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**LABOR AND
MATERIAL
REQUIREMENTS
FOR
SCHOOL
CONSTRUCTION**

BLS Bulletin 1586

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JUNE 1968

BLS Bulletin 1586

UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

Preface

This study of labor and material requirements for the construction of schools is one of a series which the Bureau of Labor Statistics have made of various types of construction that might be affected by future governmental action. It is similar to an earlier study of school construction made in 1959. Other previously published studies include highways, Federal office buildings, hospitals, civil works activities of the Army Corps of Engineers, public housing, private one-family dwelling units, college housing, and sewer works construction.

These studies are made by the Bureau's Office of Productivity, Technology and Growth under the general direction of Jerome A. Mark, Assistant Commissioner for Productivity, Technology, and Growth. The study was directed by James F. Walker. Henry Renten was responsible for the collection of data.

The Bureau gratefully acknowledges the cooperation of the Housing and Home Finance Agency for making available much of the data on federally-aided school projects.

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Introduction

Public school construction was chosen as the first in this series of studies because of the pressing need for new classrooms at the time. It was selected for restudy because of its continuing importance in total expenditures for new construction that can be affected greatly by governmental action. The changes in total labor requirements and occupational mix, as well as changes in materials used in school construction during the 5 year period since the first study, provided added justification for the recent survey. Expenditures for educational construction, both private and public, have risen steadily for many years and totaled over \$6 billion in 1966. It is second only to highways in public construction outlays.

Nature of Survey

This study is based on a survey of selected elementary and secondary public schools constructed primarily during the period 1964-65. Data were collected from 103 projects, selected from the four broad geographical regions of the U.S. ^{1/}

The study was designed primarily to determine the total man-hours of employment required for a fixed dollar volume (\$1,000) of school construction. Man-hours, as defined for the survey, include both on-site construction employment and off-site employment required to produce and deliver the materials used in school construction.

In addition to providing information on man-hours, the study also includes data on the types and value of materials used, wages paid, occupational distribution, and use of apprentices.

Results of the studies are being used to evaluate changes in costs and to attempt to measure the changes in output per man-hour for on-site construction workers between the two studies.

^{1/} For a more detailed description of method, and for a list of States included in each region, see appendix.

Limitations of the Data

The planning, developing, and building of schools vary greatly among the various school systems, and a sample of projects large enough to reflect all of the potential factors affecting some of the detail presented would have been prohibitive.

There is no known bias in the sample selection, but the number of projects studied was insufficient to insure a high degree of accuracy for all of the estimates published. The estimates on total employment, occupational distribution, and total shares of on-site wages and materials are believed to be accurate.

Certain types of employment possibly affected by school construction were not covered by the survey. No estimates were made of the employment used in planning and designing the schools. Such expenditures also were not included in the contract costs studied. (See appendix.) Also excluded from the survey was the labor involved in installations made by public-utility employees as well as any site preparation or landscaping work not covered by the construction contract.

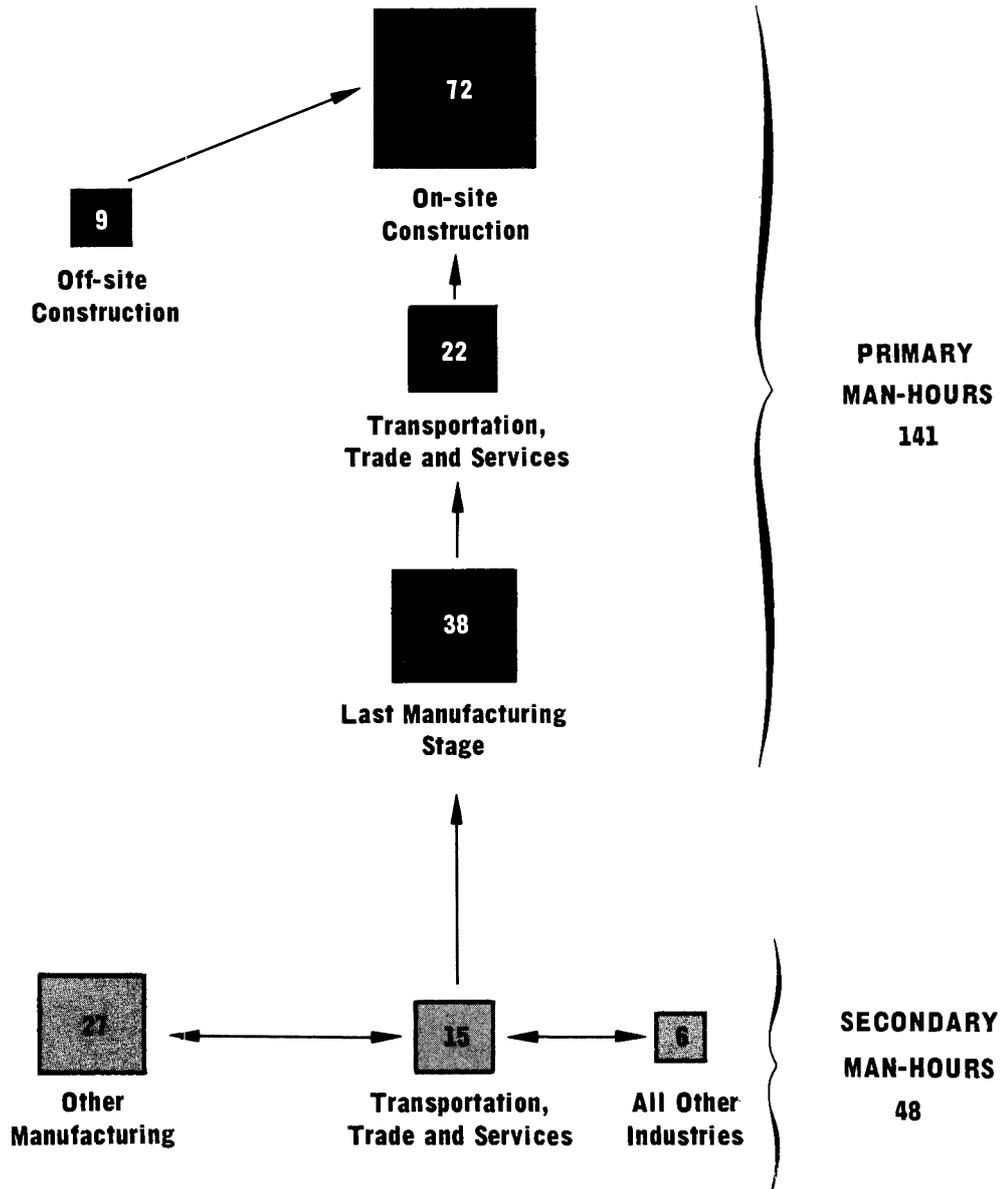
Employment created by the respending of wages and profits--commonly called the multiplier effect--also was not considered within the scope of the study.

