

Productivity trends in kitchen cabinet manufacturing

After 7 years of strong gains, output per hour fell between 1979 and 1982; declining output was the major factor in the reversal, as recession and a slump in residential construction took their toll

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Output per employee hour in the manufacture of wood kitchen cabinets rose at an average annual rate of 2.1 percent between 1972 and 1982,¹ or at virtually the same pace as for all manufacturing (2.0 percent). However, annualized increases in both output and employee hours were greater for the industry (4.7 percent and 2.5 percent) than for total manufacturing (1.4 percent and -0.5 percent).

Factors underlying the 10-year productivity advance in the making of kitchen cabinets include improvements in woodworking machinery and particleboard processing equipment; faster drying glues and coating materials; and more mechanized transfer apparatus. Capital expenditures increased strongly during the latter half of the seventies, although they subsequently tapered through the early eighties.

The productivity trend in the industry was marked by two distinct phases, which paralleled developments in all manufacturing. Between 1972 and 1979 (the industry's output peak for the period examined here), productivity rose strongly, reflecting fast-paced output gains. But over the 1979-82 period, which was marked by recession and a deep slump in residential construction, the trend reversed direction, with output declining at an even faster rate than employee hours:

	1972-79	1979-82
	<i>Kitchen cabinet manufacturing</i>	
Productivity	3.3	-2.7
Output	8.0	-10.7
Employee hours	4.6	-7.8
	<i>All manufacturing</i>	
Productivity	2.1	1.7
Output	3.3	-2.9
Employee hours	1.2	-4.5

Manufacturing generally experienced a slowdown in its productivity rate between 1979 and 1982, rather than a reversal; but the trends in output and employee hours were downward, as in kitchen cabinet manufacturing.

Year-to-year changes in the industry's productivity were quite volatile, ranging from an increase of 23 percent in 1977 to a decline of 11 percent in 1982. In 5 of the 10 years after 1972, productivity rose; in the other 5, it fell. However, in 2 of the years of rising productivity, the increase was attributable to a more rapid decline in employee hours than in output. And in 3 of the years of declining productivity, both output and employee hours increased, but the latter grew faster than the former. These patterns contrast with the experience of durable manufacturing industries generally, which evidenced a much narrower range of year-to-year fluctuations in productivity during the review period (-3 percent in 1974 to 4 percent in 1981). The volatility

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of productivity movements in kitchen cabinet manufacturing stems largely from the industry's close link to the highly cyclical demand for residential housing.

Output and demand factors

The kitchen cabinet industry manufactures stock line and custom cabinets, as well as bathroom vanities. Stock line cabinets, which account for about one-half of industry output, are mass produced, and are distributed to residential building contractors. Custom cabinets represent roughly one-third of output and, while the cabinets are built to customer specifications, large-scale production is often feasible with the application of flexible manufacturing technologies.² Vanities make up the remaining one-sixth of output. Most kitchen cabinets and vanities are made of wood; those made of plastics accounted for 14 percent of output in 1982 (up from 11 percent in 1977). The manufacture of metal cabinets, which were once a large proportion of total kitchen cabinet production, is no longer a significant industry activity.³

Industry output is closely linked with residential construction, replacement, and rehabilitation markets. Among these markets, new residential housing starts provide an estimated one-fourth of the industry's major outlets. Over the study period, such starts tended to decline from the high set in 1972, although there were secondary peaks in the late seventies. Housing starts subsequently plummeted, however, so that by 1982 levels were nearly two-fifths below those recorded in 1979.⁴

