Distr.
RESTRICTED

HOU/Working Paper No. 97
9 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Note by the Secretariat

The seventeenth session of the Housing Committee in November 1958 considered a first provisional report on the effect of government measures designed to promote the technological development of the building industry and reduce housing costs. It was agreed that a full provisional version of the report should be prepared for the eighteenth session of the Committee to be held in June 1959.

The purpose of this note is to indicate as a guide to delegates the title of the chapters of this enquiry, together with the numbers of the documents relating to the different chapters of the enquiry which will be circulated as they are completed. Chapters I and II will be circulated in the course of this month and the others subsequently. A provisional prefatory note to the enquiry is attached to the present document.

The titles of the chapters of the enquiry, together with document symbols, are as follows:

Chapter I	:	The trend of costs and prices	HOU/Working Paper No. 97 Add.1
Chapter II	:	The organization of demand	" " " " 2
Chapter III	:	The organization and structure of industry	" " " " 3
Chapter IV	:	The technological development of the industry	" " " " 4
Chapter V	:	The application of research	" " " " 5
Chapter VI	:	General conclusions	" " " " 6

In addition, national monographs relating particularly to Chapter IV, prepared by the Secretariat after consultation with the country concerned are being circulated as soon as completed with the following symbols:

HOU/Working Paper No. 97 Add.
(a) Austria
(b) Belgium
(c) Czechoslovakia
(d) Denmark
(e) Finland
(f) Federal Republic of Germany
(g) Italy
(h) Netherlands
(i) Poland
(j) Portugal
(k) Spain
(l) Sweden
(m) USSR
(n) United Kingdom
(o) Yugoslavia

These national monographs will be available in either English or French but may well not be translated into other working languages of the Commission before the eighteenth session. If not, they will of course be translated subsequently in their final form and included in the final published version as appendices. In addition, a number of other appendices are envisaged, although their exact scope has not yet been determined, probably largely prepared by rapporteurs and dealing, it is hoped, with a number of special topics relevant to the enquiry on which there is special experience in particular countries, i.e. experimental building sites in Western Germany, Scandinavian experience on winter building, and the use of heavy prefabricated elements in the USSR. Such of the appendices as are completed before the eighteenth session will be circulated as HOU/Working Paper No. 97 Add.8(a), (b), etc.

It is hoped that discussion in the Committee will concentrate on points of principle and substance and that detailed comments will be sent to the Secretariat in writing before, during or shortly after the eighteenth session.

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

PREFATORY NOTE

The ECE Housing Committee, at its twelfth session in May 1956, agreed that there should be an "attempt to make a systematic and comparative analysis of measures taken by governments to reduce or limit increases in the cost of house-building. Experience in the United States should also be included. The report could be modelled after that on the Cost of House Construction (E/ECE/165) issued in May 1953, but modified as necessary and brought up to date" (HOU/WP.1/28).

The earlier report referred to can be regarded as defining the general scope of the work, which is to concentrate on measures designed to reduce costs under the direct or indirect influence of governments, within the framework of a general trend towards the industrialization of building. As in the case of the earlier report, the scope of the present enquiry has been deliberately limited, eliminating such factors as the wider framework of housing policy, including rent and subsidy policy and financing, several aspects of which have been examined in other reports. This enquiry takes as its basic terms of reference what may be defined broadly as government technical policies in relation to the building industry. Compared with the earlier report, there are three important differences: first, the main emphasis is now rather on what has been and is being done than on the kind of things which should be done; secondly, there is a much better all-European coverage; and thirdly, although there are still considerable gaps, more systematic and complete information has now been obtained for almost all countries.

The concept of industrialization is defined for the purposes of the present enquiry as follows:

(i) continuity of production, implying a steady flow of demand;

(ii) standardization of products;

(iii) integration of the different stages of the whole production process;

(iv) a high degree of organization of work (which in the case of building implies in the first instance more complete organization of work on site);

(v) mechanization to replace manual labour wherever possible;

(vi) research and organized experimentation integrated with production.

The sources drawn upon for the enquiry are largely information provided by governments in response to specific requests for information at different times; country reports conforming to the original plan drawn up for the enquiry; and in response to enquiries on the make-up of housing costs, on mechanization and prefabrication and on methods of contracting in house-building. Authoritative published information has also been drawn upon extensively.

The enquiry has been prepared by the Secretariat aided by consultants and rapporteurs. Those who contributed to the enquiry at one time or another either in the capacity of consultant or rapporteur, are as follows:

Mr. Salicath	Denmark
Mr. Arctander	Denmark
Mr. Gunther	Federal Republic of Germany
Mr. Marini	France
Mr. Gorynski	Poland
Mr. Fitzmaurice	United Kingdom
Mr. Blokhine	USSR
Mr. Kolotilkin	USSR
Mr. Placein	USSR

Substantial comments have been received on successive drafts from delegates and other experts in the course of discussions in the Housing Committee, in other discussions and in writing. A full provisional version of the whole enquiry was discussed by the Committee at its eighteenth session held in June 1959. Subsequently, the enquiry has been revised and prepared for publication by the Secretariat on its own responsibility.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Corr.1
21 April 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda
of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Corrigendum

Reference is made to HOU/Working Paper No. 97, in which it is stated that "... national monographs relating particularly to Chapter IV, prepared by the Secretariat after consultation with the country concerned, are being circulated as soon as completed ...". In addition to those listed, national monographs relating to the following countries are now being circulated, with the following symbols:

HOU/Working Paper No. 97 Add. (p) Ireland
(q) Norway
(r) Hungary
(s) France

Distr.
RESTRICTED

HOU/Working Paper No. 97 Corr.1
21 April 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Corrigendum

Reference is made to HOU/Working Paper No. 97, in which it is stated that "... national monographs relating particularly to Chapter IV, prepared by the Secretariat after consultation with the country concerned, are being circulated as soon as completed ...". In addition to those listed, national monographs relating to the following countries are now being circulated, with the following symbols:

HOU/Working Paper No. 97 Add. (p) Ireland
(q) Norway
(r) Hungary
(s) France

Distr.
RESTRICTED
HOU/Working Paper No.97 Corr.2
6 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

Corrigendum

As was pointed out in Document HOU/Working Paper No. 97, a provisional version of country monographs drawn up according to a common plan and checked with the countries concerned is being circulated as Add.(a), (b), (c), etc. Further comments have been received from some countries and more may be expected. When these comments are of a minor character, it is not proposed to circulate them before the next session of the Committee; they will be incorporated in the final published text. When the comments are substantial in character and particularly when they bring new information, they are being brought to the notice of the Committee in appropriate form. There is a third category when substantial comments have been received which appear to require however further discussion between the Secretariat and the countries concerned. Until these discussions have taken place, it would seem preferable not to circulate the modifications or additional information to the Committee.

A revised version of the monograph on the USSR and additional information relating to Ireland and Italy are being circulated as, respectively, HOU/Document de travail No. 97 Add.(m) Rev.1, HOU/Working Paper No. 97 Add (p) Rev.1, and HOU/Working Paper No. 97 Add. (g) Rev.1.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add. 1
24 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER I

THE TREND OF COSTS AND PRICES

1. It is widely agreed that the core of the housing problem in almost all countries is the high cost of house-building. This is true if the criterion is the cost of a house in relation to the average income of the population. It also appears to be true if the trend in the real cost of a house is compared with that of other products.

2. The cost of a house averages about four times the annual earnings of a male industrial worker in western Europe and in the case of less industrialized countries in Europe about two to four times these earnings. Furthermore, if the maximum proportion of income which should be paid in rent is taken as 20 per cent, the annual charges for a dwelling which costs four times the average annual income should not exceed 5 per cent of the capital cost.[1] To a considerable extent, these figures are the result of high interest rates and

---

(1) See Financing of Housing in Europe, ECE, Geneva 1958, (E/ECE/328).

heavy land costs but there is a substantial residue which is only explicable in terms of high real cost. The high capital cost of a house has shown little change over the years in real terms. A working-class dwelling in most countries in Europe now costs more in terms of average wages than at the beginning of the century.

3. Comparisons between the trend in the real cost of a house and of other products are not possible on the basis of actual figures. There seems little doubt, however, that the real cost of a number of other products has declined substantially in the last two or three decades. Comparisons of this kind should not be pressed too far owing to the marked differences between the nature of the end products. Nevertheless, it would seem to be beyond doubt that even if building productivity has increased in absolute terms over a long period of time, it has decreased relatively to productivity in most manufacturing industries.

4. The high real cost of house-building is therefore the setting for this whole enquiry. The next chapter discusses the special problems of the organization of demand for housing, and the third the organization and structure of the building industry in the setting of the particular characteristics of the building product and of the economics of the building industry as a whole. In this chapter, with a view to providing an appropriate setting, actual trends in prices and costs of house-building are examined. Detailed information covering a substantial period of time is not available and, in addition, data are frequently not fully comparable. The approach adopted has therefore been to examine trends in selected countries which are perhaps illustrative of general trends.

5. The fact that real costs in many European countries in terms of average incomes have increased in the last half century does not mean necessarily that productivity in the house-building industry has fallen, since higher costs reflect to a marked degree improvements in the size, quality, standards and basic equipment of a house. An example illustrating this trend is shown in Table 1, on the basis of a house built by Dublin Corporation in 1905 compared with one built by the same corporation in 1958.

Table 1

Average Price of a Working-class House and Carpenter's Remuneration in Dublin, 1905 to 1958

Year	Average cost of a house		Carpenter's remuneration at end of year	
	£	Index (1905=100)	Pence per hour	Index (1905=100)
1905	164	100.0	8.25	100.0
1912	161	98.2	9.00	109.1
1913	214	130.5	9.25	112.1
1914	200	121.9	"	"
1917	199	121.3	14.00	169.7
1918	205	125.0	"	"
1923	241	147.0	18.80	227.9
1931	399	243.3	22.82	276.6
1932	391	238.4	"	"
1933	430	262.2	"	"
1934	453	276.2	"	"
1935	476	290.2	21.82	264.5
1936	493	300.6	"	"
1937	522	318.3	"	"
1938	554	337.8	23.82	288.7
1939	611	372.6	"	"
1940	704	429.3	24.82	300.8
1941	733	447.0	"	"
1942	848	517.1	"	"
1943	840	512.2	29.55	358.2
1944	880	536.6	29.57	358.4
1945	1055	643.3	"	"
1946	1182	720.8	29.92	362.7
1947	1210	737.8	36.32	440.2
1948	1217	742.1	39.32	476.6
1949	1290	786.6	"	"
1950	1478	901.2	"	"
1951	1226	747.6	43.82	531.2
1952	1644	1002.4	47.82	579.6
1953	1650	1006.1	"	"
1954	1610	981.7	"	"
1955	1694	1032.9	50.82	616.0
1956	1552	946.3	"	"
1957	1660	1012.2	"	"
1958	1710	1042.7	54.57	661.5

Source: Information supplied by the Government.