The principal difference between this and the earlier study was the inclusion in this study of estimates of the employment effect of contractors' overhead. In presenting comparisons of the two studies, adjustments have been made to the earlier data to include these estimates.

General Survey Findings

Approximately 198 man-hours of labor were required for each \$1,000 of school construction in 1964-65, representing a decline of about 16 percent from the sim-

Chart 1. Distribution of 189 Man-Hours for Each \$1,000 of School Construction Contract, 1964-65



ilar study conducted in 1959. On-site employment also decreased 16 percent, from 86 to 72.3 man-hours. 2/

A comparison of man-hour requirements for the two studies is shown below.

The comparison of man-hours per \$1,000 of construction reflects changes in construction prices and shifts in types of

schools in addition to changes in labor requirements per unit of school construction. Unfortunately, a good deflator to remove the effect of price change from value changes is not available for the construction industry. Although an attempt is made in the study to provide both a representative sample of schools in both periods and also to match the sample of schools for the two periods, the latter objective could not be realized in all characteristics.

	<u>Man-hours Per \$1,000 of Contract</u>			
	<u>1964-65</u>		<u>1959</u>	
	Number	Percent	Number	Percent
Total man-hours-----	198	100	235	100
Construction -----	81	41	96	41
On-site -----	72	36	86	37
Off-site -----	9	5	10	4
Manufacturing -----	65	33	74	31
Trade, transportation and services -----	37	19	46	20
All other industries ^{1/} ----	15	7	10	4

1/ Includes 1 hour of indirect construction employment.

2/ A quality check on the earlier study indicates that the original estimate of 84 hours was understated by about 2 hours. Adjustments also were made for off-site hours, as a result of a new input-out study (1958 interindustry data), and the inclusion of an estimate covering the contractor's overhead expenditures. The revised total employment for the 1959 study was 235 hours per \$1,000 of contract. This comparison must be qualified as must other comparisons because of the lack of strict matching of project with similiar characteristics between the two studies. Nevertheless, they are useful as indicators of the general change which has taken place in this time period.

As a result, the comparisons of square footage cost which follow do reflect some differences in characteristics. This does not obviate the conclusion of the relative stability in square footage cost over the two periods since to a very appreciable extent the schools compared were similar. Moreover, the findings need not be inconsistent with the appearance of price changes for school construction which could affect certain types of schools in certain localities in selected regions.

Comparison of Samples

In general the schools surveyed in the more recent period were larger and had more classrooms. Also a greater proportion of them had air conditioning, audio-

riums and gymnasiums. However, the schools in both surveys showed the same proportion of space utilized for non-classroom purposes. The accompanying table indicates some of the characteristics of the schools in each study.

Characteristics (Average)	1964-65	1959
Floor space (1000 square feet)-----	60.0	51.4
Cost per square foot--- \$	14.16	\$ 14.16
Number of classrooms---	24.6	21.0
Cost per classroom----- \$	34,500	\$ 35,000
Construction cost-----	\$850,000	\$730,000

Although there was no change in cost for the average school from the first to the second study, variations in construction costs were observed in comparing type of school and other building characteristics (See table 1.)

Square foot and classroom costs increased for elementary schools and decreased for secondary schools from 1959 to 1964-65.

Square foot cost increased in the Northeast and West and remained about the same or decreased in the North Central and South. In the earlier study square foot costs were higher in metropolitan areas but in the latter study the differences were small and not consistent.

In both studies the larger projects were more costly per square foot, but the difference was smaller in the more recent study.

There were no significant changes in the relationship of square foot costs by types of structure. In general, square foot cost differentials tended to narrow in all comparisons except by region.

Changes in On-site Man-hour Requirements

1. Man-hour requirements per square foot of school construction decreased from 1.19 in 1959 to 1.02 in 1964-65.

2. The total value of material put in place per man-hour increased about 16 percent during the same period. Some of this gain possibly is due to the increased use of pre-fabricated materials.

3. Man-hour requirements per \$1,000 of contract were 16 percent lower, indicating a reduction of about 2.75 percent a year (compounded during the 5-1/2 year period.)

4. The proportion of on-site wages to total contract costs remained about the same (around 26 percent) between the two periods, despite an increase of 16 percent in average hourly earnings.

On-site labor requirements in the 1964-65 study declined in each of the four broad regions, but costs per square foot between the regions varied both in level and trend.

	Square foot costs		Man-hour requirements per square foot		Decreases in man-hour requirements
	<u>1959</u>	<u>1964-65</u>	<u>1959</u>	<u>1964-65</u>	(Percent)
Northeast-----	16.99	18.98	1.291	1.192	8.3
North Central---	13.67	13.55	1.129	.957	15.2
South-----	12.11	11.56	1.199	1.025	14.5
West-----	14.25	15.53	1.149	.955	16.9
All schools-----	14.16	14.16	1.189	1.024	13.8

On-site Man-hour Requirements

On-site man-hour requirements varied considerably between projects, but over half of the projects studied had man-hour requirements (per \$1,000 of construction), ranging from 55 to 75. Most of the projects having higher man-hour requirements were in the South and North Central regions.

In general, differences in man-hour requirements between projects and specific groups of projects narrowed. The most significant change in relationships from the previous study occurred in the smaller projects. In the earlier study, smaller projects, including most of the elementary schools, had much higher labor requirements per \$1,000 of contract. In the more recent study, size of project did not appear to be a significant factor, and elementary schools as a group actually had lower labor requirements. It should be noted that only a few very small projects (under \$200,000) were included in the more recent study.

The increased efficiency in the smaller projects was not evident in the nonmetropolitan areas. Man-hour requirements in nonmetropolitan areas were over 15 percent higher than those in metropolitan areas. In the earlier study, this difference, on the average, was less than 6 percent.

When on-site labor requirements are compared on a square foot basis, the differences between projects and specific groups of projects are much smaller. Two-thirds of the projects had labor requirements between 0.8 and 1.2 man-hours per square foot.

As in the earlier study, on-site man-hour requirements were related to three major factors: (1) availability and use of labor-saving equipment, such as cranes, elevators, and conveyors; (2) amount of prefabricated components; and (3) proportion of skilled workers.

Table 3 shows the man-hour requirements of projects according to the proportion of lower skilled workers used. Labor

requirements were 60 percent greater for projects having 45 percent or more of their total man-hours in lower skill occupations than for projects with 25 percent or less in those categories.