Throughout most of the review period, replacement and remodeling activity, spurred in large part by high rates of sales of existing homes, tended to offset the impact of declining housing starts on the output of cabinets and vanities. Existing-home sales rose at an average annual rate of 10 percent between 1972 and 1979, then fell by nearly 20 percent per year to 1982. Constant-dollar outlays for major replacements—30 to 40 percent of which are for newly installed kitchen cabinets⁵—rose 4.9 percent per year over the earlier period, then dropped by 1.7 percent annually. Remodeling outlays, a significant proportion of which likewise are devoted to new kitchens and bathrooms and their furnishings, also rose, then declined, although at more moderate rates than major replacement spending.⁶ Most remodeling and replacement work is performed on older structures, which are more likely to need redesigned kitchens and enhanced storage space. (In 1982, four-fifths of replacement and remodeling expenditures were made for residential structures built prior to 1970, and more than half on structures built prior to 1960.⁷) However, the number of cabinets per kitchen—estimated to average 12 in new single-family homes in 1983, and 15 in remodeled homes⁸—is not believed to have changed much over the past 10 to 20 years,⁹ although a rising proportion of single-family homes feature two or more bathrooms, hence requiring additional vanities.¹⁰

The comparative strength of remodeling and replacement demand resulted in a considerably higher rate of production of custom than of stock line cabinets. Between 1972 and 1979, production of the former rose by nearly 8 percent a year, of the latter by only about 4 percent a year. Output of vanities paced that of custom cabinets. After 1979, however, output of both custom and stock line cabinets slumped, while production of vanities declined moderately.

Employment, hours, and occupational mix

Employment in kitchen cabinet manufacturing, currently numbering 58,000 persons, rose strongly—by 42 percent—between 1972 and 1979. By 1982, however, employment had fallen 22 percent. The expansion and subsequent decline in the industry's employment contrasts with the more moderate pattern of employment trends for manufacturing as a whole, as indicated by annualized percent changes for the two subperiods:

	<i>Kitchen cabinets</i>	<i>Manufacturing</i>
1972-82	2.8	-0.2
1972-79	4.8	1.4
1979-82	-7.6	-3.6

The number of production workers in the industry rose at only about three-fifths of the rate for nonproduction workers over the review period (2.5 percent per year versus 4.0 percent). In 1979, production worker employment stood 44 percent above 1972 levels, but then plummeted 28 percent by 1982. By contrast, nonproduction worker employment increased steadily, so that by 1982 it was nearly half again as large as 10 years earlier, and the proportion of nonproduction workers in total employment had expanded from 17 percent to 22 percent. Reasons for the rising proportion of nonproduction workers include the hiring of larger sales and distribution staffs, and increases in the number of technicians.

Average weekly hours in the industry exceeded 38.0 hours in only 4 years between 1972 and 1982. They usually ran about 94 percent of the manufacturing average. Industry sources believe that the lower average workweek arises mainly from the workweek practices of the smaller custom cabinet establishments. Industry overtime hours fell to 70 percent of the all-manufacturing average after 1973, and dropped to less than 60 percent in years of declining output. Even in years of strong output growth, neither average weekly hours nor overtime approached the manufacturing average. By comparison with all of manufacturing, then, the industry evidently preferred to hire rather than lengthen work hours during periods of increasing demand for its products, and to reduce its work force rather than work hours when demand declined.¹¹

Hourly wages of production workers in the industry averaged 17 percent below the comparable manufacturing figure for the review period. Also, they tended to decline relative to the manufacturing average over time, so that they

lagged by 21 percent in the last few years of the period. The industry's lower average hourly wage is probably a reflection of the large proportion of semiskilled workers it employs.

That this is, in fact, the case is suggested by data on the industry's occupational mix, which is weighted much more toward operative and laborer (that is, unskilled) positions than is employment in manufacturing generally. (These data apply to the group of woodworking industries of which kitchen cabinet manufacturing represents about one-quarter of the employment. But because the woodworking industries group as a whole uses similar production technologies and serves similar markets, differences in occupational composition among industries within the group are likely to be minor.¹²) Of the group's total 1983 work force, 81 percent were blue-collar workers, compared with 69 percent for all manufacturing. Most of the difference was linked to the high proportion of workers classed as laborers in the woodworking group (17 percent versus 9 percent for manufacturing). A relatively large number of laborers in the woodworking industries are engaged in such tasks as loading and unloading production machinery, handling of stock, and as helpers—tasks which tend to be mechanized in other manufacturing industries.