The cost of the house built in 1905 was £164 and that built in 1958 £1,710. If the 1905 house is taken as 100, the index of cost in 1958 is 1,043. If the index of a carpenter's salary in Dublin in 1905 is taken as 100, it rose to 662 in 1958. Therefore in terms of a carpenter's remuneration, the price of the house has become more than 1.5 times more expensive. However, between 1905 and 1958 there were striking changes in the standard of new working-class dwellings in Dublin, and also in the conditions of employment of building workers, e.g. maximum hours of work, holiday allowances, extra payments for particular kinds of work and social security allowances. The cost of providing a typical working-class house also rose owing to better standards of construction, accommodation and general amenities. Thus, the average floor area of a typical three-bedroom house rose from 656 square feet in 1938 to 790 square feet in 1958. An outside fuel store has been provided for each house since 1958. The average number of rooms per house completed by the Dublin Corporation in 1905 was 2.74 and this rose progressively to 4.12 in 1958. Thermal insulation is now provided for all external walls. The concrete ground floor has been increased in thickness by 50 per cent and a second damp-proof membrane incorporated. Thermo-plastic tiles have been substituted for concrete finishes in kitchen floors. A wash-hand basin has been provided in the bathroom. Cupboard space has been greatly improved. The experience in Dublin has been drawn upon in some detail, since it is probably illustrative in large measure of trends in urban housing in many European countries.

6. Information is available for some countries on trends in building costs and their constituent elements during the last decade and are shown in Table 2.

Table 2

Percentage change of input and output prices for house-building

Type of Series	Period	Percentage change: Total	Materials	Wages
I. Input prices				
Austria	1949 - 1957	100	88	116
Denmark	1948 - 1957	49	41	66
Finland	1951 - 1957	13	5	27
Ireland	1952 - 1957	11	6	21
Italy	1948 - 1957	33	14	68
Norway	1948 - 1957	47	..	..
Portugal	1949 - 1957	- 7	- 12	7
Sweden	1949 - 1957	45	48	43
United Kingdom	1948 materials - 1957 1950 wages - 1957	..	46	59
Western Germany	1948 - 1957	24	23	40

Type of Series	Period	Total
II. Output prices		
Belgium	1950 - 1956	6
France	1953 - 1957	27
Netherlands	1948 - 1957	30
Switzerland	1948 - 1957	7
United Kingdom (a)	1949 - 1957	41

Source: Quarterly Bulletin of Housing and Building Statistics for Europe, ECE, Geneva.

(a) All new building work.

The input series relate to prices of materials, wages and certain other input factors such as architect's fees, weighted on the basis of a standard house. These indices, therefore, do not reflect changes in real building costs, productivity and profits and are only reliable for an analysis of trends of costs so far as the "index house" remains representative. This, however, is not necessarily the case and therefore percentage changes should be interpreted with caution. It appears that building costs have risen in almost all western European countries, except Portugal, during the post-war period and that labour cost has risen faster than building material prices.[1] It also appears to have been a general trend that wages of unskilled labour have risen more than those of skilled workers. The combined materials index conceals wide variations in trends among some of the items included in the index as a whole. Thus, in a number of countries the prices of timber and of steel products used in building have increased more rapidly than those of other building materials.

7. The output indices relate to actual costs based either on the price of various units of work weighted on the basis of a standard house (Belgium and Switzerland); the price, for example, of m^3 of houses now being built of more or less the same size and quality (France and the Netherlands); or on a combination of such factors as prices of materials, labour, overheads, profits and output per man (United Kingdom). The trend of output prices has been different from country to country. The increase has been fairly low in Belgium and Switzerland and much greater in France, the Netherlands and probably the United Kingdom.[2] In the case of Belgium, the increase of 6 per cent between 1950 and 1956 applies only to social housing schemes, and it is not known whether the trend of output prices for private building has been the same. In France, on the basis of prices per m^2 of HLM houses, there was a fall between 1950 and 1956. Yet the trend shown in Table 2 is very different. In the case of the Netherlands, the high increase may be to some extent explained by improved quality and equipment in the dwellings concerned.

8. For Finland, Italy, Sweden, Switzerland and Western Germany, data on the breakdown of the different input factors or work categories are available and are shown in Tables 3, 4, 5, 6 and 7. The make-up of these indices, their breakdown and the items included in the tables are different from country to country. Hence, comparisons should be made with great reserve and the conclusions which can be drawn must be tentative.

---

(1) The relatively lower percentage increase of wages in Sweden may be due to the fact that the bases for calculating the index of wage rates derive from collective agreements and are therefore on the low tide.

(2) The index for the United Kingdom relates to both residential and non-residential new building.

Table 3

Percentage Change of Input Prices for House-building in Finland

1951 to December 1957

Items	Percentage change	Items	Percentage change
Total	16	B. Side and subcontracting work	16
A. Building materials	13	Rockblasting and earthmoving	14
a. Mineral materials	12	Water pipes and sewers	19
Bricks, clay	28	Heating ducts and ventilation	19
Bricks, lime	7	Electrical wiring	14
Porous concrete	6	Low voltage wiring	15
Cement	25	Electric ranges	0
Mortar	6	Painting	8
Sand	30	C. Labour costs	24
Gravel	7	a. Skilled labour	19
Bricks for interior walls	5	Carpentry	29
Floor tiles	8	Brick-laying, masonry and plastering	12
Window glass	14	Reinforced-concrete and insulation work	10
Stairs and cement-mosaic work	- 2	Tinplate and railing work	30
Stone slabs (natural)	34	b. Unskilled labour	30
Poured concrete works	20	Hod-carriers	- 2
b. Wood materials	10	Miscellaneous work (male)	30
Heavy timber	16	Miscellaneous work (female)	39
Sawn timber	0	D. General and overhead costs of the building site	
Planed timber	-12	a. Supervisory and social costs	30
Doors and windows	17	Supervisory and office personnel	34
Kitchen furniture and cupboards	18	Insurance; paid vacations	24
c. Metallic materials	16	b. Other costs	12
Building steel	35	Transports	11
Nails	11	Tools, machinery, supplies, warehouses	10
Tinplate	-11	Electricity	21
Hinges, fittings	- 6	Heating fuels	14
d. Insulation and coverings	20	E. Expert fees	17
Water insulation	9	F. Interest on building capital	- 5
Heat insulation	- 4	Total index, ecl. groups E and F	17
Linoleum	49		

Source: Bank of Finland, Helsinki.

Table 4

Percentage Change of Input Prices for House-building in Western Germany, 1948 to 1957

Items	Percentage change	Items	Percentage change
Earthmoving	20	Main structure	
Building materials	24	Earth moving	20
Bricks	9	Bricklaying	22
Lime	14	Concrete work	32
Cement	20	Carpentry	52
Timber	60	Roofing	34
Iron	77	Metal work	6
Wages	40	Total	31
Subcontractor	15	Inside work and fitments	
Total cost of building work	26	Plasterwork and cleaning up	29
Overheads		Joinery	21
Designing and supervision	5	Glazing	18
Building dues and charges	12	Painting	2
Interest on contractor's advance	59	Decorating	0
Total overheads	12	Heating installations	16
		Water and gas installations	23
		Electrical installations	-12
		Total	18
Total	24	Total	26

Source: Statistisches Jahrbuch für die Bundesrepublik Deutschland, 1958.

Table 5

Percentage Change of Input Prices for House-building in Italy, 1948 to 1957

Items	Percentage change
Labour	68
Building Materials	15
Bedding materials	14
Bricks	31
Covering materials	40
Timber and timber work	40
Metal and metal work	- 7
Glass work	- 16
Sanitary installation	- 14
Heating	- 18
Electrical materials	8
Painting	- 30
Other costs	121
Total	32

Source: "Index", Centro per la statistica aziendale, Florence.

Table 6

Percentage Change of Output Prices for House-building in Switzerland (Zurich), August 1948 to August 1957

Items	Percentage change
Cost for main structure	6
Excavation, masonry and pipe-laying	- 2
Artificial stonework	- 11
Carpentry	26
Metalwork	- 1
Roofing	52
Cost for inside work and fitments	7
Locksmith's work	10
Venetian shutters and roller blinds	1
Sun-blinds	5
Plaster-work	5
Wallboards and floor slabs	- 3
Sanitary fittings	8
Electrical installations	7
Kitchen range and hot water supply	55
Glazing	- 3
Joinery	3
Hardware	- 13
Wooden floors	9
Linoleum	- 7
Painting	8
Decorating	- 1
Central heating	4
Drying-out	2
Cleaning-up	15
Other costs	19
Connecting-up to mains	1
Laying-out of gardens	0
Architects' fees Superintendence	27
Dues and charges	13
Interest on building capital	13
Total	8
Source: Statistisches Jahrbuch der Stadt Zürich.	

Table 7

Percentage Change of Input Prices for House-building in Sweden, 1 January 1950 to 1 January 1959

Items	Weights of items	Percentage Change.
1. Materials for concrete and bricklaying	11.5	47
Aggregate	1.8	61
Cement	2.4	31
Mortar and plaster	1.8	48
Concrete blocks	0.4	33
Light-weight concrete	1.3	32
Bricks	3.2	61
Partition wall slabs	0.6	25
2. Timber and joinery	9.5	68
Sawn timber	3.5	83
Planed timber	0.3	88
Windows and frames	1.0	67
Doors and frames	2.3	50
Kitchen equipment and wardrobes	2.4	63
3. Iron goods	4.0	28
Reinforcing iron	2.0	20
Nails, screw, strip iron	0.4	30
Hinges, hinge mountings	0.3	32
Locks, locking handles	0.2	58
Doors	0.4	52
Ventilators and gratings	0.2	-
Other iron goods	0.5	32
4. Other materials	7.0	28
Asphalt	0.1	24
Brickpipes and eternite	0.4	37
Heat insulating materials	1.1	30
Cardboard	0.4	31
Roofing brick	0.5	93
Stoves	1.7	34
Refrigerators	1.3	4
Sink fittings	0.6	17
Washing machines) Laundry machinery)	0.9	19
5. Earnings labourer	20.5	54
Bricklayer	4.5	
Carpenter and joiner	7.0	
Unskiller labourer	9.0	
6. Painting	5.5	41
Materials	1.5	27
Earnings	3.5	47
Administration	0.5	41
7. Heating and sanitary fittings	12.0	40
Materials	8.0	40
Earnings	2.5	40
Administration	1.5	40
8. Electrical installations	4.0	22
Materials	2.0	5
Earnings	1.5	44
Administration	0.5	22
9. Other side and sub-contractors work	9.5	53
Excavation and transport	1.1	74
Prefab stairs	0.7	69
Building forge	1.2	45
Sheet metal works	0.7	61
Glass works	0.5	64
Stone work	1.2	56
Tile	0.9	40
Parquet	1.9	48
Linoleum	1.3	40
10. Contractors costs	12.5	63
Machinery and tools	1.7	55
Transports	0.5	65
Supervisor	1.8	93
Fuel	0.8	40
Other building site costs	0.7	31
Management, representation	4.2	53
Office premises	1.3	58
Office staff	1.5	97
11. Builders costs	4.0	87
Interest and credit costs	1.2	25
Architects fee	1.0	85
Constructional designers fee	1.0	69
Other costs	0.8	54
Total	100.0	50

Source: Information supplied by the Government.