Requirements by Occupation

Changes in the occupational distribution between the two studies were insignificant and more or less predictable. Decreases in the proportion of plasterers, lathers, and ornamental iron workers, and increases in operating engineers, sheet metal workers, and tile setters were typical of occupational trends in building construction.

The most important job numerically continued to be carpenters, in spite of a 12 percent decrease in their share of the work. Many carpenters performed jobs not connected with lumber as they have developed skills in materials which have replaced lumber.

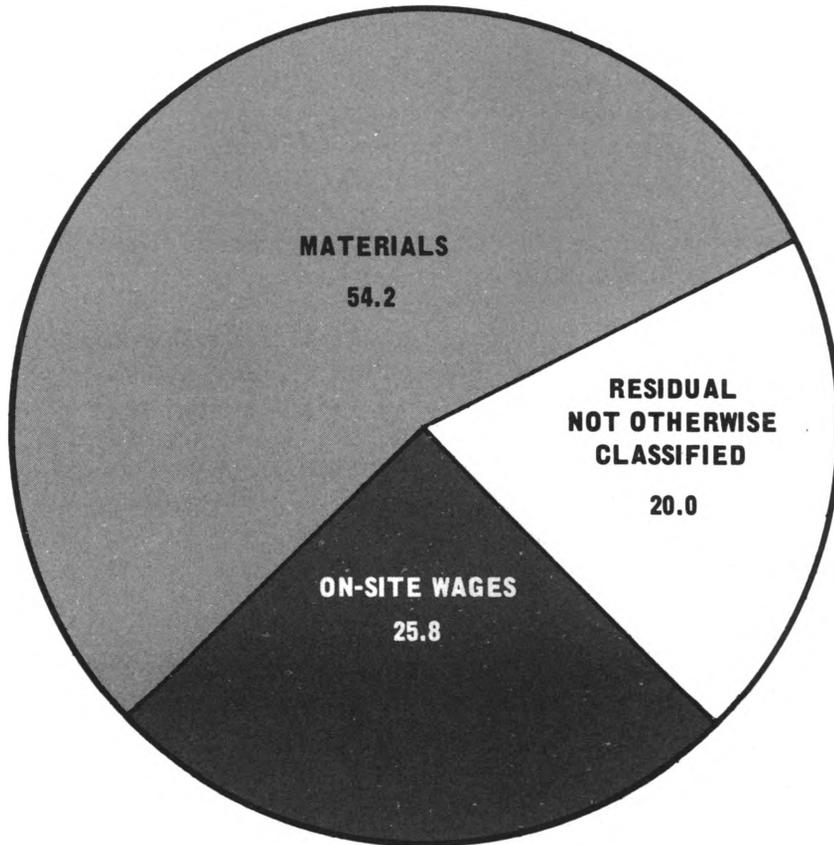
Lower skilled jobs continued to represent about 30 percent of the occupational work force. Although the proportion of lower skilled workers declined in the Northeast, North Central, and Western regions during the interim between the two surveys, the Southern region employed a higher percentage of these workers in 1964-65 (43.4 percent) than in 1959 (40.3 percent).

Formal apprentices represented 4.1 percent of the work force, an increase over the 3.7 percent reported in 1959. Electricians accounted for the largest proportion of apprentices, 15.1 percent. Most of the trades had higher proportions of apprentices working than in the earlier study. Apprenticeship programs were most evident in the West.

Contractors' Shares

The trend toward subcontracting continues, and the general contractor's share of total employment (in man-hours) declined from 47.4 percent in 1959 to 42.0 percent in the later study. The largest increase was in masonry subcontracting (see table 8). Subcontracting increased in all regions, but

**Chart 2. Percent Distribution of On-Site Wages
and Materials Used for Each \$1,000
of School Construction Contract, 1964-65**



the increased use of subcontractors was most pronounced in the North Central region.

The average number of subcontractors per project increased from 19 in 1959 to 26 in the 1964-65 study. Part of this increase was due to the greater size of the projects, since larger projects almost inevitably involve more subcontractors.

On-site Wages

Average wage rates for on-site labor advanced over 16 percent between the two studies. This increase in worker earnings, however, did not alter the relationship of wage payments to total contract costs, 25.8 percent in 1964-65 compared with 25.7 percent in 1959. Increased wages in the industry have been offset by lower man-hour requirements, to the extent that on-site wages are a smaller proportion of the contract dollar than they were 30 years ago (31.1 percent).^{3/} On-site wages in more than half of the projects studied in the more recent survey (55.6 percent) fell into a very narrow range, between 22.6 and 27.5 percent of the contract dollar.

The proportion of on-site wages was fairly consistent among specific groups of projects regardless of wage levels. (See table 9.) Projects with higher wage rates required less man-hours (per \$1,000 of contract).

It should be noted that the wage information presented in this report does not include many costs which might be considered labor costs. For example payroll taxes, workmen's compensation, fringe benefit costs. These items were not studied, but it can be assumed safely that such costs have increased more proportionately, than wage rates.

Construction Time

The average school project studied required 52 weeks from the beginning of the

contract to its completion. As can be expected, construction time varied by size of project and geographical location. Construction time was generally comparable to the earlier study and no significant reduction was observable by project size and region. (See table 10.)

When construction time for each project was divided into deciles, it was shown that a majority of the work force (53.5 percent) is employed from the 4th through the 7th deciles. For the typical project, only 4.3 percent of the employment occurs in the first 5 weeks and only 3.5 percent in the last 5 weeks. Peak employment is reached in the sixth 5-week period, when 14.6 percent of the total man-hours are worked. (See table 11.)

Affect on Other Industries

Employment generated in manufacturing industries from school construction runs a close second to the number of jobs occurring in the construction industry. Labor requirements per \$1,000 of school construction total 82 man-hours in the construction industry and 65 in manufacturing; almost one-third of the total labor requirements is fulfilled by the manufacturing sector. (See table 12.) About 38 of these hours would be in the last stage of manufacturing, and the balance in other manufacturing plants supplying those manufactures, directly or indirectly.

The total employment effect is felt in all sectors of the economy. The trade sector accounts for about 11 percent of the total hours and transportation industries over 4 percent. Service industries are increasing their share of employment participation and in the latest study accounted for over 3 percent of all jobs.

Materials Used

A little over 54 percent of each contract dollar was spent for materials, supplies, and equipment. Nearly half of this was for two major groups of materials: stone, clay, and glass products, \$130 (out of every \$1,000 of contract); and metal products, \$134.60.