The proportion of operatives employed in the woodworking industries group is slightly higher than in all manufacturing (42 percent versus 40 percent). Here, the difference stems chiefly from the greater relative importance of assemblers, sawyers, edgers, and other workers in occupations typical for woodworking. The group also employs a marginally greater relative number of craft and related workers than manufacturing generally. White-collar workers, however, play a comparatively lesser role in the woodworking group, despite the increase in the share of nonproduction workers in kitchen cabinet manufacturing employment noted earlier. In 1982, white-collar workers represented 19 percent of employment in the group, as against 31 percent for all manufacturing. Much of this difference reflects the much smaller proportion of professional and technical workers in the woodworking group than in general manufacturing (3 percent versus 10 percent). The share of clerical workers in the group (8 percent) also was significantly smaller than in all manufacturing (12 percent).

Technology

The manufacture of wood kitchen cabinets and vanities entails the sawing, shaping, planing, and sanding of hardwood components (less often softwood, hardwood plywood, and hardwood veneer components), most often used for the facing of the final product or drawers, and of particleboard (or fiberboard), which usually constitutes the "box" or interior of the cabinet. After the components are imprinted with ink by means of cylindrical presses and hardware is

affixed, cabinets are assembled by stapling and gluing. Larger firms may locate the fabricating plant close to lumber supply areas, and perform assembly and other nonfabricating operations in separate establishments from which markets may be readily served.

Kitchen cabinet manufacturers use the same basic woodworking technologies employed in millwork generally. (Prior to 1972, the industry was defined as a subset of millwork for purposes of Federal statistical studies.¹³) The specialization and large-scale operations that came to characterize the stock line segment of the cabinet industry, and to a lesser extent its custom segments, did not fully develop until the 1950's. Kitchen design then shifted away from metal cabinets, partly because of certain disadvantages associated with use of the latter;¹⁴ and distributor networks enabling nationwide distribution sprang up. As in millwork generally, large-scale production of kitchen cabinets and vanities was to some extent promoted by the introduction of synthetic resin adhesives, which yield a quick-curing bond.¹⁵

Kitchen cabinet and vanity manufacturing is highly mechanized: all work that transforms the lumber and processes the shaped components and particleboard is done by machines or mechanically driven devices (such as inking cylinders). Especially in the stock line segment of the industry, transfer of stock has been increasingly conveyORIZED, rather than being performed by material handling equipment or manually. ConveyORIZATION has in turn been made possible by the economies of scale of mass production, and also by advances in technology, such as those that permit the rapid application and curing of inks and glue.¹⁶

First in the sequence of the industry's manufacturing operations is the treatment of the rough lumber. The lumber is delivered in uniformly sized sheets to predrying facilities. Predrying facilities began to be installed by the industry during the late sixties. They are designed to reduce the drying process from 5 months—if the lumber were to be left to dry in the open air—to 1 month (more or less, depending upon the species of wood). Predrying generally shrinks the lumber's moisture content by about 70 percent; it has the additional advantage of preventing the quality degradation characteristic of lengthier drying processes.¹⁷ The lumber is then transferred to kilns, usually for a 15-day period, so as to further reduce moisture content.

The machinery used in kitchen cabinet manufacturing reflects woodworking technologies that have been applied for many decades. However, a large proportion of such machinery appears to be comparatively new, and thus features the many minor innovations and modifications that cumulatively enhance the productivity of manufacturers' capital stock. According to a 1979 survey conducted by *Woodworking and Furniture Digest*,¹⁸ much of the existing woodworking and other equipment used in kitchen cabinet manufacturing establishments was less than a decade old. For example, one-half of all sawing and profiling machinery

was 10 years old or less, as were two-thirds of all dado, grooving, planing, and mitering machines. Most types of sanding machines were likewise of comparatively recent vintage. Well over four-fifths of edge banding machines employing hot-melt adhesives had been installed within the previous 10 years. Where the proportion of equipment 10 years old or less fell below 50 percent—as in the case of manually operated shapers, certain kinds of lathes, carving machines, tenoners, and sanders—it was preponderantly between 10 and 20 years old.