9. In Finland wages, particularly of unskilled labour, increased considerably and the same was true of overheads for supervision and office work. The item for sub-contractors increased to a limited extent. The cost of carpentry work rose considerably more than other labour costs. The trends of prices of building materials were divergent, those of cement and building steel increasing most rapidly. The main feature in Italy was again the increase in labour costs and other costs, probably overheads. Trends in building materials prices were also very divergent, roofing materials and timber increasing most rapidly. The main feature in Switzerland was the large increase in the cost of carpentry work and roofing and also architect's fees and supervision. The cost of building the main structure increased rather more than that of internal work and elements. The item for sub-contractors rose comparatively little. In Western Germany wages again increased much more than the cost of other items. Once again, the cost of timber and building steel increased more than that of other materials. The trend in the cost of sub-contractors' work was similar to that in Finland and Switzerland, but in contrast to these two countries the cost of planning and supervision remain virtually unchanged. Also in contrast to Switzerland, the cost of work on interiors rose more than that of the main structure. In Sweden the cost of timber, joinery and roofing materials increased considerably and also expenses for supervision and office work.

10. The cost of house-building has a major influence on a large part of fixed capital formation in almost all European countries. During the last five years, for example, from one-fifth to one-quarter of all fixed capital formation in most western European countries was accounted for by residential construction. The same was or shortly will be true of most eastern European countries. This investment, however, is not solely due to the operations of the house construction industry, since it is also accounted for by industries providing a large number of materials and components.(1)

---

(1) Of the total value of residential building produced in Western Germany in 1955, namely, DM 9 milliard, about one-third was represented by materials supplied by other industries to the house-building industry and two-thirds by the value created by the house-building industry proper (see "Evolution de la Construction dans la République Fédérale Allemande: Rapport de la Mission Française de productivité", Paris, September 1958).

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add. 1
24 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda
of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER I

THE TREND OF COSTS AND PRICES

1. It is widely agreed that the core of the housing problem in almost all countries is the high cost of house-building. This is true if the criterion is the cost of a house in relation to the average income of the population. It also appears to be true if the trend in the real cost of a house is compared with that of other products.

2. The cost of a house averages about four times the annual earnings of a male industrial worker in western Europe and in the case of less industrialized countries in Europe about two to four times these earnings. Furthermore, if the maximum proportion of income which should be paid in rent is taken as 20 per cent, the annual charges for a dwelling which costs four times the average annual income should not exceed 5 per cent of the capital cost.(1) To a considerable extent, these figures are the result of high interest rates and

(1) See Financing of Housing in Europe, ECE, Geneva 1958, (E/ECE/328).

heavy land costs but there is a substantial residue which is only explicable in terms of high real cost. The high capital cost of a house has shown little change over the years in real terms. A working-class dwelling in most countries in Europe now costs more in terms of average wages than at the beginning of the century.

3. Comparisons between the trend in the real cost of a house and of other products are not possible on the basis of actual figures. There seems little doubt, however, that the real cost of a number of other products has declined substantially in the last two or three decades. Comparisons of this kind should not be pressed too far owing to the marked differences between the nature of the end products. Nevertheless, it would seem to be beyond doubt that even if building productivity has increased in absolute terms over a long period of time, it has decreased relatively to productivity in most manufacturing industries.

4. The high real cost of house-building is therefore the setting for this whole enquiry. The next chapter discusses the special problems of the organization of demand for housing, and the third the organization and structure of the building industry in the setting of the particular characteristics of the building product and of the economics of the building industry as a whole. In this chapter, with a view to providing an appropriate setting, actual trends in prices and costs of house-building are examined. Detailed information covering a substantial period of time is not available and, in addition, data are frequently not fully comparable. The approach adopted has therefore been to examine trends in selected countries which are perhaps illustrative of general trends.

5. The fact that real costs in many European countries in terms of average incomes have increased in the last half century does not mean necessarily that productivity in the house-building industry has fallen, since higher costs reflect to a marked degree improvements in the size, quality, standards and basic equipment of a house. An example illustrating this trend is shown in Table 1, on the basis of a house built by Dublin Corporation in 1905 compared with one built by the same corporation in 1958.

Table 1

Average Price of a Working-class House and Carpenter's Remuneration in Dublin, 1905 to 1958

Year	Average cost of a house		Carpenter's remuneration at end of year	
	£	Index (1905=100)	Pence per hour	Index (1905=100)
1905	164	100.0	8.25	100.0
1912	161	98.2	9.00	109.1
1913	214	130.5	9.25	112.1
1914	200	121.9	"	"
1917	199	121.3	14.00	169.7
1918	205	125.0	"	"
1923	241	147.0	18.80	227.9
1931	399	243.3	22.82	276.6
1932	391	238.4	"	"
1933	430	262.2	"	"
1934	453	276.2	"	"
1935	476	290.2	21.82	264.5
1936	493	300.6	"	"
1937	522	318.3	"	"
1938	554	337.8	23.82	288.7
1939	611	372.6	"	"
1940	704	429.3	24.82	300.8
1941	733	447.0	"	"
1942	848	517.1	"	"
1943	840	512.2	29.55	358.2
1944	880	536.6	29.57	358.4
1945	1055	643.3	"	"
1946	1182	720.8	29.92	362.7
1947	1210	737.8	36.32	440.2
1948	1217	742.1	39.32	476.6
1949	1290	786.6	"	"
1950	1478	901.2	"	"
1951	1226	747.6	43.82	531.2
1952	1644	1002.4	47.82	579.6
1953	1650	1006.1	"	"
1954	1610	981.7	"	"
1955	1694	1032.9	50.82	616.0
1956	1552	946.3	"	"
1957	1660	1012.2	"	"
1958	1710	1042.7	54.57	661.5

Source: Information supplied by the Government.

The cost of the house built in 1905 was £164 and that built in 1958 £1,710. If the 1905 house is taken as 100, the index of cost in 1958 is 1,043. If the index of a carpenter's salary in Dublin in 1905 is taken as 100, it rose to 662 in 1958. Therefore in terms of a carpenter's remuneration, the price of the house has become more than 1.5 times more expensive. However, between 1905 and 1958 there were striking changes in the standard of new working-class dwellings in Dublin, and also in the conditions of employment of building workers, e.g. maximum hours of work, holiday allowances, extra payments for particular kinds of work and social security allowances. The cost of providing a typical working-class house also rose owing to better standards of construction, accommodation and general amenities. Thus, the average floor area of a typical three-bedroom house rose from 656 square feet in 1938 to 790 square feet in 1958. An outside fuel store has been provided for each house since 1958. The average number of rooms per house completed by the Dublin Corporation in 1905 was 2.74 and this rose progressively to 4.12 in 1958. Thermal insulation is now provided for all external walls. The concrete ground floor has been increased in thickness by 50 per cent and a second damp-proof membrane incorporated. Thermo-plastic tiles have been substituted for concrete finishes in kitchen floors. A wash-hand basin has been provided in the bathroom. Cupboard space has been greatly improved. The experience in Dublin has been drawn upon in some detail, since it is probably illustrative in large measure of trends in urban housing in many European countries.

6. Information is available for some countries on trends in building costs and their constituent elements during the last decade and are shown in Table 2.

Table 2

Percentage change of input and output prices for house-building

Type of Series	Period	Percentage change		
		Total	Materials	Wages
I. Input prices				
Austria	1949 - 1957	100	88	116
Denmark	1948 - 1957	49	41	66
Finland	1951 - 1957	13	5	27
Ireland	1952 - 1957	11	6	21
Italy	1948 - 1957	33	14	68
Norway	1948 - 1957	47	..	..
Portugal	1949 - 1957	- 7	- 12	7
Sweden	1949 - 1957	45	48	43
United Kingdom	1948 materials - 1957 1950 wages	..	46	59
Western Germany	1948 - 1957	24	23	40
		Total		
II. Output prices				
Belgium	1950 - 1956	6		
France	1953 - 1957	27		
Netherlands	1948 - 1957	30		
Switzerland	1948 - 1957	7		
United Kingdom[(a)]	1949 - 1957	41		

Source: Quarterly Bulletin of Housing and Building Statistics for Europe, ECE, Geneva.

(a) All new building work.

The input series relate to prices of materials, wages and certain other input factors such as architect's fees, weighted on the basis of a standard house. These indices, therefore, do not reflect changes in real building costs, productivity and profits and are only reliable for an analysis of trends of costs so far as the "index house" remains representative. This, however, is not necessarily the case and therefore percentage changes should be interpreted with caution. It appears that building costs have risen in almost all western European countries, except Portugal, during the post-war period and that labour cost has risen faster than building material prices.(1) It also appears to have been a general trend that wages of unskilled labour have risen more than those of skilled workers. The combined materials index conceals wide variations in trends among some of the items included in the index as a whole. Thus, in a number of countries the prices of timber and of steel products used in building have increased more rapidly than those of other building materials.

7. The output indices relate to actual costs based either on the price of various units of work weighted on the basis of a standard house (Belgium and Switzerland); the price, for example, of m^3 of houses now being built of more or less the same size and quality (France and the Netherlands); or on a combination of such factors as prices of materials, labour, overheads, profits and output per man (United Kingdom). The trend of output prices has been different from country to country. The increase has been fairly low in Belgium and Switzerland and much greater in France, the Netherlands and probably the United Kingdom.(2) In the case of Belgium, the increase of 6 per cent between 1950 and 1956 applies only to social housing schemes, and it is not known whether the trend of output prices for private building has been the same. In France, on the basis of prices per m^2 of HLM houses, there was a fall between 1950 and 1956. Yet the trend shown in Table 2 is very different. In the case of the Netherlands, the high increase may be to some extent explained by improved quality and equipment in the dwellings concerned.

8. For Finland, Italy, Sweden, Switzerland and Western Germany, data on the breakdown of the different input factors or work categories are available and are shown in Tables 3, 4, 5, 6 and 7. The make-up of these indices, their breakdown and the items included in the tables are different from country to country. Hence, comparisons should be made with great reserve and the conclusions which can be drawn must be tentative.