^{3/} According to an unpublished study of public works projects in the late 1930's.

Major items in these two groups were ready-mix concrete, \$32.90; brick and structural tile, \$19.60; structural steel, \$32.70; and reinforcing bars and joists, \$28.30. ^{4/}

Lumber and lumber products were valued at \$50.90; millwork represents the major item in this group.

Heating and ventilating equipment, including air conditioning, totaled \$51.90 and other electrical equipment and materials, \$52.90. Plumbing products totaled \$39.

The total material expenditure was about 2 percent lower than the earlier study. Comparisons of individual times were difficult because of changes in classification and other reasons. ^{5/}

Some changes in material requirements were notable. Air conditioning, which was rare in the earlier study, was reported in 27 percent of the projects studied and represented \$9.20 in material purchases. Uses of precast concrete products increased. Other

significant gains included the use of acoustical tile, vinyl asbestos tile, laboratory equipment, kitchen equipment, and folding partitions. Decreases were noted in the use of asphalt tile, metal windows, and ornamental iron.

The reduction in window glass was probably attributable to a greater use of preglazed windows, plus a decrease in the number and size of windows generally associated with air conditioning. The apparent reduction in copper products was due to definitional changes in the standard industrial classification, and the reduction in temperature controls was due to classification in greater detail of their components.

Some of the changes in material requirements were even greater when viewed on a regional basis. Nearly all of the air-conditioned schools were located in the South and West. A relatively large expenditure for shop equipment was made in the North Central region. Increased expenditures for fixed school equipment were noted in all areas.

^{4/} Currently, there is about \$6 billion a year being spent on educational construction, both public and private. This indicates expenditures for materials in this area is \$3.25 billion (at the site valuation). The \$28.30 expenditure for reinforcing bars and joists, for example, represents a current annual requirement of over \$100 million in these items alone.

^{5/} Comparisons of material usage between the two studies are difficult and frequently misleading. The major reasons are:

1. Differences in classification to accommodate the 1947 input-output matrix used in the 1959 study, and the 1958 input-output matrix used in the 1964-65 study.
2. Changes in prices which can make it appear that the volume of a specific material has changed when in fact the change is due to price increases or decreases.
3. Introduction of new materials or equipment, such as air conditioning, which tends to reduce the relative dollar value of all other items.

Table 1. Number and Cost of Surveyed School Construction Projects, by Selected Characteristics and Region, 1964-65

Characteristic	United States			Northeast			North Central			South			West		
	Number	Cost per		Number	Cost per		Number	Cost per		Number	Cost per		Number	Cost per	
		Square foot	Class-room (thousands)		Square foot	Class-room (thousands)		Square foot	Class-room (thousands)		Square foot	Class-room (thousands)		Square foot	Class-room (thousands)
All Schools.....	103	\$14.16	\$34.5	18	\$18.98	\$43.7	27	\$13.55	\$34.9	34	\$11.56	\$28.6	24	\$15.53	\$35.9
Elementary.....	53	14.31	26.3	9	17.73	33.3	14	12.62	22.9	18	12.82	23.8	12	15.43	27.6
Secondary.....	50	14.09	40.3	9	19.63	51.3	13	13.95	43.6	16	11.08	31.4	12	15.59	43.5
In a metropolitan area.....	62	14.56	33.8	12	18.69	44.8	15	13.20	28.6	21	11.76	28.0	14	15.89	37.1
Not in a metropolitan area.....	41	13.68	35.5	6	19.44	42.0	12	13.89	43.5	13	11.40	29.1	10	14.48	32.7
Construction cost group (In thousands):															
\$500,000 and under.....	43	12.61	23.6	3	14.56	20.3	11	13.18	22.3	21	11.71	24.3	8	14.02	24.5
\$500,001 to \$1,000,000.....	28	14.22	31.2	6	17.86	35.2	8	11.51	28.1	5	12.49	27.8	9	15.59	33.1
\$1,000,001 and over.....	32	14.69	42.2	9	19.81	52.0	8	14.66	47.3	8	11.31	31.7	7	16.12	46.3
Type of framing:															
Steel.....	39	15.32	37.2	11	18.64	46.1	10	13.36	35.5	13	12.24	26.1	5	16.26	37.0
Concrete.....	19	13.84	37.9	1	(1/)	(1/)	5	14.30	47.0	10	11.65	28.5	3	14.68	42.9
Load-bearing masonry.....	40	12.78	29.2	6	17.44	31.1	12	13.04	25.7	11	11.23	30.0	11	14.12	30.2
Wood.....	5	19.46	44.1	--	-----	-----	--	-----	-----	--	-----	-----	5	19.46	44.1
1 story.....	84	13.87	32.4	13	18.91	39.0	20	13.36	32.4	29	11.34	28.1	22	15.83	34.5
2 to 4 stories.....	19	14.86	40.6	5	19.07	51.6	7	13.89	40.1	5	12.32	30.1	2	(1/)	(1/)
Full or partial basement.....	11	14.80	42.2	1	(1/)	(1/)	2	(1/)	(1/)	3	12.07	31.4	5	14.71	43.6
No basement.....	92	14.07	33.6	17	18.39	42.0	25	13.78	34.8	31	11.52	28.4	19	15.94	33.3
Exterior:															
Masonry.....	89	13.90	34.9	15	18.99	45.9	26	13.62	36.4	31	11.49	28.8	17	14.52	34.2
Curtain wall.....	8	16.48	26.4	3	18.83	30.8	1	(1/)	(1/)	2	(1/)	(1/)	2	(1/)	(1/)
Other.....	6	17.38	39.3	--	-----	-----	--	-----	-----	1	(1/)	(1/)	5	19.35	41.7

1/ Too few projects to warrant presentation.

