24.

United States Patents, Committee on, *Report Adverse to the Extension of the Woodworth Patent* (House of Representatives Report No. 156, July 17, 1852).

5 *Op. Cit.*, Richards, p. 19

Journal of the Franklin Institute of the State of Pennsylvania; Devoted to the Mechanic Arts, Manufactures, General Science, and the Recording of American and Other Patented Inventions NS 4 (July, 1829): pp. 115-116.

Op. Cit., *American Polytechnic Journal*, pp. 248, 251.

6 *Op. Cit.*, Richards, p. 19.

John Richards, *Wood Conversion By Machinery* (London & New York: E. & F.N. Spon, 1876), p. 95.

7 Paul Huey, *The Saw*, unpublished thesis, Smithsonian Institution, 1967: pp. 44-48.

Op. Cit., Tompkins, p. 47.

Huey uncovered a couple of references to early machine moulding; one in 1820 in New York State, another in 1822 near Baltimore. Tompkins wrote that he believed that there were moulding machines operating in New York City before 1848.

8 *Op. Cit.*, Tompkins, pp. 45-46.

9 There is a little disagreement on this point in late nineteenth century accounts. F.R. Hutton, writing for the federal census of 1880, says that iron frames were introduced as early as 1850 (volume 22, p. 212). Charles Tompkins, on the other hand, says that H.B. Smith was the first to manufacture iron-framed moulders some time around 1863 (*History of the Planing-Mill*, p. 47). Tompkins seems to be mistaken here, since a broadside of 1858 in the collection of the Elutherian Mills Historical Library advertises an all iron and steel H.B. Smith outside moulder (another term for an overhanging head moulding machine).

10 Broadside, H.B. Smith & Company. Elutherian Mills Historical Library.

11 *Op. Cit.*, Tompkins, pp. 48, 49.

12 Manfred Powis Bale, *Handbook of Sawmill and Wood Converting Machinery With Notes on Construction, Speeds, Etc.* (London & New York: William Rider & Son, 1899), p. 83.

Op. Cit., Richards, *A Treatise*, p. 72.

13 *Op. Cit.*, Bale, *Woodworking Machinery*, pp. 113-114.

14 *American Artisan and Patent Record, A Weekly Journal of Arts, Mechanics, Manufactures, Mining, Engineering and Chemistry and Repertory of Patents* NS 1 (June 28, 1865): 113.

15 W.J. MacQuorn Rankine, *The Cyclopaedia of Machine and Hand Tools* (London: William MacKenzie, 1869), p. 2, Plate Q/16.

16 John Richards, *On the Arrangement, Care, and Operation of Woodworking Factories and Machinery; Forming a Complete Operator's Handbook* (London & New York: E. & F.N. Spon, 1873), pp. 143-144.

17 F.R. Hutton, *Report on Machine Tools and Wood-Working Machinery* (Federal Census of 1880, volume 22), p. 245.

18 J. Stafford Ransome, *Modern Woodworking Machinery;* Rider's Technical Series No. 6 (London: William Rider and Son, Ltd., ca 1890), pp. 187-188.

19 *Op. Cit.*, Ransome, p. 188.

20 Broadside, A.S. & John Gear and Company. Elutherian Mills Historical Library.

21 Broadside, J.H. Blaisdell's Upright Moulding Machine. Elutherian Mills Historical Library.

22 *Ibid.*

23 *Op. Cit.*, Richards, *On the Arrangement...*, p. 144.

24 Polly Anne Earl, "Craftsmen and Machines: The Nineteenth Century Furniture Industry," Winterthur Conference Report: *Technological Innovation & the Decorative Arts*, Ian M.G. Quimby, Polly Anne Earl, eds. (Charlottesville: University Press of Virginia, 1974), p. 318.

25 *Op. Cit.*, Hutton, p. 249.

25 Journal of the Franklin Institute 39 (June 1845): 413.

26 Vernon Royle, *Retrospective: A Generic Sketch of the Development of the Routing Machine* (Paterson, New Jersey: John Royle & Sons, 1918), pp. 9-10.

27 Charles Tomlinson, ed., *Cyclopaedia of Useful Arts & Manufactures* (London & New York: George Virtue & Company, 1854), p. 334.