---

(1) The relatively lower percentage increase of wages in Sweden may be due to the fact that the bases for calculating the index of wage rates derive from collective agreements and are therefore on the low tide.

(2) The index for the United Kingdom relates to both residential and non-residential new building.

Table 3

Percentage Change of Input Prices for House-building in Finland

1951 to December 1957

Items	Percentage change	Items	Percentage change
Total	16	B. Side and subcontracting work	16
A. Building materials	13	Rockblasting and earthmoving	14
a. Mineral materials	12	Water pipes and sewers	19
Bricks, clay	28	Heating ducts and ventilation	19
Bricks, lime	7	Electrical wiring	14
Porous concrete	6	Low voltege wiring	15
Cement	25	Electric ranges	0
Mortar	6	Painting	8
Sand	30	C. Labour costs	24
Gravel	7		
Bricks for interior walls	5	a. Skilled labour	19
Floor tiles	8	Carpentry	29
Window glass	14	Brick-laying, masonry and plastering	12
Stairs and cement-mosaic work	- 2	Reinforced-concrete and insulation work	10
Stone slabs (natural)	34	Tinplate and railing work	30
Poured concrete works	20		
b. Wood materials	10	b. Unskilled labour	30
Heavy timber	16	Hod-carriers	- 2
Sawn timber	0	Miscellaneous work (male)	30
Planed timber	-12	Miscellaneous work (female)	39
Doors and windows	17	D. General and overhead costs of the building site	
Kitchen furniture and cupboards	18		
c. Metallic materials	16	a. Supervisory and social costs	30
Building steel	35	Supervisory and office personnel	34
Nails	11	Insurance; paid vacations	24
Tinplate	-11		
Hinges, fittings	- 6	b. Other costs	12
d. Insulation and coverings	20	Transports	11
Water insulation	9	Tools, machinery, supplies, warehouses	10
Heat insulation	- 4	Electricity	21
Linoleum	49	Heating fuels	14
		E. Expert fees	17
		F. Interest on building capital	- 5
		Total index, ecl. groups E and F	17

Source: Bank of Finland, Helsinki.

Table 4

Percentage Change of Input Prices for House-building in Western Germany, 1948 to 1957

Items	Percentage change	Items	Percentage change
Earthmoving	20	Main structure	
Building materials	24	Earth moving	20
Bricks	9	Bricklaying	22
Lime	14	Concrete work	32
Cement	20	Carpentry	52
Timber	60	Roofing	34
Iron	77	Metal work	6
Wages	40	Total	31
Subcontractor	15	Inside work and fitments	
Total cost of building work	26	Plasterwork and cleaning up	29
Overheads		Joinery	21
Designing and supervision	5	Glazing	18
Building dues and charges	12	Painting	2
Interest on contractor's advance	59	Decorating	0
Total overheads	12	Heating installations	16
		Water and gas installations	23
		Electrical installations	-12
		Total	18
Total	24	Total	26

Source: Statistisches Jahrbuch für die Bundesrepublik Deutschland, 1958.

Table 5

Percentage Change of Input Prices for House-building in Italy, 1948 to 1957

Items	Percentage change
Labour	68
Building Materials	15
Bedding materials	14
Bricks	31
Covering materials	40
Timber and timber work	40
Metal and metal work	- 7
Glass work	- 16
Sanitary installation	- 14
Heating	- 18
Electrical materials	8
Painting	- 30
Other costs	121
Total	32

Source: "Index", Centro per la statistica aziendale, Florence.

Table 6

Percentage Change of Output Prices for House-building in Switzerland (Zurich), August 1948 to August 1957

Items	Percentage change
Cost for main structure	6
Excavation, masonry and pipe-laying	- 2
Artificial stonework	- 11
Carpentry	26
Metalwork	- 1
Roofing	52
Cost for inside work and fitments	7
Locksmith's work	10
Venetian shutters and roller blinds	1
Sun-blinds	5
Plaster-work	5
Wallboards and floor slabs	- 3
Sanitary fittings	8
Electrical installations	7
Kitchen range and hot water supply	55
Glazing	- 3
Joinery	3
Hardware	- 13
Wooden floors	9
Linoleum	- 7
Painting	8
Decorating	- 1
Central heating	4
Drying-out	2
Cleaning-up	15
Other costs	19
Connecting-up to mains	1
Laying-out of gardens	0
Architects' fees Superintendence	27
Dues and charges	13
Interest on building capital	13
Total	8

Source: Statistisches Jahrbuch der Stadt Zürich.

Table 7

Percentage Change of Input Prices for House-building in Sweden, 1 January 1950 to 1 January 1959

Items	Weights of items	Percentage Change.
1. Materials for concrete and bricklaying	11.5	47
Aggregate	1.8	61
Cement	2.4	31
Mortar and plaster	1.8	48
Concrete blocks	0.4	33
Light-weight concrete	1.3	32
Bricks	3.2	61
Partition wall slabs	0.6	25
2. Timber and joinery	9.5	68
Sawn timber	3.5	83
Planed timber	0.3	88
Windows and frames	1.0	67
Doors and frames	2.3	50
Kitchen equipment and wardrobes	2.4	63
3. Iron goods	4.0	28
Reinforcing iron	2.0	20
Nails, screw, strip iron	0.4	30
Hinges, hinge mountings	0.3	32
Locks, locking handles	0.2	58
Doors	0.4	52
Ventilators and gratings	0.2	-
Other iron goods	0.5	32
4. Other materials	7.0	28
Asphalt	0.1	24
Brickpipes and eternite	0.4	37
Heat insulating materials	1.1	30
Cardboard	0.4	31
Roofing brick	0.5	93
Stoves	1.7	34
Refrigerators	1.3	4
Sink fittings	0.6	17
Washing machines) Laundry machinery)	0.9	19
5. Earnings labourer	20.5	54
Bricklayer	4.5	
Carpenter and joiner	7.0	
Unskiller labourer	9.0	
6. Painting	5.5	41
Materials	1.5	27
Earnings	3.5	47
Administration	0.5	41
7. Heating and sanitary fittings	12.0	40
Materials	8.0	40
Earnings	2.5	40
Administration	1.5	40
8. Electrical installations	4.0	22
Materials	2.0	5
Earnings	1.5	44
Administration	0.5	22
9. Other side and sub-contractors work	9.5	53
Excavation and transport	1.1	74
Prefab stairs	0.7	69
Building forge	1.2	45
Sheet metal works	0.7	61
Glass works	0.5	64
Stone work	1.2	56
Tile	0.9	40
Parquet	1.9	48
Linoleum	1.3	40
10. Contractors costs	12.5	63
Machinery and tools	1.7	55
Transports	0.5	65
Supervisor	1.8	93
Fuel	0.8	40
Other building site costs	0.7	31
Management, representation	4.2	53
Office premises	1.3	58
Office staff	1.5	97
11. Builders costs	4.0	87
Interest and credit costs	1.2	25
Architects fee	1.0	85
Constructional designers fee	1.0	69
Other costs	0.8	54
Total	100.0	50

Source: Information supplied by the Government.

9. In Finland wages, particularly of unskilled labour, increased considerably and the same was true of overheads for supervision and office work. The item for sub-contractors increased to a limited extent. The cost of carpentry work rose considerably more than other labour costs. The trends of prices of building materials were divergent, those of cement and building steel increasing most rapidly. The main feature in Italy was again the increase in labour costs and other costs, probably overheads. Trends in building materials prices were also very divergent, roofing materials and timber increasing most rapidly. The main feature in Switzerland was the large increase in the cost of carpentry work and roofing and also architect's fees and supervision. The cost of building the main structure increased rather more than that of internal work and elements. The item for sub-contractors rose comparatively little. In Western Germany wages again increased much more than the cost of other items. Once again, the cost of timber and building steel increased more than that of other materials. The trend in the cost of sub-contractors' work was similar to that in Finland and Switzerland, but in contrast to these two countries the cost of planning and supervision remain virtually unchanged. Also in contrast to Switzerland, the cost of work on interiors rose more than that of the main structure. In Sweden the cost of timber, joinery and roofing materials increased considerably and also expenses for supervision and office work.

10. The cost of house-building has a major influence on a large part of fixed capital formation in almost all European countries. During the last five years, for example, from one-fifth to one-quarter of all fixed capital formation in most western European countries was accounted for by residential construction. The same was or shortly will be true of most eastern European countries. This investment, however, is not solely due to the operations of the house construction industry, since it is also accounted for by industries providing a large number of materials and components.(1)

---

(1) Of the total value of residential building produced in Western Germany in 1955, namely, DM 9 milliard, about one-third was represented by materials supplied by other industries to the house-building industry and two-thirds by the value created by the house-building industry proper (see "Evolution de la Construction dans la République Fédérale Allemande: Rapport de la Mission Française de productivité", Paris, September 1958).

Distr.
RESTRICTED

HOU/Working Paper No.97 Add. 2
16 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER II

THE ORGANIZATION OF DEMAND

1. In this chapter the organization of demand in the house-building industry in Europe is examined. For present purposes the term demand means effective market demand on the building industry, whatever may be the potential demand in a social sense. Owing to the wide differences between the institutional and economic framework in western and eastern Europe the problem is discussed in two separate parts. The main points discussed are the volume of demand, its degree of stability, how it is fed to the industry through contracting systems, the extent to which demand is collectivized, thus affording opportunities of promoting technical progress, and the policies being followed in different countries in relation to the different aspects of the organization of demand.

2. The volume of demand in the house-building industry has been traditionally fluctuating and unstable. This arises partly because demand for new housing is more easily deferred than demand for other consumer necessities. New housing competes with the existing stock of dwellings which can temporarily be more intensively occupied or remain in use longer than may be socially desirable. Another factor has been the effect of two world wars during which house-building virtually ceased. Subsequently pent-up demand, inflated by destruction of dwellings, led to rapid upsurges in demand with the danger of subsequent recession. A further cause of instability is the high capital and annual cost of a dwelling in terms of the income of the majority of consumers, making effective housing demand particularly sensitive to credit conditions and interest rates.

3. The instability of total effective housing demand has had a marked effect on the structure of the house-building industry, since in the long run conditions have not been conducive to a steady evolution towards greater capital investment, which in many industries is a condition of technical progress. Apart from the instability of total demand, however, house-building demand is necessarily in some degree fragmentary in character. Much of it is local, arising from the fixed and heavy nature of the product, and necessarily subject to much variety in terms of the product sought by the consumer. These factors go far to account for the basic characteristics of the building industry; the multiplicity of concerns, with a small average scale of production, low capital investment and impermanence of basic organization. The structure of the industry is discussed more fully in the next chapter. The point to be noted here is that there is something of a vicious circle in that the instability and fragmentation of demand tends to promote an industrial structure which is in turn geared to small-scale unstable demand. The foregoing brief discussion of the nature of housing demand applies to pure free market conditions.