Of innovations to the production processes of the industry only a few examples can be given here. Defects in the lumber used in manufacturing kitchen cabinets were formerly spotted by a worker's trained eye and had to be laboriously removed with hand tools. Now, an electronic device "finds" the defect, and programs the cut so as to isolate and eliminate the defect. Labor requirements as well as material waste are thus considerably reduced.

Cutting heads of shapers, as well as saw blades, have been toughened by tungsten carbide, reducing time spent in removing and sharpening such devices. Particleboard pieces of similar thickness can now simultaneously be sawed to varying dimensions (as specified by different customers) by programming a computer, which generates a machine-readable tape that informs the sawing machinery of the cuts to be made and their sequence. The computer also generates a tape that can be read by the machine operator, so that he or she may check and follow the cutting operations, and override when necessary. Such lumping of small orders for processing of particleboard without manual resetting of machinery has raised output per unit of labor input in some establishments by three to five times.¹⁹

Secondary sanding operations, traditionally performed by hand, have been disappearing gradually; the use of multifunctional sander attachments, which reduce or eliminate the relatively high labor requirements associated with hand sanding, is becoming more prevalent. Automatic thickness settings permit a wide range of bites, down to finest surface

polish.²⁰ In addition, air-operated hand-held polishing apparatus has been developed that also dispenses with secondary sanding, and prevents swirl patterns by means of its so-called random orbit action.²¹ A shift away from electrically powered tools to air-operated hand tools is widely believed to have improved operator efficiency. Air-powered tools are lighter and less fatiguing to operate, and offer a wider choice of such options as handles and styles adaptable to operator preferences.

Adhesives and the means of applying them have likewise been improved. High-speed production and assembly requires rapid curing, and gluing has become an integral part of the production process in the larger, mass-producing establishments. However, stapling has not yet been eliminated in kitchen cabinet and vanity assembly, where it supplements gluing in the fastening of parts. Gluing, like stapling is performed by hand-held power tools. Such tools have been redesigned so as to minimize operator fatigue, and technically improved for ease and speed of operation: for example, screw-in cartridges now permit quick replacement of the glue-dispensing head.²²

Processing of particleboard gained considerably in efficiency during the review period with the introduction of synthetic precision coaters, which ensure that the board is free of voids or craters, and of ultraviolet light as a device for rapidly curing such coaters.²³

Fast curing is, of course, indispensable in the mass production of the cabinet box (which, as noted, consists of particleboard). The board is also run through a wood grain printer consisting of chrome cylinders engraved with the desired grain pattern, and is imprinted with the pattern by means of inks that dry almost immediately when the board has been run through an oven. Prior to the introduction of these processes, the cabinet box was left unfinished, meaning that more expensive particleboard had to be used. Despite the expense of capital investment in the new process, costs of fabricating the box have declined, while the final product has become more attractive.²⁴

Table 1. Productivity and related indexes for the wood kitchen cabinet industry, 1972-82

[1977 = 100]

Year	Output per hour			Output	Employee hours		
	All employees	Production workers	Nonproduction workers		All employees	Production workers	Nonproduction workers
1972	82.3	80.9	90.1	73.2	88.9	90.5	81.2
1973	83.6	83.6	83.3	80.5	96.3	96.3	96.6
1974	78.6	81.3	67.6	68.9	87.7	84.8	101.9
1975	86.7	90.9	70.5	61.2	70.6	67.3	86.8
1976	81.4	81.9	79.3	63.0	83.5	83.0	85.7
1977	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1978	100.5	100.2	102.3	116.7	116.1	116.5	114.1
1979	96.4	95.7	100.2	118.5	122.9	123.8	118.3
1980	102.1	104.5	91.4	110.7	108.4	105.9	121.1
1981	99.3	104.4	80.3	105.2	105.9	100.8	131.0
1982	88.7	96.2	63.9	83.7	94.4	87.0	131.0
Average annual rates of change (in percent)							
1972-82	2.1	2.6	0.0	4.7	2.5	2.0	4.7
1977-82	-1.6	0.0	-8.4	-3.6	-2.0	-3.6	5.2