Table 2. On-Site Man-Hour Requirements for School Construction Projects, by Selected Characteristics and Region, 1964-65

Characteristics	United States			Northeast			North Central			South			West		
	Man-hours per			Man-hours per			Man-hours per			Man-hours per			Man-hours per		
	\$1,000 of cost	1,000 square feet	Class-room	\$1,000 of cost	1,000 square feet	Class-room	\$1,000 of cost	1,000 square feet	Class-room	\$1,000 of cost	1,000 square feet	Class-room	\$1,000 of cost	1,000 square feet	Class-room
All schools.....	72.3	1,024	2,495	62.8	1,192	2,743	70.6	957	2,462	88.7	1,025	2,535	61.5	955	2,209
Elementary.....	66.9	957	1,757	59.3	1,051	1,976	67.1	847	1,539	80.1	1,027	1,906	57.9	894	1,597
Secondary.....	74.8	1,055	3,014	64.5	1,266	3,306	71.9	1,003	3,137	92.4	1,024	2,903	63.5	990	2,761
In a metropolitan area....	67.6	985	2,283	61.6	1,151	2,757	63.8	842	1,825	83.1	977	2,330	62.5	993	2,317
Not in a metropolitan area.	78.3	1,072	2,779	64.7	1,258	2,721	76.7	1,066	3,389	93.4	1,065	2,717	58.2	843	1,901
Construction cost group (In thousands):															
\$500,000 and under.....	73.5	926	1,730	64.0	932	1,302	67.0	883	1,495	83.9	982	2,039	58.3	817	1,426
\$500,001 to \$1,000,000..	66.6	946	2,076	60.1	1,073	2,118	70.5	811	1,978	86.0	1,074	2,390	58.0	904	1,919
\$1,000,001 and over.....	74.1	1,089	3,126	63.7	1,263	3,313	71.7	1,051	3,391	91.7	1,037	2,906	64.8	1,045	3,001
Type of framing:															
Steel.....	67.1	1,028	2,495	63.9	1,192	2,947	70.7	944	2,507	80.1	980	2,091	52.3	862	1,932
Concrete.....	77.5	1,073	2,940	61.7	1,563	3,876	75.3	1,077	3,540	84.1	980	2,394	77.9	1,444	3,342
Load-bearing masonry....	76.6	979	2,239	58.9	1,028	1,832	64.5	841	1,656	95.4	1,071	2,858	60.5	854	1,828
Wood.....	58.7	1,143	2,588	---	---	---	---	---	---	---	---	---	58.7	1,143	2,588
1 story.....	71.1	987	2,301	60.6	1,145	2,362	68.3	913	2,213	89.2	1,012	2,512	57.8	915	1,966
2 to 4 stories.....	75.1	1,117	3,051	65.6	1,251	3,386	74.5	1,034	2,989	86.8	1,069	2,609	82.9	1,176	3,924
Full or partial basement...	69.0	1,021	2,908	61.7	1,563	3,876	74.7	869	2,675	75.2	907	2,364	68.2	1,002	2,970
No basement.....	72.8	1,025	2,445	62.9	1,157	2,646	70.2	968	2,444	89.7	1,034	2,547	58.4	931	1,944
Exterior:															
Masonry.....	73.7	1,025	2,573	63.3	1,203	2,908	70.7	963	2,573	89.8	1,032	2,587	62.8	912	2,147
Curtain wall.....	59.9	987	1,584	58.3	1,099	1,795	66.9	702	690	64.6	1,002	1,583	56.6	936	2,180
Other.....	61.2	1,064	2,403	---	---	---	---	---	---	80.2	772	2,157	58.8	1,138	2,451

10

Table 3. On-Site Man-Hour Requirements Per \$1,000 of School Construction by Proportion of Lower Skilled Labor Employed ^{1/} and Region, 1964-65

Percent of lower skilled workers	United States	North East	North Central	South	West
All occupational groups..	72.3	62.8	70.6	88.7	61.5
25.0 and under.....	61.8	62.0	66.0	---	57.0
25.1 to 35.0.....	71.9	64.3	76.7	75.1	70.8
35.1 to 45.0.....	86.3	---	---	86.3	---
45.1 and over.....	99.2	---	---	99.2	---

^{1/} For purposes of this comparison, laborers, helpers, and tenders were considered lower skilled.

Table 4. Percent Distribution of School Projects, by Number of On-Site Man-Hours Required for Each \$1,000 of Construction Contract, by Region, 1964-65

Percent group	United States	North East	North Central	South	West
Average man-hours.....	72.3	62.8	70.6	88.7	61.5
Under 55.0.....	10.1	8.5	3.3	---	36.6
55.0 to 64.9.....	31.5	57.6	36.7	7.8	42.3
65.0 to 74.9.....	24.1	33.9	34.4	14.7	18.3
75.0 to 84.9.....	18.5	---	22.2	34.5	2.8
85.0 to 94.9.....	7.4	---	3.3	19.0	---
95.0 and over.....	8.3	---	---	24.1	---

NOTE: Because of rounding, sums of individual items may not equal 100.

Table 5. On-Site Man-Hour Requirements Per \$1,000 of School Construction Contract, by Occupation and Region, 1964-65

Occupation ^{1/}	United States		Northeast		North Central		South		West	
	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent
All occupations.....	72.3	100.0	62.8	100.0	70.6	100.0	88.7	100.0	61.5	100.0
General supervisors.....	2.3	3.2	2.0	3.2	2.3	3.2	2.6	2.9	2.2	3.6
Professional, technical, and clerical.....	.3	.4	.8	1.2	---	---	.2	.3	.1	.2
Asbestos workers.....	.6	.9	.6	1.0	.9	1.3	.5	.6	.5	.8
Bricklayers.....	6.7	9.2	6.5	10.3	8.7	12.3	7.3	8.2	3.3	5.4
Carpenters.....	11.9	16.5	10.1	16.1	10.7	15.2	12.9	14.6	14.0	22.8
Cement finishers.....	1.4	1.9	1.1	1.8	1.3	1.9	1.5	1.7	1.4	2.3
Electricians.....	5.3	7.3	5.4	8.7	5.6	7.9	5.0	5.6	5.2	8.4
Glaziers.....	.5	.6	.5	.8	.6	.8	.5	.5	.3	.5
Lathers.....	.7	1.0	.8	1.3	.7	1.0	.7	.8	.7	1.2
Operating engineers.....	2.0	2.7	1.7	2.6	1.8	2.5	2.4	2.7	2.2	3.5
Ornamental-iron workers.....	.4	.5	.6	.9	.5	.6	.2	.3	.3	.5
Painters.....	2.5	3.5	2.2	3.5	2.5	3.5	2.8	3.1	2.5	4.0
Plasterers.....	.7	1.0	.7	1.0	.6	.8	.9	1.0	.8	1.3
Plumbers.....	7.0	9.6	6.9	11.0	8.0	11.4	6.5	7.3	6.4	10.4
Reinforcing iron workers....	.7	.9	.3	.5	1.1	1.5	.6	.7	.6	.9
Roofers.....	1.0	1.4	1.0	1.5	1.3	1.8	.9	1.0	1.0	1.7
Sheet-metal workers.....	2.5	3.4	2.0	3.1	3.2	4.6	1.8	2.0	3.2	5.3
Soft floor layers.....	.4	.6	.4	.6	.4	.6	.4	.4	.5	.8
Structural-iron workers.....	1.2	1.7	1.8	2.8	1.4	2.0	.9	1.1	.8	1.2
Terrazzo workers and tile setters.....	.9	1.3	1.2	1.9	1.1	1.6	.9	1.1	.4	.7
Truck drivers.....	.5	.6	.2	.4	.5	.7	.5	.5	.7	1.1
Laborers.....	17.2	23.8	12.2	19.4	11.9	16.9	30.2	34.1	10.4	16.9
Helpers and tenders.....	5.1	7.1	3.3	5.2	5.2	7.4	7.6	8.6	3.3	5.4
Custodial workers.....	.1	.2	.2	.3	(<u>2/</u>)	(<u>2/</u>)	.2	.2	(<u>2/</u>)	(<u>2/</u>)
Other.....	.5	.7	.4	.6	.3	.5	.6	.6	.6	.9

^{1/}Working foremen and apprentices are included with journeymen.