Western Europe.

4. In fact during the present century there has been government intervention in most western European countries, mainly to make available a substantial part of the capital funds required for house-building and to bridge the gap between the annual economic cost of a dwelling and average incomes. These policies can be accounted for largely through considerations of social policy which has recognized the need for reasonable minimum housing standards of dwelling accommodation incapable of being attained at the current levels of income and at current levels of building costs by a substantial part of the population. A counterpart of these policies has been rent control which has tended to discourage private enterprise housing. The general effect has been that in most countries, and to an increasing extent, public policy has supported an effective demand for the services of the house-building industry at existing levels of efficiency and cost.

5. The question arises whether the type of intervention practised by governments has not tended to diminish the incentive to the industry towards technical improvement since of its very nature government policy tends to take largely for granted whatever is the given level of real cost. Furthermore, demand on the

5. Another proposal, on the subject of building codes and regulations, is not new in the Committee's work programme (see Note by the Secretariat IM/HOU/WP.2/31, September 1954; and recommendations by the Committee IM/HOU/WP.2/38, November 1954), but it seems now possible to consider a fresh approach to the question of reform of building codes and regulations, with a view to promoting the introduction of modern building techniques and contributing to the lowering of building costs. The purpose and scope of this possible project is set out in Appendix II. In drawing up this paper the Secretariat has also had the benefit of advice from an expert consultant.

6. It has also emerged from the enquiry on government measures designed to promote the technological development of the building industry and reduce housing costs that materials and components are much the largest element in total building costs in all countries. Consequently there is in the first instance scope for continued efforts to reduce the volume and weight of materials used and, where possible, to substitute lighter materials. The problem of reducing the volume and weight of materials used is in the first instance one of design. At the present stage of development some of the newer materials are no cheaper and frequently more expensive than traditional materials. There would appear to be scope therefore for exchange of information and further analysis of the use of newer materials and components from an economic point of view, in the light of future perspectives. In addition, it has also emerged that in most countries new materials and components, or adaptations of existing materials, are developing rapidly. There would therefore appear to be scope for exchange of information between countries on recent and prospective developments, perhaps in part through organized exchange between Building Centres in different countries. These organizations are generally concerned at the national level with dissemination of information in response to specific enquiries as to availabilities, properties and costs of materials and components. A suggested outline of a possible enquiry and possibly other action which might be encouraged by the Housing Committee in this field will be circulated shortly as Appendix III (with the symbol HOU/Working Paper No. 101 Add.1).

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.4
27 April 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER IV

THE TECHNOLOGICAL DEVELOPMENT OF THE INDUSTRY

A general review of factors affecting the technical evolution of the housing industry

1. Information available as to the trend of evolution in the various countries of Europe is variable in the extent to which it is complete; indeed it might require the efforts of a lifetime of a team of skilled investigators to obtain a full and accurate picture, with statistically comparable data, of the progress being made. Nevertheless the material now available provides a basis for a first assessment of the broad trends. This chapter attempts to make such an assessment and to draw such conclusions as can be justified at this stage.

2. There are certain factors which, though they differ in degree, are common to all countries of Europe. Though in fact some of them are obvious, it seems reasonable to state them at the inception, since they are the background to the subject. They stem from the nature of the product on one hand, and the structure of the industry on the other.

3. A house, in comparison with many other necessities of life, is a large object. It calls for the assembly of a large volume of material, and large amounts of earth need to be moved in the process of locating the house on its site. There is therefore an obvious advantage in adopting all means possible to reduce the cost of handling materials in bulk, and in every European country mechanical power is replacing human effort in the handling of bulk materials. The process of mechanization of handling can have established itself only because it has positively saved cost and it is quite safe to assume that, as standards of living improve, mechanical handling of bulk material must become universal. The process of assembly of building materials and components, as opposed to moving them, presents a less clear

picture. The amount of labour involved, by comparison with, say, the mechanical industry, is not great. The heavy capital expenditure involved in highly mechanized methods of house production has primarily to be offset by savings in labour if costs are to be reduced, and unless the ratio of cost of labour/cost of materials is high the possible decrease in cost by such methods is limited. In view of the importance of the bulk of the house in the make-up of costs it can be concluded that the first line of attack is the avoidance of waste of space, i.e. better design, and the reduction of mass in the structure to the limit of what is possible.

4. The house differs again from many other manufactured articles in that it is usually required to have a much longer life. A garment is discarded after a relatively short period of use and it is recognized that a motor vehicle or a refrigerator will become unserviceable and need replacement within maximum of a decade. The problem of longevity is, of course, bound up with expenditure on maintenance but, generally speaking, it is universal to require that the main structure of a dwelling shall remain serviceable with a minimum of maintenance for at least half a century. This requirement has a powerful influence in determining the form of a dwelling since it tends to enforce the use of massive materials in construction; such materials as stone, brick and concrete are normal, and so far can only be dispensed with at the expense of high maintenance cost. One of the difficulties of substitution by light materials is that the massive materials normally used are cheap in themselves and the substitutes more costly. This trend towards massive durable materials in the main structure is an important factor in maintaining volume and weight of material in the construction of dwellings, a condition which, as already noted, is a handicap to industrialized production off the site. It is interesting to note that in USSR and Czechoslovakia considerable thought is being given to the reduction in weight of house components without recourse to costly alternatives. The possibility of reducing weight materially is an importance advantage of the newer techniques in reinforced concrete construction. Technically there are interesting problems in reducing weight without impairing durability. With the reduction in weight of the main house components there are important problems of thermal and sound insulation which have now to be dealt with in other ways.

5. In Chapter II an analysis has been made of the nature of the demand for dwellings, and the reasons for the variations which occur in different countries. In a number of respects, the situation is different in the eastern and western European countries.

It is necessary to distinguish between "need" and "demand". In Chapter II "demand" has been taken to mean "effective demand": the quantity of new dwelling construction for which orders to proceed can be given at any one time. The effects of the character of demand on the technical development of the industry are undoubtedly important and, looking to the future, the long-term trend can be deduced with reasonable clarity if the assumption is accepted that within reasonable time every family in a European country will occupy a dwelling offering decent conditions of space and hygiene. Starting from the immediate postwar years there are heavy arrears to be made up due to war destruction, to cessation of building during wartime, and to accumuldated arrears subsequently. This means inevitably an expansion of the house building sector of the industry, either at the expense of other types of building or by the creation of additional building capacity. At some point in time it can be assumed that the arrears will be largely overtaken, as has already happened in a few countries, and it will then be necessary to provide dwellings at a rate sufficient to deal with the normal population increase and to replace a proportion of the older housing as it becomes inadequate by the standards of the day. The overall picture therefore is an expanding demand, followed at different points of time, of course, in different countries by contraction at a relatively steady rate.

6. Within this general framework, there are usually considerable fluctuations, which are discussed in Chapter II, so that the conditions of stability in the rate of expansion of the demand are rarely achieved. Owing to the importance of housing in the national social framework it is subject to shifting emphasis as national policies change and develop. The welfare, well being and development of efficiency of the house building industry frequently tend to be of secondary consideration. In western Europe it is in one or two countries only that conditions have been contrived to enable the technical development of the industry to be advanced, by adjustment of demand in terms of continuity and scale. In this connexion it is interesting to note the trend of prices after the 1914-18 war when, in many countries, as after the second world war demand was expanding. Thus in the United Kingdom, in the years between 1920 and 1930 the average cost of a three bedroom house fell by stages from £930 to £350. Effective demand increased steadily from 1924 until 1937 and the average house cost was at its lowest in 1933. During this period of falling costs and steadily expanding demand, it should

be noted that the house building industry in the United Kingdom reached a high state of technical efficiency, though strictly within the limitations of traditional practice. Factors in evidence were a high degree of repetition of work enabling an organized flow of production, payment by results in various forms on a large scale, bulk purchase of materials and a measure of voluntary standardization which enable large-scale factory production of a number of housing components to be set up.

7. So far, some of the features of global demand expressed purely quantitatively have been considered. An important factor is the dispersal of demand in terms of numbers of dwellings which can be let in a single contract, and the geographical dispersion of contracts. In many national housing programmes at least 50 per cent of all dwellings fall into contracts comprising no more than one or two dwellings each. This implies that a considerable proportion of the total demand is on a multiplicity of small concerns; clearly, the problem of increasing technical efficiency is more difficult with the small unit.

8. The pattern within eastern Europe is similar in form but different in degree. The two salient facts are that the housing shortage is greater in many eastern European countries, and that national planning systems make it possible to aim consciously at raising the efficiency of the industry as well as meeting the expanding demand for houses. The problem of the small operation comprising only a few dwellings on a site exists; this is dealt with by varying degrees of self-help and by the increasing use within the radius of delivery of the factories of type plans and factory constructed elements. The prefabricated timber dwelling in the USSR plays an important part in rural development. There are also groupings of small enterprises which should make for a higher standard of technical efficiency.

9. It has been shown in Chapter III that an essential characteristic of the building industry in many European countries is its heterogeneity. The functions of design, estimating and control of prices, manufacture of materials, and construction on the site are exercised independently in the great majority of cases. This is in marked contrast with the type of organization in advanced industries where design and production are controlled by a single organization, and where market research, cost control and purchasing of materials are a background to every phase. Attention has been drawn repeatedly to the disadvantages inherent in the divorce between functions in the building industry but there has been, in fact, no real change so far in western Europe.

10. It seems that the trend in countries with a planned economy is somewhat different. There is a measure of integration of functions but it is not complete. Thus the functions of design and to some extent of price fixing are concentrated in "project institutes" and all functions of construction in "constructional organizations". The major constructional organizations concerned with new house-building are brought into large groups so that adequate equipment is thereby facilitated. A certain degree of integration of project institutes and constructional organizations is due to the fact that both are complying with the requirements of a national plan; the relation between investor, designer and contractor is established at the inception of a project.

11. The size of building undertakings in western European countries varies over an extremely wide range, from small firms, capable at most of undertaking a contract for a very small group of houses, and at the other end of the scale large firms capable of tackling contracts including several hundreds, or even thousands, of dwellings. This stems primarily, as has already been shown, from the fact that the demand for small units is important.