Capital investment

Expenditures for plant and equipment by kitchen cabinet manufacturers paralleled output trends over the review period. Capital expenditures by the industry, in constant dollars,²⁵ rose at an average annual rate of nearly 7 percent between 1972 and 1979, then declined at a rate of 17 percent per year to 1982. The industry's capital spending varied from year to year in line with its output, although fluctuations in spending were far greater than those in production. Thus, in 1977, capital spending soared 51 percent compared with 47 percent for output, while in 1980, it plummeted 44 percent (always in terms of price-adjusted dollars) as against a 7-percent output drop. Average annual percentage changes in capital spending for the industry differ markedly from similar estimates for all manufacturing:

	<i>Kitchen cabinets</i>	<i>Manufacturing</i>
1972-82	1.9	3.7
1972-79	6.7	8.1
1979-82	-16.8	-6.0

In terms of current dollars, assets per worker in the kitchen cabinet manufacturing industry have risen less than in total manufacturing. According to Bureau of the Census data, assets per worker in the industry increased 42 percent during the review period, compared with 76 percent for all manufacturing. The industry used considerably less capital per worker than manufacturing generally throughout the period, and in recent years, its capital intensity actually declined. Until the mid-1970's, assets per worker in the industry averaged 34 percent of the comparable figure for manufacturing, thereafter dropping to an estimated 26 percent. The decline to some extent reflected a decrease in the value of structures (that is, plant) relative to the industry's gross asset value—from about two-fifths in the earlier part of the period to one-third in the later years. The industry thus tended to place relatively more emphasis on installing new equipment than on constructing new plants.

Structure of the industry

The number of establishments in kitchen cabinet manufacturing rose 65 percent between 1972 and 1982. Most of the growth occurred before 1978, but despite slackening output in subsequent years, the number climbed by an additional 15 percent by 1982. The increase centered on custom cabinet fabricators rather than stock line firms, attesting to the strength of demand for replacement and remodeling of kitchen cabinets and vanities. It is possible that the rapid rise in the number of custom cabinetmaking firms contributed to the productivity slowdown in the industry in the more recent years of the review period. Virtually all the employment increase in the industry during the seventies occurred among custom cabinet and vanity fabricators rather than among stock line establishment.

The great majority of industry establishments are small firms employing fewer than 20 workers. In 1977, four-fifths

of all establishments classified in the industry accounted for but one-fifth of total employment. Three percent of all establishments employing 100 workers or more accounted for 40 percent of all workers. Changes over time in the distribution of establishments by employment size were small. Concentration ratios shifted upward for stock line manufacturers, with the eight largest firms accounting for 71 percent of the value of shipments in 1977, as against 49 percent in 1972. The upward shift was less pronounced for custom fabricators (25 percent in 1977 versus 22 percent in 1972.)

Outlook

Swings in residential construction, and high interest rates (if they persist), are likely to retard short- or medium-term productivity improvements in kitchen cabinet manufacturing, because they tend to depress capacity utilization and capital investment. Nevertheless, the experience over the 1972-82 period suggests that, over the long term, productivity should continue to advance. Productivity gains are also foreshadowed by continued diffusion of innovations, at least in the large establishments.

Automated systems are likely to be adopted more widely in the industry as costs of numerical controls decline. The precision of cuts made by such woodworking machinery as saws, shapers, and planers is likely to be controlled much more readily by the use of microcomputers, which would reduce setup time and waste, and improve product quality.²⁶ The application of coating also appears likely to become increasingly computerized: In a new type of technology, an electronic eye determines the dimensions of the wood component to which the coating is applied, relaying the information to a computer that operates revolving spray heads. These spray heads turn on and off as programmed. Changes in the color of the coating do not require significant downtime. The chemical characteristics of the spray have evolved so as to reduce drying time to little more than 2 minutes, and further reductions are in the offing. Together with appropriate changes in factory layout, such innovations have at least halved labor requirements of establishments in which they have been adopted.²⁷