^{2/}Less than 0.05 percent.

NOTE: Because of rounding, sums of individual items may not add to totals.

Table 6. Percent of Apprentices Employed on School Construction Projects
Occupation and by Region, 1964-65 ^{1/}

Occupation	United States	North East	North Central	South	West
All workers.....	4.1	3.6	4.4	3.5	5.6
Skilled trades only.....	6.6	5.1	6.2	6.5	8.1
Bricklayers.....	5.8	9.6	6.1	3.0	6.7
Carpenters.....	4.6	3.9	1.6	4.8	6.2
Cement finishers.....	1.5	.6	2.3	(2/)	4.1
Electricians.....	15.1	14.3	10.4	16.7	16.8
Glaziers.....	5.6	9.3	---	5.5	6.5
Lathers.....	8.0	2.0	.8	8.2	19.7
Ornamental-iron workers.	.5	---	---	1.4	---
Painters.....	4.8	3.3	9.8	2.8	5.0
Plasterers.....	7.2	.4	---	10.9	8.5
Plumbers.....	8.9	2.3	11.6	11.1	8.6
Reinforcing-iron workers.....	1.6	---	---	1.7	3.7
Roofers.....	4.5	7.5	5.5	3.4	2.8
Sheet-metal workers.....	13.2	2.4	14.0	14.9	16.9
Soft floor layers.....	5.9	3.4	9.0	1.8	10.2
Structural-iron workers.	1.0	---	---	.9	5.0
Terrazzo workers and tile setters.....	2.8	---	4.9	4.4	---

^{1/}Based on data from federally aided school projects only.

^{2/}Less than 0.05 percent.

Table 7. Average Number of Contractors Per School Construction Project, by Cost Group and Region, 1964-65

Cost group (in thousands)	United States	North East	North Central	South	West
All groups.....	26	27	27	21	33
\$500,000 and under.....	22	22	23	19	28
\$500,001 to \$1,000,000.	25	23	24	23	30
\$1,000,001 and over....	33	34	36	23	49

Table 8. Percent of Total On-Site Man-Hour Requirements for School Construction, by Type of Contractor and Region, 1964-65

Type of contractor	United States	North East	North Central	South	West
All types.....	100.0	100.0	100.0	100.0	100.0
General.....	42.0	37.6	36.7	45.5	42.3
Electrical.....	7.8	8.8	8.3	6.9	8.4
Masonry.....	9.6	10.8	10.5	10.7	5.9
Painting.....	3.2	2.7	4.0	2.8	3.6
Plastering and lathing.	3.6	3.3	3.0	4.1	3.0
Plumbing and heating...	14.8	14.0	17.1	13.5	16.2
Roofing and sheet metal.....	3.1	3.0	2.9	3.7	2.2
Site preparation and excavation.....	2.9	4.2	2.8	2.4	2.9
Structural and ornamental work.....	2.4	4.4	3.0	1.3	2.6
Tile and terrazzo work.	2.4	2.6	2.8	2.3	1.9
All other types.....	8.3	8.5	8.9	6.8	10.9

Table 9. Average On-Site Earnings on School Construction Projects, by Selected Characteristics and Region, 1964-65 ^{1/}

Characteristics	United States		Northeast		North Central		South		West	
	Average hourly earnings	Wages as a percent of contract	Average hourly earnings	Wages as a percent of contract	Average hourly earnings	Wages as a percent of contract	Average hourly earnings	Wages as a percent of contract	Average hourly earnings	Wages as a percent of contract
All schools.....	\$3.57	25.8	\$4.18	26.2	\$3.86	27.2	\$2.70	23.9	\$4.27	26.3
Elementary.....	3.77	25.2	4.29	25.4	4.02	27.0	2.88	23.1	4.49	26.0
Secondary.....	3.48	26.1	4.13	26.6	3.80	27.3	2.62	24.3	4.16	26.4
In a metropolitan area.....	3.87	26.2	4.41	27.2	4.16	26.5	2.87	23.8	4.32	27.0
Not in a metropolitan area.....	3.23	25.3	3.83	24.8	3.63	27.9	2.56	24.0	4.10	23.9
Construction cost group (In thousands)										
\$500,000 and under.....	3.40	25.0	3.93	25.2	4.09	27.4	2.79	23.4	4.41	25.7
\$500,001 to \$1,000,000.....	3.79	25.2	4.23	25.4	3.76	26.5	2.70	23.3	4.32	25.1
\$1,000,001 and over.....	3.54	26.3	4.17	26.6	3.83	27.5	2.65	24.3	4.20	27.2
Type of framing:										
Steel.....	3.82	25.7	4.03	25.8	3.87	27.3	2.95	23.7	4.60	24.0
Concrete.....	3.49	27.1	(2/)	(2/)	3.66	27.5	2.84	23.9	3.90	30.4
Load-bearing masonry.....	3.24	24.8	4.17	24.6	4.14	26.7	2.52	24.0	4.11	24.9
Wood.....	4.74	27.8	--	--	--	--	--	--	4.74	27.8

^{1/} Includes data on both federally aided and non-federally aided projects.

^{2/} Insufficient data to warrant presentation.

Table 10. Average Number of Weeks Required for Construction of School,
by Cost Group and Region, 1964-65

Cost group	United States	North East	North Central	South	West
All groups.....	52	62	51	49	50
\$500,000 and under.....	40	36	40	41	39
\$500,001 to \$1,000,000.	52	58	48	52	49
\$1,000,001 and over....	71	76	74	63	76

Table 11. Percent of On-Site Employment for School Construction in Each Tenth of Total Construction Time, by Region, 1964-65 ^{1/}

Region	1st tenth	2nd tenth	3rd tenth	4th tenth	5th tenth	6th tenth	7th tenth	8th tenth	9th tenth	Last tenth
United States.....	4.3	8.2	10.2	12.0	12.9	14.6	14.0	11.7	8.6	3.5
Northeast.....	3.6	4.9	8.0	11.8	13.7	15.5	14.9	13.1	10.7	3.7
North Central.....	5.1	8.6	9.1	11.1	11.7	13.1	14.4	13.8	9.2	3.8
South.....	4.0	8.8	10.7	13.0	13.3	14.5	14.0	11.0	7.5	3.1
West.....	4.9	9.3	11.7	10.6	12.2	15.0	13.0	10.5	8.8	4.1

^{1/} Based on data from federally aided schools only.