12. When the technical development of the industry is considered the existence of a large number of small undertakings is a complicating factor. A small undertaking cannot be expected to employ the highly qualified personnel directing operations normal in a large organization. The small firm cannot be expected to hold a reserve of large items of mechanical equipment nor can it purchase its materials in bulk. Since it seems virtually certain that the demand for small housing projects will continue to form a significant percentage of all house-building, it seems probable that in western European countries there will be a continuance of small contractors working on small projects; by their very nature they will be outside the main stream of technical development and will require special consideration. The small firm working within the traditional framework on a small project has the advantage that the whole operation can be visualised and controlled by a single person in charge. As a result the costs of supervision and organization are reduced and the personal element has full scope. On the other hand the financial structure, and particularly the capital structure, has far-reaching effects. Thus, in several countries smaller firms are hampered in the development of mechanization by lack of the capital necessary to acquire the machines they need and the supply of materials tends to be organized on a credit basis through, in many countries,

a strong organization of "builders merchants". Owing to the fact that the trading risks are considerable, interest rates tend to be high, and this again is a powerful factor tending to the disadvantage of the small contractor. Limited enquiries have been made in some countries on the nature and effects of the capital structure of the industry, particularly in respect of the position of the smaller firms, but it has not, so far, been considered on an international scale.

13. The traditional character of the building industry has its foundations in the period where local materials were assembled by local craftsmen using methods which had been tried and accepted after generations of practice. The essential basis of the art, for an art it was, was the common basis of knowledge, on the part of all the participants, of the nature of the materials and the methods of handling them. Thus the architect had only to indicate his requirements within very broad limits, and could rely on the skill of the craftsman to carry out the details in the traditional manner. Similarly the contractor knew his market for the purchase of materials intimately, and also the cost of every operation in terms of labour, so that prices were stable and organization simple since it followed a well-tried pattern. A great deal of knowledge was acquired, but it was essentially descriptive and historical. The industry knew how to do its job without concerning itself overmuch as to why it did it that way. The training of the industry at all levels followed a set pattern and, in consequence, there is a powerful vested interest in that there are a large body of men who only recognize the accepted methods of designing, organizing and executing work.

14. The purely traditional character of building began to break down when modern conditions of tranaport made a much wider range of materials available which were no longer local in character. It changed even more drastically when new methods of construction began to be introduced. The final blow was the complexity of services which have to be installed in the larger modern building. These changes have had to be assimilated and grafted on to the traditional methods of organization of the industry, which remain basically the same, although the conditions over a large part of the industry have changed almost out of recognition. The result is a horde of specialist designers and sub-contractors whose functions tend to be only loosely co-ordinated in the building operation as a whole. Indeed the success of this co-ordination is a measure of the efficiency of the whole project.

15. As a result of the complexity of a great part of building under modern conditions technique is changing to meet new needs. Already it is possible to distinguish the designing and contracting organizations who have moved a long way to meet modern conditions. There is already evidence of a duality which will increase as time passes: of medium to large concerns, well equipped and using modern production methods; and small organizations still rooted in the traditional approach, but some highly efficient within their inherent limitations.

16. In the building industry it is probably true to state that in most countries the small house, erected on a small site, is the last stronghold of the traditional method and traditional organization and needs special study. But the public works sector of the constructional industry bears little resemblance to the type of organization 40 years ago. As late as the 1920's any major public works project such as a new road, a dam or a bridge involved the recruitment of a large labour force, with all the problems of housing, transport and feeding involved. The numbers often amounted to thousands. Today on similar projects the labour force is counted in hundreds, but the array of highly specialized machinery is infinitely greater. The increased speed of working sets many problems of co-ordination of supply of materials, verification of quality requirements and the like and, generally speaking, a higher degree of technical competence in many fields on the part of the organizers and supervisors. The entry of public works contractors into the field of housing has brought a new element into housing operations: a high standard of technical competence.

17. So much for traditionalism and its implications. For the purposes of this enquiry "industrialization" has been defined in a broad sense: continuity of production, implying a steady flow of demand; standardization of products; integration of the different stages of the whole production process; a high degree of organisation of work; mechanization to replace manual labour; and research and organized experimentation integrated with production. This in turn implies a thorough study of the whole production process in the light of modern scientific and technological developments, leading to a rational choice of materials and method as opposed to an empirical choice. On this basis it is quite possible that traditional materials and methods of construction, suitably modified so far as the organization of the work is concerned, and using modern

equipment, can be the correct solution in certain circumstances. There has been a tendency in postwar years to assume that modern industrialized technique of necessity implies a radical change in materials and method, and that a large array of machinery was the least to be expected. When after trials on a considerable scale in some western European countries it was found that the results were not revolutionary in cost reduction or speed of production there was a tendency to decry the whole basis of "industrialization", and revert to traditional techniques. This was of course an extreme reaction which tended to throw away the baby with the bath water. If this view of the trend of evolulution is the correct, if not the only one, a gradual transformation of building operations from a purely traditional and empirical basis to a more rational and organized pattern can be expected in many countries. Indeed this process is already well under way in all countries, though there are differences in the extent to which it has progressed.

18. The natural process of evolution can be accelerated by governmental intervention; it may also be retarded. Thus in some countries in western Europe conditions have been created such that new and highly industrialized techniques have a reasonable opportunity to show their worth. The important factor has been to ensure sufficient continuity of effective demand to enable production to develop and to spread amortization over a reasonable volume of work. In eastern Europe, with a planned economy and where the effective demand is greater and continuity assured over a long period of time, it has been government policy to introduce a high degree of new technology under conditions which should be highly favourable to its development. By virtue of the completeness and rapidity of its adoption the results in a decade or so will be of great value to the whole world, and it will be particularly informative to make a comparison with the state of development reached in other countries by the normal evolutionary process. In this attempt to define the nature of the evolutionary process it will be noted that no reference has been made to "prefabricarion" as such nor to "new methods of construction". There are certain production techniques which, given the appropriate conditions, may be beneficial, but are not to be regarded as objectives in themselves.

19. Passing from broad principles it remains to consider in detail the various factors which make up the production process. There are two factors which condition all productive processes and which have special importance in housebuilding: repetition and continuity of operations. In principle, it is

true that the most striking effect of industrialization in the frequently accepted sense of the term is that large scale production makes it possible to produce a wide range of useful commodities at a price which brings them within the means of all sections of the population. If the scale of production is sufficient, large savings in labour are possible by the use of machinery in place of manual labour; but it must be noted that a striking reduction in cost by large scale production is possible only in the case of commodities where labour accounts for a high proportion of total cost. Where the labour element is small or moderate and the material element large it is evident that no economy in labour can possibly have a revolutionary effect on the cost of the completed article. It can be foreseen that in certain circumstances the cost of installation and operation of machinery may outweigh the labour cost saving, and the article may cost more when it is made by highly mechanized processes. It is evident that a complete dwelling is at the point where the possible cost savings are of the order of 10 to 15 per cent.

20. If, however, the process of site erection is regarded as the assembly of a large number of components, which in fact it is, the picture is quite different in respect of the production of the components. Since a large number of the components of a dwelling are common to many dwellings, it is evident that the element of repetition exists even at the production stage; by the normal process of evolution, it is to be expected that more and more of them will be produced by industrialized technique. This, in fact, is happening, and wherever the ratio labour cost/material cost is high large scale, highly mechanized production is in progress and expanding. In almost every case of organized production it is axiomatic that the larger the scale of production, the cheaper is the product, provided there is sufficient assurance of continuity of business to amortize the cost of a complex production process. In the evolutionary process the manufacturer has played the essential part, often with little help or encouragement from the building industry. The reason for the acceptance of mass-produced product has been invariably the fact that it has been cheaper; the less efficient producers have had perforce to improve their production process or go out of business.

21. Since the war, with larger housing programmes in every European country, it has been realized that large scale production could be encouraged by reducing unnecessary multiplication of types and patterns of materials and components,

and thus enabling manufacturers to concentrate their resources on a more limited range of products and so reduce costs. As a result many countries have introduced standards for types, patterns and dimensions of housing elements and the result has been advantageous to a varying extent in different countries, depending on the extent to which the essential conditions are fulfilled. From the point of view of reduction of costs of production it is only by reduction of varieties of types and patterns that concentration of production is possible, so that it can be postulated that standardization without reduction of types and patterns will have no effect whatever in reducing the cost of housing components. If this reduction of types and patterns is to be effective, there is implied a sacrifice on the part of the purchaser or his architect of his freedom of choice. It is in this field that governments and public authorities can exercise a profound influence. Where, owing to the heterogeneity of the industry, or even to national temperament, there is a reluctance to accept the discipline involved in a limitation of choice, the government or public authority can recommend or compel the observance of standards in the housing developments over which it has financial control. Once the standard article has established itself in one sector of the industry, and provided it has obtained the objective of lowering cost and maintaining quality, it will inevitably obtain wider acceptance. There are several cases where standards, devised originally by large housing authorities for their own purposes, have met general acceptance without the intervention of a national standardizing body. Clearly, however, where there is national standardizing authority, it is to the advantage of the industry as a whole for the task of standardization to be centralized. In addition economy in production of components for dwellings by reduction in numbers of types and shapes benefits the small undertaking equally with the large one and, consequently, is particularly desirable.

22. The importance of repetition and continuity in the manufacturing process as a means to cost reduction is clear. It remains to consider the part which they can play in the process of assembly of components and materials on site - what is normally described as building operations. A workman, or a working gang, performing a particular operation may be expected to improve in the rate of executing a piece of work after a certain number of repetitions. They acquire familiarity, avoid waste of effort and establish a rhythm. This is common to all industrial processes, but the improvement can only be maintained

for a certain length of time after which the rate is steady, with, sometimes, a tendency to fall away owing to monotony. Thus for craft processes in building it is usually considered that an improvement of productivity of the order of 10 to 20 per cent. may be expected after ten repetitions of a closely similar, but not necessarily identical, operation. Equally from the point of view of continuity, it is common knowledge that there is an appreciable expenditure of time in starting up and closing down an operation. A working gang will therefore gain in productivity where it can be continuously employed on a series of operations continuing successively without a break. The whole of a contractor's organization is subject to the same loss where there is no continuity.

23. Repetition is also important in determing the use of machinery. In many cases it is not profitable to bring a heavy machine to a building site for a single operation. The cost of moving it would far outweigh any saving in cost due to its use. If, however, the operation is repeated the point is soon reached where the machine can show a significant reduction in cost.

24. These factors add up to an appreciable reduction in cost and where the size of the project makes it possible, it is clearly advantageous to let contracts in such a way that repetition of work and continuity are respected. One of the problems in many European countries lies in the fact that budgetary and administrative practices make it difficult to arrange long-term continuing contracts. The tap is turned on and off at annual intervals and the public sector suffers in consequence. The eastern European countries, working on 5-year and 10-year plans, should be in a much better position than western countries to demonstrate how important these factors may be.