Flexibility in setting up woodworking machinery afforded by microelectronic devices and numerical controls should also advance the efficiency of custom cabinet production. Moreover, families of common parts are more efficiently produced where group technology concepts or flexible manufacturing systems have been adopted by establishments in this segment of the industry.²⁸

The Bureau of Labor Statistics has projected an average annual rise in the employment of the industry group to which kitchen cabinet manufacturing belongs of 2.3 to 2.4 percent between 1982 and 1995. These rates are somewhat lower than the 2.8-percent annual increase recorded for the 1972-82 span. The occupational mix of the industry group is not projected to change significantly. The Bureau also projects

great strength in residential construction in the years ahead, with 2.16 million private housing starts in 1988, and 1.9 million annually thereafter to 1995.²⁹ Expenditures for replacement and remodeling are also likely to increase, considering the large additions to the stock of residential housing

in the 1970's.³⁰ Consequently, if demand for kitchen cabinets and vanities grows with the projected rise in residential construction and replacement and remodeling outlays, capital investment in the industry should be spurred, ensuring continued productivity improvement. □

—FOOTNOTES—

¹ Establishments primarily manufacturing wood kitchen cabinets and wood bathroom vanities are classified as number 2434 in the *Standard Industrial Classification (sic) Manual* of the Office of Management and Budget. As discussed in the text, the industry also manufactures cabinets made of plastics. Average annual rates shown in the text and the table are based on the linear least squares trend of the logarithms of the index numbers. The indexes for productivity and related variables will be updated annually and published in the annual BLS bulletin, *Productivity Measures for Selected Industries*.

² Made-to-measure units (custom cabinets) can often be manufactured with standard production methods and high-speed production machinery, although the range of designs may be limited. According to one report, up to 200 different sizes can be made in the same establishment, with setup changes causing little loss in efficiency. See *Woodworking and Furniture Digest*, April 1981, pp. 17–18. See also footnote 28.

³ Metal cabinets are classified on sic 2514. In 1982, they accounted for 1 percent of total kitchen cabinet output, compared with up to 25 percent during the late forties and early fifties. See William B. Lloyd, *Millwork, Principles and Practices* (Chicago, Cahners Publishing Co., 1966), p. 353.

⁴ Housing starts surged in 1983, rising by 60 percent from 1982. A continued, if moderate, increase is indicated for 1984. Evidence suggests that output and employment in kitchen cabinet and vanity manufacturing also rose strongly over these 2 years.

⁵ Unpublished data, Bureau of the Census.

⁶ The rates noted in the text mask year-to-year swings of sometimes great amplitude. For example, in 1975, remodeling outlays (in constant dollars) soared 90 percent; in 1978, they dropped 36 percent. These swings, of course, affected kitchen cabinet and vanity output.

⁷ U.S. Department of Commerce, Bureau of the Census, *Residential Alterations and Repairs*, Annual, 1982, table 7, p. 14.

⁸ Estimate from National Kitchen and Bath Association.

⁹ Information from National Kitchen and Bath Association.

¹⁰ Number of bathrooms in new housing in percent:

	<u>1</u>	<u>1-1/2</u>	<u>2</u>	<u>2-1/2 or more</u>
1982	22	11	45	22
1979	16	16	48	26
1975	24	17	40	20
1971	21	21	34	16

See Bureau of the Census, *Characteristics of New Housing*, various years.

¹¹ Average annual rates of change in employment and employee hours in kitchen cabinet manufacturing compared with manufacturing generally as follows:

	<i>Kitchen cabinets</i>	<i>Manufacturing</i>
1972–82:		
Employment	2.8	–0.2
Employee hours	2.5	–1.2
Ratio	1.12	0.17
1972–79:		
Employment	4.8	1.4
Employee hours	4.6	0.5
Ratio	1.04	2.80

1979–82:

Employment	–7.6	–3.6
Employee hours	–7.8	–4.5
Ratio	0.97	0.80

¹² Data from the Bureau of Labor Statistics. See also Jack Veigle and Horst Brand, "Millwork industry shows slow growth in productivity," *Monthly Labor Review*, September 1982, pp. 21–26.