28 *Op. Cit.*, Earl, p. 318.

Loc Cit., Tomlinson.

29 *Op. Cit.*, Gear, pp. 3-4, 8.

30 Hinkle, Guild, & Company, *Plans of Buildings, Mouldings, Architraves, Base, Brackets, Stairs, Newels, Balusters, Rails, Cornice, Mantels, Window Frames, Sash, Doors, Columns, &c* (Cincinnati: 1862), p. iii.

31 H. Wilson, compiler, *Wilson's Business Directory of New York City* (New York: John F. Trow, 1849), p. 198.

32 *Op. Cit.*, Tompkins, p. 47.

A Partial Bibliography for Machine Woodworking of the Nineteenth Century

American Artisan and Patent Record, A Weekly Journal of Arts, Mechanics, Manufactures, Mining, Engineering and Chemistry and Repertory of Patents. May 1864 - April 1868.

The American Polytechnic Journal, A New Monthly Periodical, Devoted to Science, Mechanic Arts, & Agriculture. Vol. I: 1853.

Arbey, F.D. *Travail Mechanique du Bois et des Metaux.* Paris: A. Morel, 1865.

Bale, Manfred Powis. *Handbook of Sawmill and Wood Converting Machinery With Notes on Construction, Speeds, Etc.* London & New York: William Rider & Son, 1899.

________. *Woodworking Machinery, Its Rise, Progress, And Construction With Hints on the Management of Saw Mills And the Economical Conversion of Timber.* London: Crosby, Locbwood, and Son, 1914.

Ball, Norman. "Observations on A Contemporary Account of Naval Blockmaking Machinery, 1824," *Bulletin*, Association for Preservation Technology, IX, i (1977), 74-80.

Clark, Daniel Kinnear. *The Exhibited Machinery of 1862: A Cyclopaedia of the Machinery Represented at the International Exhibition.* London: Day & Son, 1864.

Craik, David. *The Practical American Millwright And Miller.* Philadelphia: Henry Carey Baird & Co., 1877.

Curtis, John O. "The Introduction of the Circular Saw in the Early Nineteenth Century," APT *Bulletin*, V, ii (1973).

Disston, Henry & Sons. *The Saw in History*, 5th ed. Philadelphia: 1921.

Earl, Polly Anne. "Craftsmen and Machines: The Nineteenth Century Furniture Industry," *Technological Innovation & The Decorative Arts.* Ian M.G. Quimby, Polly Anne Earl, eds. Winterthur Conference Report, 1973. Charlottesville: University Press of Virginia, 1974.

Eassie, P.B. *Wood And Its Uses.* Gloucester: William Eassie & Co., Ltd., 1874.

Gilbert, K.R. "The Ames Recessing Machine: A Survivor of the Original Enfield Rifle Machinery," *Technology and Culture*, IV, ii (Spring, 1963), 207-211.

Greeley, Horace, ed. *Art and Industry As Represented in the Exhibition at the Crystal Palace.* New York: Redfield, 1853.

Grimshaw, Robert. "Saws," *Journal of the Franklin Institute*, vol. 109 (Jan-June 1880), 25-41, 168-175, 228-244.

_________. *Saws: The History, Development, Action, Classification, And Comparison of Saws of All Kinds.* Philadelphia: E. Claxton & Company; London: E. & F.N. Spon, 1882.

Huey, Paul. *The Saw.* Unpublished thesis, Smithsonian Institution, 1967.

Hutton, F.R. *Report on Machine Tools And Wood-Working Machinery.* U.S. Census of 1880, volume 22.

Kouwenhoven, John A. *Made in America.* Garden City, New York: Anchor Books, 1962.

Lowe, N.M. *Report on Wood-Industries.* Washington: Government Printing Office, 1875.

Miner, J.H. *The Mill and Lumberman's Success, A Treatise on the Care of All Kinds of Saws.* Baton Rouge: 1890.

Nicholson, Peter. *Nicholson's Dictionary of the Science and Practice of Architecture, Building, Carpentry, Etc. From the Earliest Ages to the Present Time with Detailed Estimates, Quantities, Prices, Etc.* London & New York: London Printing and Publishing Company, 1847.