25. These considerations of repetition and continuity bring in the question of typification of house plans, considered apart from the standardization of materials and components. So far as the erection or assembly process goes the advantages of repetition will be apparent within the compass of one site, one contract, or one major project but would not be expected to extend so widely when the whole process is transferred to another site. Close adherence to type plans is important when large, standardized components are used within the compass of a single contract or large site.

26. It has been noted that by the evolutionary pattern of development the trend is towards standardization of building components and elements, with the primary object of reducing types and forms to enable production to be concentrated,

to achieve, in fact, a larger measure of repetition and continuity of production. When the assembly process is considered, apart from the production aspect, there are a further set of requirements. The various components should be such that they can be fitted together with a minimum of labour and waste at the assembly point. This imposes a further set of requirements and another discipline since freedom of choice is again restricted. The necessary conditions can be achieved by typification of details of construction in which overall dimensions of meeting components are laid down, together with positions of fixing and attachments, and this is the method followed in the eastern European countries. At present there is no clear indication of the trend of evolution in western Europe but there are pointers. Thus many countries are working intensively on modular co-ordination, which bases itself primarily on the adoption of a common multiple of dimensions. In several countries a national module has been adopted but it is too early as yet to assess the results or to detect any significant effect on the trend of costs. In a few countries the heights of storeys in housing have been standardized. It is interesting to note that there is no uniformity here; some countries have fixed the height from floor to ceiling and others from floor to floor.

27. There is ample evidence of a great increase in the degree of mechanization of building operations in all European countries and every indication that it is a continuing process. In reviewing the trends it is necessary to differentiate between the main functions of mechanization. It is suggested that so far as building is concerned these functions fall under three main headings: handling, control of dimensions and processing.

28. It has already been noted that a dwelling is a large object and tends to be made of massive and durable materials. Consequently there is a large quantity of material to be moved and, additionally, in locating the dwelling on its site there is the need to move a large quantity of earth. As a result, the cost of handling materials assumes a substantial proportion of the total cost of a building. Carrying the argument right through to the point of origin, i.e. the claypit, the quarry or the forest it may well be that handling costs are greater than costs of processing. It is not surprising, therefore, to find that in most countries there has been a steady process of mechanization of handling which has gone a long way, even when there has been no government intervention. The manufacturer or producer of materials is in a favourable

position. His work is normally in one place; his materials pass through his plant at a constant rate and do so continuously. Consequently it is a comparatively simple matter to choose a machine, since its operating costs can be estimated with very fair accuracy. In fact, under European conditions materials handling is highly mechanized in all modern manufacturing plants.

29. The building site is in a different category and the problem is far more complicated. The process is discontinuous and the volume and weight of the material to be moved changes materially during the course of building operations. For economical operation of machinery certain essential conditions must be fulfilled: first, idle time must be reduced to a minimum. This implies that the site needs to be organized so that the machine can complete its work and move to another job with a minimum of delay. Secondly, moving a machine can be costly. With the heavier machines the cost of moving them is a serious proportion of the total cost of an operation. Work must be grouped in place and time so that the machine can be used to the maximum advantage. Thirdly, repair and maintenance of machinery is an important part of total cost. Adequate arrangements need to be made which are easy for the large enterprise, with large resources in machines of all kinds, but less so for the medium and small contractor.

30. The problem of introducing machinery on the traditional building site stems from the fact that machines are by nature highly specialized; the unskilled manual labour which they replace is extremely versatile. A gang of labourers digging a trench can be called off to unload a lorry of bricks, whereas a trench-digging machine can only do one job. Labourers with wheelbarrows can thread their way through the labrynths of a building site; the powered machine requires a reasonably clear run. From these considerations three important points emerge. First, the large enterprise, working on a large site, is much better able to take advantage of mechanical handling aids than the small contractor on a small site. This is another factor tending to accentuate the condition in the industry where two sectors are working side by side at different levels of technical development. Secondly there is scope for the development of small mobile machines for the small builder; in addition multi-purpose machines are highly desirable. There is evidence of this trend in many countries. Thirdly, to be successful mechanical handling requires a different kind of site organization. Work has to be planned and laid out to suit the machine.

31. The machine has a most important characteristic in that it operates at a constant speed, within limits, and consequently sets the pace for all associated operations. If it is to work continuously as it should there are many organizational problems to be solved. Materials must be supplied and removed at the rate required by the machine. Labour must be balanced to suit the rate of operation. It will quickly be found that scientific "method study" becomes an essential feature on the building site, and thus the effect of introducing mechanical handling is an all round stepping up of the level of organization.

32. There is a problem in many countries of finding the capital necessary for the acquisition of builders' machinery. It is a familiar problem of industry in general and, normally, a drastic change in methods of production may call for the investment of fresh capital. The process of more gradual evolution is usually made possible by the accumulation of reserve funds in the course of normal trading. The traditional building industry is grossly under-capitalized by the standards of modern industry and, consequently, the accumulation of capital is not normal. In some countries governments have assisted by setting up "pools" of equipment, or by making loans to builders at low rates of interest. In some cases facilities of this kind have operated for a time, being withdrawn when the industry seemed able to stand on its own feet. Some of the countries of eastern Europe put aside a proportion of savings over cost targets for re-equipment; and this is in principle equivalent to the accumulation of reserves for this purpose.

33. Bulk delivery of certain materials and packaged delivery of materials such as bricks and tiles are important aspects of building economy and are intimately related with the development of mechanical handling.

34. It is perhaps unusual to consider the principles involved in measurement and setting out in the traditional building industry but, in fact, the subject is at the root of the complete transformation which has taken place in many other industries and is relevant to the process of evolution which is taking place in building technology. Taking first the question of dimensions which is intimately related with mechanization: no object whether made by the human hand or produced on a machine, can be made to accord precisely with any pre-determined dimension. The most that can be achieved is to ensure that the finished article falls within certain predetermined limits on either side of an average dimension. This involves the specification of the average, together with the acceptable "tolerance" for the article in question. The interesting feature of the traditional building

industry is that all dimensions were given in absolute values - with the corollary that none of the participants in the industry assumed for a moment that the specified dimensions would in fact be maintained or exacted. What happened was that the traditional methods of making and assembling the various materials and components were such that a recognized sequence was always followed, and the awkward junctions were made good by the skill of the craftsmen. The results were satisfactory but the labour involved considerable.

35. The method began to break down when materials and components came to be assembled from widely distributed sources. Such components had to be accepted as they were delivered, and could no longer be tailored to suit site exigencies. At the present stage of evolution of the industry in many countries the conception of dimensional tolerances is accepted for a considerable number of components, but the interrelation of the tolerances has not yet been intensively studied, so that the task of the craftsman in dealing with junctions is not yet appreciably lightened. It would be a logical extension of the work of standardizing organizations to make such studies, and indeed, a start has been made through modular co-ordination which is developing in many countries.

36. The next question which arises is that of the physical processes involved in maintaining dimensions. Provided there is repetition, much of the time spent by craftsmen in measuring and setting out work can be saved by using elementary jigs and gauges. It is becoming in fact, a commonplace for the manufacturer of a component to supply with it a simple jig for fixing, even if this is no more than a full-sized paper diagram, or a cardboard template. The wider use of the jig has been the subject of interesting experiments by builders in some countries, and considerable claims have been made for the economies which can be effected. The difficulty in assessing these claims has always been that the man who is keen enough to devise the jig is also likely to be a better organizer than the average. The subject is a stage in the evolutionary process and one where methodical study may be profitable. If, in fact, the assembly of building components is to become a matter of precision, as is envisaged by the exponents of modular co-ordination, setting-out will require precision methods and often jigs will be developed.

37. Mechanical aids for processing, in the widest sense, are becoming increasingly used in all European countries. The reasons for their adoption are twofold.

In the first instance they save labour, in that the time occupied on an operation is considerably reduced. Secondly the quality of the work produced with the mechanical aid is better and more uniform. Even more, there are certain classes of work which would be impossible to perform without such aid. In the first category are rock and concrete breaking drills and hammers, power chisels for cutting chases and fixing holes, paint sprays, wood saws, pipe and bar bending machines etc. In the second are mechanical vibrators and tampers for placing concrete, power floats for concrete surfacing and grinding and surfacing machines for floors (which perhaps fall into both categories). In many cases these appliances are field versions of devices which have their origin in the workshop or factory. They normally originate with their manufacturers who bear the costs of design and development. There is considerable variation in detail between machines produced for the same work and particularly in the type of prime mover employed. On the basis of general workshop experience it seems almost certain that the small electric motor holds the field for versatility and low running costs, but the building site presents particular problems of safety at normal working voltages. Since there seems to be every likelihood that the conception of the organized production line flowing past the job will be a major trend of development, it is only logical to encourage the development of the powered hand tool to the maximum.

38. The subject of weather protection of building site operations is becoming increasingly important since in various countries building operatives are enjoying a "guaranteed week" or some form of compensation for time lost due to inclement weather, rain and frost being the important causes of lost time. In the northern latitudes where frost presents a very real problem there is accumulating a considerable fund of knowledge and experience of ways and means of keeping work going during the winter and there is a comprehensive literature on the subject.(1) Rain is the cause of a considerable loss of working time and much can be done to avoid unnecessarily high costs of work below ground by phasing operations so that site works are carried out in the summer, and completions during the winter. Governments are not yet able to control the weather, but they can

(1) See HOU/Working Paper No. 97 Add. 8 (a).

influence administrative practices so that the letting of contracts can be biassed towards the more desirable season rather than away from it. Cases are known where a combination of budgetary and administrative practice tends to predispose to the commencement of building operations in the winter months where the contrary would be preferable.

39. An interesting development is the use of transparent plastic sheeting as a complete cover for winter building operations. It is claimed that in 1958, a notably wet season, the saving in operatives' time lost by rain was sufficient to repay the cost of the cover. It is believed that in the present state of development it is difficult to find a cheap transparent plastic sheet with a long useful life when fully exposed to the weather, but, in view of the very rapid progress being made by the plastics industry, it may not be unreasonable to hope for more durable material in the foreseeable future. Such developments could then become important in those countries liable to persistent rainy periods.

40. In the northern latitudes there is, of course, considerable encroachment on the working day by inadequacy of daylight in winter. Consequently artificial lighting of building operations can be an important item in promoting productivity. The illuminating engineer contributes materially to the efficiency of industry by scientific investigation of the best conditions of lighting for specific classes of work, leading to the production of suitable appliances. There is little literature on the subject of illumination of building works, though in some countries there have been methodical studies on a limited scale to provide improved conditions.

41. The evolutionary process and the planned programme alike demand adjustments of the pattern of the productive organization of the industry, and call for the exercise of new skills and techniques. The basic functions to be performed are common to all industries, and an analysis of them as they are dealt with in house-building seems a convenient way of assessing the progress of technical evolution.