¹³ Until 1972, kitchen cabinet and vanity manufacturing was classified as part of the millwork industry in the Census of Manufactures. See also Veigle and Brand, "Millwork industry," especially the technology section of the article.

¹⁴ *Millwork, Principles and Practices*, p. 353.

¹⁵ Information from William Lloyd, author of *Millwork, Principles and Practices*.

¹⁶ Information from industry sources.

¹⁷ Information from industry sources.

¹⁸ See *An Inventory of Machines and Equipment in the Woodworking and Furniture Market*, issued by *Woodworking and Furniture Digest*, Wheaton, Ill., 1979. *An Inventory* presents the number of woodworking machines, by type, for each woodworking industry (as classified by the *Standard Industrial Classification Manual*). In a separate presentation, *An Inventory* shows the age breakdown of each type of woodworking machinery, but the age breakdown is not grouped by industry. The discussion in the text assumes that the age breakdown applies to machinery in kitchen cabinet manufacturing where this industry accounts for a relatively large proportion of a given type of woodworking machinery. The authors of *An Inventory* believe this assumption to be valid.

¹⁹ *Furniture/Woodworking Product News*, May 1983.

²⁰ "Larger manufacturers . . . have been quick to pick up many kinds of sanding attachments, narrow belts, abrasive wheels . . . , and anything else that can reduce or eliminate secondary steps in process when these attachments are offered on multifunction machines." See *Woodworking and Furniture Digest*, May 1981, pp. 18–19.

²¹ *Ibid.*, under "New developments," pp. 16 ff.

²² *Woodworking and Furniture Digest*, January 1981, p. 10.

²³ Industry sources. See also *Furniture/Woodworking Product News*, March 1976, p. 16.

²⁴ Industry sources.

²⁵ Constant-dollar data based on deflators from the Bureau of Business Economics, U.S. Department of Commerce.

²⁶ Industry sources.

²⁷ Industry sources.

²⁸ Flexible manufacturing systems depend on automatically adjustable machinery, often linked with robots or other automatic transfer devices. See *American Machinist*, December 1981, pp. 55–56.

²⁹ See Arthur J. Andreassen and others, "Economic outlook for the 1990's: three scenarios for economic growth," *Monthly Labor Review*, November 1983, pp. 11–23.

³⁰ The number of housing units rose 17 percent between 1960 and 1970, and 28 percent between 1970 and 1980. See *Statistical Abstract of the United States, 1982–83*, p. 751.

APPENDIX: Measurement techniques and limitations

Indexes of output per employee hour measure changes in the relation between the output of an industry and employee hours expended on that output. An index of output per employee hour is derived by dividing an index of output by an index of industry employee hours.

The preferred output index for manufacturing industries would be obtained from data on quantities of the various goods produced by the industry, each weighted (multiplied) by the employee hours required to produce one unit of each good in some specified base period. Thus, those goods that require more labor time to produce are given more importance in the index.

In the absence of adequate physical quantity data, the output index for this industry was constructed using a deflated value technique. The value of shipments of the various product classes was adjusted for price changes by appro-

priate Producer Price Indexes and Industry Sector Price Indexes to derive real output measures. These, in turn, were combined with employee hour weights to derive the overall output measure. The result is a final output index that is conceptually close to the preferred output measure.

Employment and employee hour indexes were derived from data published by the Bureau of Labor Statistics. Employees and employee hours are each considered homogeneous and additive, and thus do not reflect changes in the qualitative aspects of labor, such as skill and experience.

The indexes of output per employee hour do not measure any specific contributions, such as that of labor or capital. Rather, they reflect the joint effect of factors such as changes in technology, capital investment, capacity utilization, plant design and layout, skill and effort of the work force, managerial ability, and labor-management relations.

Erratum

The provisions related to financing and disqualification under Rhode Island's unemployment insurance program were not enacted, contrary to the report in "Changes in unemployment insurance legislation during 1984," *Monthly Labor Review*, January 1985.