NOTE: Because of rounding, sums of individual items may not equal 100.0.

Table 12. Total Man-Hour Requirements Per \$1,000 of School Construction, 1964-65

Industry sector	Total man-hours	Primary man-hours	Secondary man-hours
All sectors.....	198.0	144.2	53.7
On-site construction.....	72.3	72.3	---
Off-site construction.....	9.8	9.0	.8
Agriculture.....	2.6	.2	2.4
Mining.....	3.2	.7	2.5
Manufacturing.....	64.9	37.7	27.1
Lumber products.....	5.5	3.0	2.4
Furniture.....	2.3	2.1	.2
Paper.....	2.5	.9	1.6
Printing.....	1.1	---	1.1
Chemical.....	1.7	.2	1.5
Stone, clay, and glass products.....	11.7	9.3	2.4
Primary metals.....	9.5	2.3	7.2
Fabricated metal products.....	13.0	10.2	2.8
Machinery.....	5.2	2.7	2.5
Electrical products.....	5.1	3.0	2.1
Instruments.....	1.8	1.4	.4
Other and unallocated...	5.5	2.6	2.9
Transportation.....	8.3	3.8	4.6
Trade.....	22.0	17.3	4.7
Services.....	6.5	1.1	5.4
Other.....	8.4	2.2	6.2

NOTE: Because of rounding, totals may not equal sums of individual items.

Table 13. Total Cost of Material Components for Each \$1,000 of School Construction Contract, by Region, 1964-65

Selected products and product groups	United States	Northeast	North Central	South	West
All products.....	\$542.00	\$495.90	\$569.30	\$567.50	\$523.90
Stone, clay, and glass products.....	\$130.00	\$113.20	\$139.80	\$154.00	\$101.30
Cement, concrete, and gypsum products.....	71.40	64.20	70.90	86.80	57.30
Ready-mix concrete.....	32.90	31.00	30.00	38.90	30.20
Concrete block.....	14.10	15.00	19.30	13.40	7.20
Precast concrete products.....	10.80	7.10	9.30	21.00	1.60
Gypsum products.....	5.10	5.10	3.70	4.80	7.40
Cement.....	5.00	3.30	4.80	5.20	7.00
Concrete pipe.....	1.50	.40	2.50	1.20	2.00
Miscellaneous aggregate.....	1.30	1.80	.70	1.40	1.50
Structural clay products.....	27.50	24.60	31.20	35.40	14.00
Brick and structural tile.....	19.60	17.30	20.50	26.90	9.80
Ceramic tile.....	5.00	6.20	4.50	5.90	2.60
Clay sewer pipe.....	1.50	.30	3.40	1.20	1.20
Terrazzo.....	1.30	.80	2.70	1.00	.40
Other stone, clay, and glass products.....	31.20	24.30	37.60	31.80	30.00
Sand and gravel.....	8.40	4.70	12.00	7.80	9.30
Accoustical tile ¹ / ₂	7.80	5.90	8.10	8.10	9.10
Fiber glass products, except accoustical tile.....	6.00	5.20	7.40	6.00	5.00
Window glass.....	3.70	3.00	4.50	3.40	3.90
Cut stone.....	2.20	2.70	3.10	2.10	.40
Asphalt tile.....	1.70	.70	1.50	3.00	1.10
Metal products (except plumbing and heating).....	134.60	119.60	147.70	149.20	113.70
Fabricated structural metal products.....	100.70	90.40	109.10	116.40	78.60
Structural steel.....	32.70	35.80	32.40	35.50	24.70
Reinforcing bars and joints.....	28.30	20.50	34.90	38.70	13.50
Fabricated sheet metal.....	19.00	15.60	17.20	20.90	22.60
Metal windows.....	7.70	8.30	7.30	9.60	4.60
Metal doors.....	7.60	4.40	9.90	8.00	8.00
Ornamental metal.....	2.10	3.50	3.30	.40	1.60
Registers, grills, diffusers.....	1.90	.90	2.10	2.00	2.40
Wire mesh.....	1.10	1.00	1.70	.90	.70
Other fabricated metal products.....	13.60	13.20	12.60	14.60	14.00
Builder's hardware.....	11.40	9.10	11.10	14.00	10.60
Other metal products.....	20.20	16.00	26.00	18.20	21.10
Partitions, lockers, and shelves.....	7.50	5.60	8.50	8.40	7.40
Copper products.....	6.20	5.40	7.00	6.20	6.30
Aluminum sheet metal.....	2.80	2.90	4.90	.70	3.00
Galvanized sheet metal.....	2.60	1.50	4.60	1.80	2.90

See footnote at end of table.

Table 13. Total Cost of Material Components for Each \$1,000 of School Construction Contract, by Region, 1964-65 - continued