Norcross, Nicholas G. *N.G. Norcross's Planing Machine and Circular Sawmill, patented Feb 12, 1850.* Boston: Dambrell & Moore, 1850.

Prescott, D. Clint. *The Evolution of Modern Band Saw Mills for Sawing Logs.* Menominee, Michigan, 1910.

Pye, David. *The Nature and Art of Workmanship.* Cambridge: Cambridge University Press: 1968.

Rankine, W.J. MacQuorn. *The Cyclopaedia of Machine and Hand-Tools.* London: William Mackenzie, 1869.

Ransome, J. Stafford. *Modern Woodworking Machinery.* Rider's Technical Series No. 6. London: William Rider and Son, Ltd: ca 1890.

Richards, John. *On The Arrangement, Care, and Operation of Wood-Working Factories and Machinery; Forming a Complete Operator's Handbook.* London & New York: E. & F.N. Spon, 1873.

_________. *A Treatise on the Construction And Operation of Wood-Working Machines Including A History of the Origin And Progress of the Manufacture of Wood-Working Machinery.* London & New York: E. & F.N. Spon, 1872. First serialized in *Journal of the Franklin Institute* beginning in 1870.

_________. *Wood Conversion By Machinery.* London & New York: E. & F.N. Spon, 1875.

Rogers, C.B. *The Mechanic's Companion And Builder's Guide; or Hand-Book of Wood-Working Machinery.* Norwich, Connecticut, 1856.

Romaine, Lawrence B. *A Guide to American Trade Catalogs 1744-1900.* New York: R.R. Bowker Co., 1960.

Royle, Vernon. *Retrospective: A Generic Sketch of the Development of the Routing Machine.* Paterson, New Jersey: John Royle & Sons, 1918.

Tomlinson, Charles. *Cyclopaedia of Useful Arts & Manufactures.* Lonson & New York: George Virtue & Co., 1854.

Tompkins, C.R. *A History of the Planing Mill, With Practical Suggestions For the Construction, Care, And Management of Wood-Working Machinery.* New York: John Wiley & Sons, 1889.

United States Patents, Committee on. *Report Adverse to the Extension of the Woodworth Patent.* Report No. 156, House of Representatives, July 17, 1852.

Whitworth, Joseph. *The Industry of the United States in Machinery, Manufactures, and Useful and Ornamental Arts.* London & New York: George Routledge & Company, 1854.

_________. *New York Industrial Exhibition.* London: Harrison & Son, 1854.

Wood and Iron, A Review of the Progress of Industrial and Mechanical Arts in the Northwestern States and Territories. Minneapolis, Minnesota. Periodical, 1880's.

Woods, S.A. *S.A. Woods Machine Co's Illustrated Catalogue of Improved Planing and Moulding Machinery, Including a Description of Many of Our Valuable Patents.* South Boston, 1876.

The Woodworker. Indianapolis, Indiana. Periodical, 1880's into twentieth century.

Worssam, S.W. Jr. *On Mechanical Saws.* London: E. & F.N. Spon; Philadelphia: Henry Carey Baird, 1868.

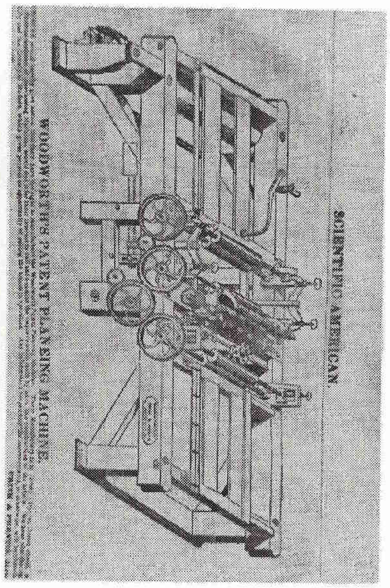


Fig. 5 Woodworth's Planing Machine. This is the planer which completely dominated the industry for nearly thirty years. Illustration from *Scientific American*, II #51: 407. Courtesy Paul Huey and the Smithsonian Institution.

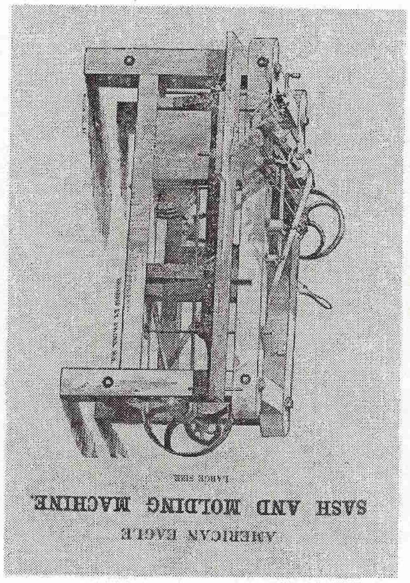


Fig. 6 An early outside shaper of the mid-1850's. The wooden table, whose height is controlled by two hand screws, supports the work as it passes beneath the two small feed rolls and cutterhead. From Rogers, *The Mechanic's Companion*, 1856. Courtesy Old Sturbridge Village.

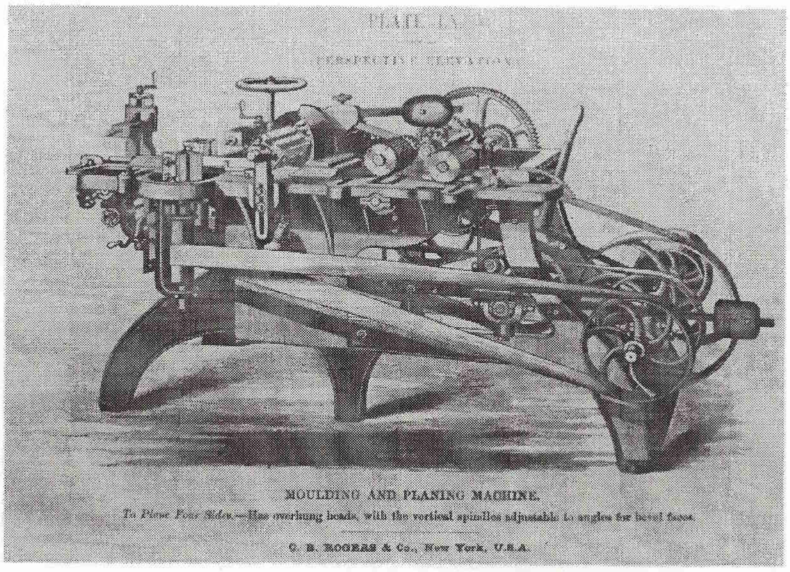


Fig. 7 An outside shaper of the 1870's. Essentially the same as the earlier machine, but with a few refinements. The frame, of course, is now cast iron. There is also a cutterhead in the table, and two vertical edging cutters beyond the moulding head, so that all four sides of a moulding can be dressed in a single pass through the machine. From Richards, *A Treatise...* 1872. Courtesy, Engineering Societies Library, New York.

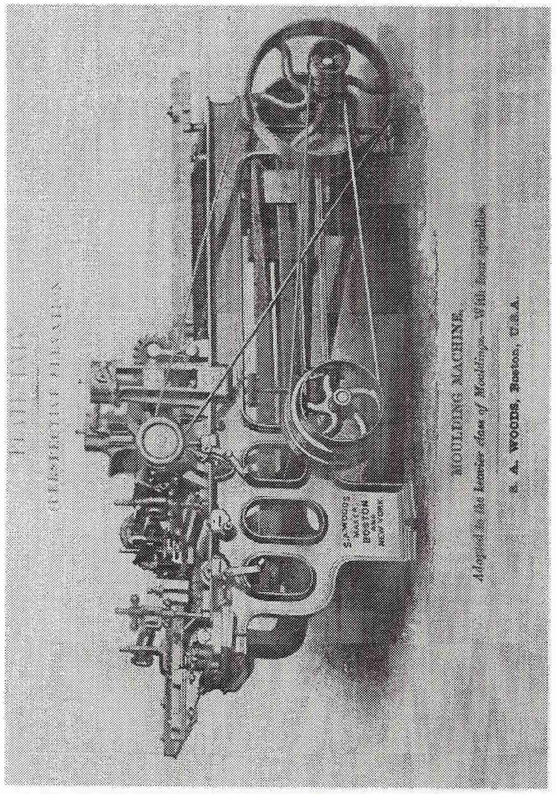


Fig. 8 An inside shaper of the 1870's. Capable of heavy work. From Richards, 1872. Courtesy Engineering Societies Library, N.Y.