Selected products and product groups	United States	Northeast	North Central	South	West
Plumbing products.....	\$ 39.00	\$ 37.90	\$ 40.00	\$ 38.30	\$ 39.80
Plumbing fixtures.....	11.20	9.30	12.40	13.20	8.90
Steel and galvanized pipe.....	10.20	10.20	8.70	9.00	13.70
Cast-iron pipe.....	6.90	7.20	7.20	7.00	6.20
Valves and specialties.....	6.00	5.40	6.50	5.60	6.70
Pumps.....	1.70	1.70	2.50	1.40	1.00
Storage tanks.....	1.10	1.50	1.10	1.20	.50
Heating and ventilating equipment.....	51.90	48.80	54.00	56.40	46.40
Radiators, convectors, and boilers.....	17.70	19.30	22.70	13.60	15.60
Unit heaters and ventilators.....	11.40	12.40	6.40	13.80	13.10
Air-conditioning equipment.....	9.20	2.40	8.30	16.60	7.40
Temperature controls.....	7.30	7.40	9.20	6.60	5.70
Blowers, exhaust, and ventilating fans.....	4.20	3.10	5.60	4.30	3.60
Oil burners.....	1.40	3.40	.90	.90	.50
Electrical equipment, fixtures, and wire.....	52.90	48.50	51.20	51.60	62.40
Lighting fixtures.....	20.20	17.00	20.10	21.20	22.90
Switchboards and panelboards.....	7.80	5.20	7.60	8.00	10.90
Conduit.....	6.40	6.70	5.70	6.20	7.30
Wire and cable.....	5.80	5.80	5.10	5.70	7.00
Intercom and fire alarm and sound.....	5.20	7.00	4.40	3.80	6.10
Current-carrying wiring devices.....	2.40	1.40	3.00	2.00	3.30
Noncurrent-carrying wiring devices.....	1.60	.90	2.00	1.70	1.70
Clock system.....	1.30	1.40	1.80	1.00	.90
Transformers.....	1.10	1.20	.80	1.50	.60
Lumber and lumber products.....	50.90	42.90	46.10	48.50	70.60
Millwork.....	21.50	16.60	17.70	26.30	25.00
Roughed dressed lumber.....	12.00	12.10	7.20	7.30	25.40
Wood fiber board.....	6.20	3.20	10.10	7.50	2.90
Folding partitions and doors.....	4.30	4.40	5.70	2.80	4.60
Flooring.....	2.60	3.20	2.30	3.00	1.50
Structural laminates.....	2.20	2.00	1.70	---	6.40
Plywood.....	1.90	1.00	1.30	1.40	4.70
Petroleum products.....	12.30	11.50	12.80	12.70	11.90
Asphalt paving.....	5.20	4.20	6.50	4.20	6.20
Asphalt and tar pitches.....	3.00	3.00	2.80	3.60	2.60
Asphalt felts.....	2.90	3.20	3.00	2.90	2.60
Gas, oil, grease, diesel fuel.....	1.10	1.10	.40	2.00	.50
Fixed school equipment.....	36.60	40.00	50.20	26.80	29.90
Kitchen equipment.....	12.70	14.20	18.30	10.60	6.80
Laboratory equipment.....	6.60	10.70	7.60	4.10	3.70
Seats and built-in furniture.....	5.00	3.50	9.30	2.30	5.40
Chalkboards and tackboards.....	4.40	4.10	4.80	4.70	4.00
Shop equipment.....	2.60	1.90	6.40	---	1.80
Metal cabinets.....	2.10	1.20	1.80	2.10	3.70

See footnote at end of table.

Table 13. Total Cost of Material Components for Each \$1,000 of School Construction Contract, by Region, 1964-65 - continued

Selected products and product groups	United States	Northeast	North Central	South	West
Paints and other chemical compounds.....	\$ 5.20	\$ 4.70	\$ 5.80	\$ 6.20	\$ 3.60
Paints.....	4.50	4.00	4.80	5.40	3.30
All other.....	28.50	28.90	21.80	23.80	44.30
Construction equipment.....	15.30	15.20	10.70	11.30	27.40
Vinyl asbestos tile.....	4.40	4.50	4.80	3.70	4.80
Skylights.....	1.00	1.20	.70	1.20	.90

^{1/} Includes all types of acoustical tile, some of which does not belong in this general classification.

NOTE: Group totals include products not shown separately.

Survey Criteria

This study is based on data covering 103 contracts for the construction of schools. Of these, 58 were federally-aided school projects for which on-site payroll data were readily available. The remaining 45 schools were selected throughout the 48 contiguous States to give an optimum geographic distribution. Both groups of schools were selected to give proper representation of four factors which were considered significant in man-hour requirements. These were regional distribution, type of school (elementary or secondary), degree of urbanization, and size of project.

The projects were weighted to give fair representation of the above factors based on the distribution and characteristics of schools constructed in 1963.

Man-hour Estimates

Estimates of total man-hour requirements for school construction are derived by combining estimates of on-site and off-site man-hours.

On-site man-hours for the federally-aided projects were obtained from payrolls submitted by the contractors under the provisions of the Davis-Bacon Act. These were checked for completeness by interviews with the contractors and their subcontractor. Estimates were made for unobtainable missing data. Man-hours for the other projects were obtained by interview with the prime contractor and his subcontractors. The contractors were also requested to furnish on-site employment data for occupations not covered by the Davis-Bacon Act, such as supervisory, technical, and clerical personnel, and self-employed subcontractors (working proprietors).

Off-site man-hour requirements represent chiefly the hours required to produce and distribute the materials, supplies, and equipment used in the construction. Estimation of these hours, therefore, began with a listing of the value of all such items. These

data were obtained by the BLS field representative from the prime contractor and his subcontractors. For a relatively small number of subcontractors who were out of business or otherwise inaccessible, uncooperative, or whose contracts were exceedingly small, estimates of materials used were prepared on the basis of reports for similar jobs. Approximately 3000 contractors were contacted to obtain the necessary labor and material data.

The materials listings thus obtained were classified into categories (consistent with the 4-digit Standard Industrial Classification) as found in the Census of Manufactures product groups. For each of these groups, the average amounts required for \$1,000 of construction were calculated. Each of these averages was reduced by a ratio representing the difference between the manufacturer's and contractor's valuation. The amounts thus reduced were consistent with Census data published for these various components.

Primary man-hours for manufacturing materials (i.e., the hours required in the final manufacturing stage) were developed by multiplying these average amounts by a ratio of manufacturing man-hours to \$1,000 of production. These ratios were computed from the output and employment data in the 1964 Survey of Manufactures.

Primary man-hours for trade and transportation were derived in a similar manner. Here, however, employment ratios were applied to the difference between producer's and purchaser's valuation, which was taken as the total of all distribution costs between the sites of final manufacture and construction.

To compute secondary man-hours to produce the materials (i.e., hours required in all stages of production other than final manufacture and transportation), the 1958 interindustry study by the Office of Business Economics of the U.S. Department of Commerce was used. This study indicates the amount of secondary product or service

required of each of its 78 industry sectors to produce the primary product. Summing these amounts and applying the appropriate employment ratios produced the number of secondary man-hours required in each of the sectors.

Two other minor components were required to complete the compilation of total off-site hours as defined for this series of studies. One of these is the hours required to produce the contractors' purchases of overhead materials and services. The quantities of these items were estimated and included in the man-hour conversions just described. The other is the hours worked by the off-site employees of the construction industry. The estimate for these hours is based on the difference between the proportion of all nonconstruction workers in the contract construction industry as reported in the BLS employment trend series, and the proportion of on-site nonconstruction man-hours as developed in this study.

Area Definition

The study covered only public school construction, elementary and secondary, in the 48 contiguous States. They were grouped for regional comparisons as follows:

Northeast--Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; North Central--Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin; South--Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; and West--Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

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