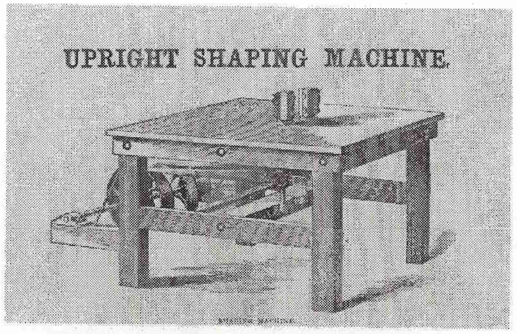


Fig. 9 Two-spindled vertical spindle shaper, 1856. From Rogers, courtesy Old Sturbridge Village.

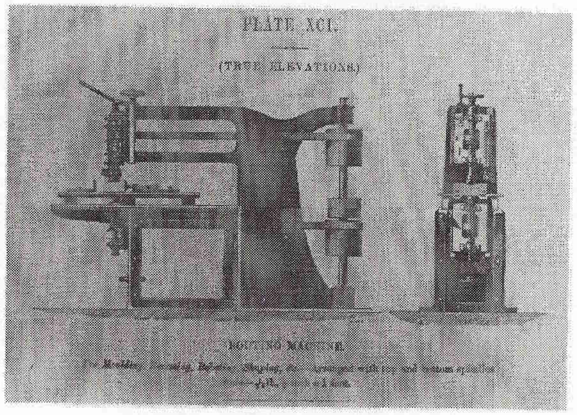


Fig. 10 A combination router and spindle shaper. From Richards, 1872. Courtesy, Engineering Societies Library.

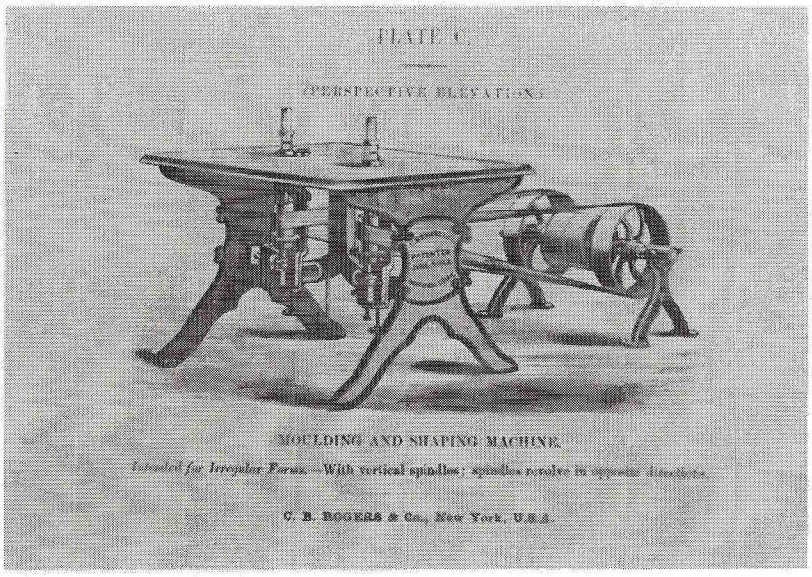


Fig. 11 Vertical spindle shaper, 1872. From Richards. Courtesy, Engineering Societies Library.

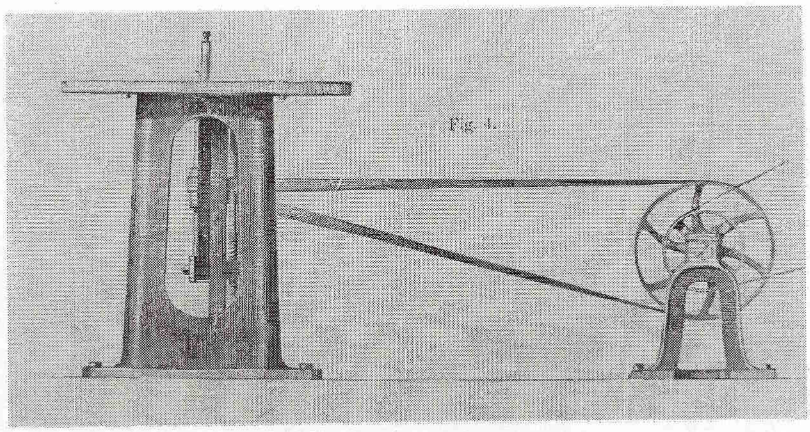


Fig. 12 A single spindle machine. From Rankine, *The Cyclopaedia of Machine and Hand-Tools*, 1869.

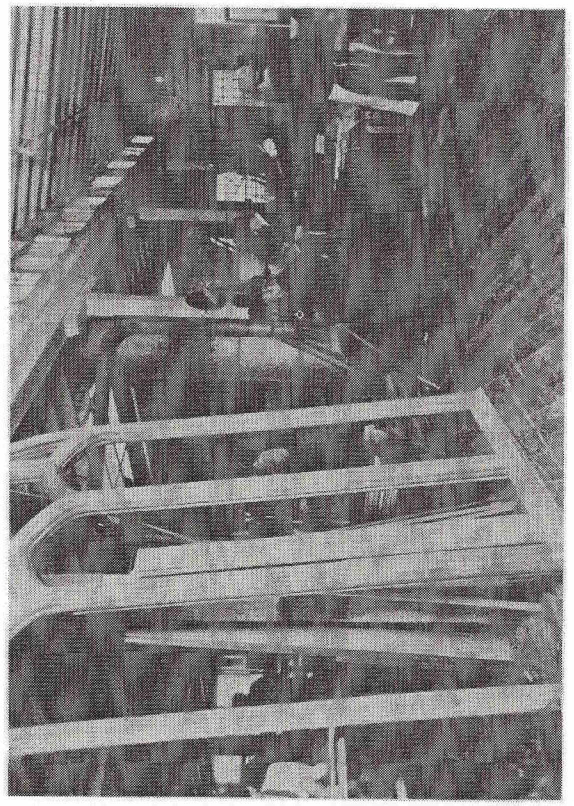


Fig. 13 The sash shop at Lumb Woodworking Company of Poughkeepsie, New York. The Gothic window in progress was the sort of work which made good use of the spindle shaper's capabilities. One can just make out a bit of a shaper through the window, directly in front of the man with the necktie. Courtesy of Lumb Woodworking.

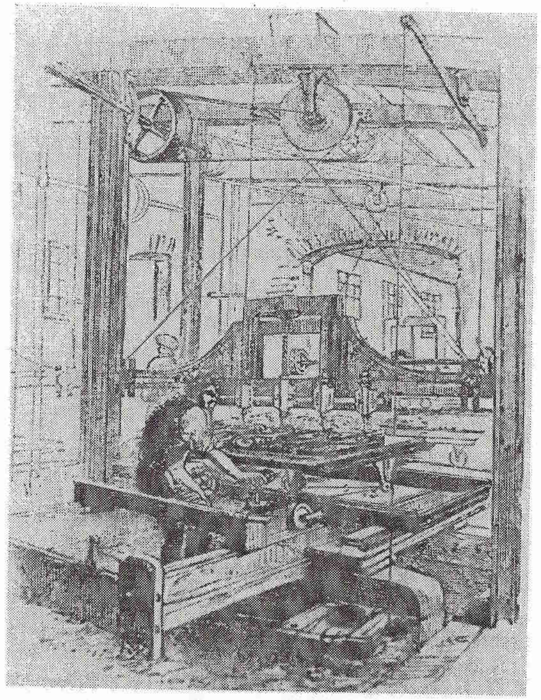


Fig. 14 A Jordan carving machine at work in 1854. The piece in the center of the table is the pattern. The operator moves the frame bearing the tracer and four cutters vertically, and the table horizontally; causing the cutters to duplicate the pattern. From Tomlinson's *Cyclopaedia*, 1854, courtesy, Engineering Societies Library.