42. In order to reduce costs the first prerequisite is a knowledge of them, such that "cost consciousness" is a habit of thought of all those who are responsible for the various phases of a building job. Apart from the general attitude it is necessary to study the constituent operations, and in the course of work to record constantly the level at which costs are running so that any deviation from targets can be detected at once, the cause established and a remedy found. In industry generally efficient cost control implies an intimate knowledge of the production process, and a system of cost recording and analysis which produces reliable results sufficiently quickly to enable excessive costs to be corrected before they get out of control.

43. The building industry in almost all countries suffers from certain disadvantages in respect of cost determination. In the first place, owing to its traditional basis, systems of control by price have been built up which were adequate when conditions were stable and the product relatively simple. When conditions change rapidly and often, and when the product is more complex a system of control based on prices is less reliable and increasingly difficult to adapt to changing conditions. The second difficulty stems from the fact that the industry has a unique pattern in that, over a large sector, the functions of design and price control are separated from those of production. As a result the whole emphasis in the industry is on prices and most of its serious studies available have been on prices. The successful contractor records his costs, but is required to establish his claim for payment on a basis of prices and, in order to avoid duplicating his records, his methods of analysis are forced into a form which may not be the most suitable for investigation of costs. Thus the position in many countries is that available knowledge is vested in prices, but costs are exclusive to the contractor and manufacturer and, normally, are not disclosed.

44. The disadvantages inherent in the system are known and recognized in many countries. The subject is controversial and the vested interests in the complex system which has been built up are strong. It may well be that this is one of the reasons why the establishment of improved techniques in many western European countries has not had an appreciable effect in reducing housing costs. It is conceivable, in fact, that costs have been reduced, but that prices have been maintained at the level of the less technically developed sector of the industry.

45. One of the drawbacks of the existing methods of control by prices has been that the designer, who has the choice of many possible combinations of materials

and methods for the various elements of his building, has been on rather insecure ground in assessing which combination would give the lowest cost whilst satisfying the physical requirements of the case. The difficulty arises from the fact that each change in a combination involves a considerable change in the work of a number of other trades dealing with associated elements. As a means of overcoming this disadvantage there have been interesting developments in what has been termed "cost planning", whereby approximate estimates are made on an operational basis of the effects of introducing a number of physical variants. These estimates are made on a basis of prices, and the cost of preparing them is quite appreciable, but it is an important development in that major design decisions can be taken with a price background, instead of in an almost complete vacuum so far as prices or costs are concerned. In effect it partially obviates the disadvantage, inherent in the structure of the industry, of the divorce between design and construction.(1)

46. The fact that costs as such are frequently not current knowledge in European building practice at government level is undoubtedly one of the major factors which has militated against efforts to make international comparisons of housing costs. The results have often been disappointing and the analyses have needed so much qualification that no clear cut conclusions have emerged.

47. One of the advantages of a purely traditional industry is that the fixed pattern of organization of work is common knowledge to all participants. Consequently the conscious planning of work becomes very simple, since precedent provides the solution for the majority of situations which can arise. The increasing complexity of building operations, and the experience of a number of new techniques, changes the situation substantially, and it becomes necessary to plan operations thoroughly in advance, to prepare time schedules for the various phases of work, so that craftsmen are recruited at the right time and materials can be purchased and delivered on schedule. When work has started it is equally necessary for the site supervisors to ensure that time schedules are maintained. Where machines are used they must arrive at the proper time and the balance of labour must be adjusted to suit the rate of work of each machine. The fact that a complicated programme and time schedule has to be produced, emphasises that the function of management has become more complicated and, consequently, considerably more knowledge and experience is required than hitherto. There is increasing awareness of this problem. The preplanning of sitework has been

(1) See in this connexion HOU/Working Paper No. 97 Add.8 (b).

made a condition of contract for housing in the official sector. Programming of building works has been the subject of special studies and the government departments concerned with the building industry have published information and provided an advisory service. In some countries the services of industrial consultants have been made available to the building industry under government auspices, to deal with programming as well as with other problems of management. There are also cases where the industry itself has retained industrial consultants for advisory services in building management, and has organized permanent courses of instruction for higher management executives. These are all steps in the transition of the building industry to a higher technical level; yet most of the measures taken are mainly to the advantage of the larger and more technically active firms. The majority of arrangements for instruction and training in higher management are of recent origin, and necessarily, at the outset, of strictly limited scope. Nevertheless they represent an appreciation of the problem on the part of governments and of the industry alike and it can be assumed that, though exceptional at the moment, they will quickly become commonplace and an essential part of the training for management in the not so distant future.

48. In an assembly industry such as house buidling on site the factors influencing productivity of labour are complicated and, in the traditional sector, it was rare for any analysis to be made of this. Under such conditions it could be expected that there would be wide variations in productivity and the somewhat meagre data available indicates that this is so. Thus in one country, in a survey of productivity in house building by the traditional sector of the industry, it was found that the dispersion of the labour cost about the mean was extremely high. The better sites were two or three times better than the worst. It was concluded that the greatest contribution which could be made to the national house building programme would be to raise the level of the less efficient sites to the average. In a somewhat similar but more restricted survey reported from another country the best site was almost but not quite twice as good as the worst. Unfortunately, the majority of productivity studies available have been designed to show the effects of variations in technique rather than of productivity within a uniform technique. The extreme variability in the two cases mentioned above, however, suggests that it is difficult to establish any standard figure for productivity in any sector, short of a full scale statistical survey. Where a figure is given for a type of construction it is essential to know whether it is a mean value and also what was

the dispersion about the mean in the sample considered. It is clear that overall figures for productivity need to be treated with reserve.

49. It has been noted in Chapter III that building differs from most other industries in that in many countries labour now tends to be rather more highly paid than the general run of industry. The turnover of labour is often higher and, since the workman must go to the site, building labour is of necessity rather more mobile than other industries. Work is inclined to be physically arduous. Much of it is carried out in the open air exposed to all weathers, and by the dispersed nature of building, site activities cannot be subjected to the close supervision exercised in factories. As a result the general character of building labour tends to produce a physically active, self-reliant type of man who considers himself to a certain extent as a member of a corps d'élite, more easily led than driven.

50. Certain repetitive operations in building lend themselves readily to methodical work studies and, in particular, the optimum distribution of labour in association with certain machine operations provides a field where time study can be rewarding. The use of time and method studies in building is beginning to be recognized as a function of modern management and a start has been made in some countries; it is likely to continue as a part of the general evolutionary trend. At the moment there is not sufficient experience to be able to hazard a guess as to the ultimate effect on the productivity of the industry, but it may well be that the adoption of up-to-date methods of managemnnt and use of labour will have as much effect in the long run on drastic changes in methods of construction.

51. A number of studies have been made which show that the output of the worker is increased when monetary incentives are related to productivity. Information is meagre as to the general practice in western Europe but payment by results is normal in eastern Europe. In eastern Europe the system of incentives is applied to groups of workers as well as to individuals and this may have advantages. In some countries the system of sub-contracting for "labour only" is a common practice, and where this is the case it is in effect a system of group incentive, where the group can be relied upon to deal with the laggard.

52. The post-war years have seen many important changes in conditions of work in the building industry in various countries. Apart from national social services, such features as a "guaranteed week", holidays with pay, canteen and washing accommodation on building sites are features which have come to stay and which

obviously influence building costs, though the credit side of the account is equally clear even if it cannot be quantified.

53. The technical evolution in most European countries brings strongly into relief the shortage of personnel trained in modern methods of management and supervision. The conclusion is inescapable that technical evolution in the building industry is moving faster than the facilities available for training. Many countries are initiating training projects, often through the agency of the industry itself, but it would seem that this is a subject where government intervention may be beneficial, in providing the channels through which to direct potential leaders of the industry through the general educational scheme of the country.

54. After this general review of factors affecting the technical evolution of the housing industry in Europe, attention is next focussed on specific trends, illustrated by experience in different countries

The relative importance of traditional and non-traditional methods of house construction

55. In the post-war period many European countries have developed alternative methods of house construction with two main objects in view. In the first place owing to expanding demand for houses, it was necessary to provide additional production which would decrease the need for skilled workers on the building site. In the second place it was hoped by the wider use of more advanced techniques, that the costs of housing would be reduced. If it had no other effect, a wide development of new methods of construction might have been expected to act as a spur to the efficiency of the traditional sector of the industry.

56. Thus in the immediate post-war period the history of technical evolution in the industry is largely influenced by the development of new methods of construction. The underlying thesis has been that an increasing proportion of building components should be made in factories or workshops separate from the building site proper. This could be done in centralised factories, facing a somewhat higher transport cost, or in workshops set up close to the building site which could be removed to another site when their work was done. This prefabrication sub-industry became strongly established, and in many countries the first attempts were directed to the main structural components of the dwelling: walls, floors and partitions. In no case has it been claimed that these methods of partial prefabrication led to any

significant reduction in total cost of housing though, undoubtedly, they eased the strain on certain kinds of skilled labour and on brick production. Individual components have frequently been comparable in price with traditional alternatives. In retrospect it is clear that this was inevitable since the cost of the carcass of a dwelling amounts to no more than 20 to 30 per cent of total cost, the major proportion being accounted for by finishings and fixtures.(1) In the United Kingdom for example alternative methods of construction, based mostly on methods of partial prefabrication, were developed to the extent of one quarter of total house production at the peak of the period of expanding demand. When demand ceased to grow, it was found that the alternative methods were not resulting in any savings in cost. There was also a strong preference for traditional types of dwellings on the part of the public authorities responsible for housing, so that the use of the new methods declined quite rapidly.

57. Apart from complete house systems, in many European countries there has been a considerable increase in the use of prefabricated structural components, mainly in reinforced concrete, of which the following appear to be the more important: floor beams and slabs, stairs, balconies and parapets, large wall panels in light weight concrete, window surrounds and large partition units. The manufacture and use of components of this kind can be regarded as a normal evolutionary process, and it can be assumed that since they became established, they proved competitive in cost.

58. With the wider realisation of the limitations of partial prefabrication, the conception of fuller prefabrication emerged in which the factory-made components tended to be larger, and to be supplied complete with finishes and attachments for the various fittings and services which have to be provided to make a house fit for habitation. Site assembly is, in principle, reduced to simple operations of jointing prefabricated elements, coupling up services, attaching fittings, clearing down and some attention to decoration.(2)

59. In this category of full prefabrication there is as yet no definite information as to cost savings actually achieved in large scale-production in Western Europe. Eastern European countries, with their certain and steadily growing demand are organizing large-scale development of full prefabrication for major projects in their housing programme and it is calculated that when production is fully established there will be savings in real cost of at least 10 per cent over

(1) See G. Schindler: Report on Possible Advantages of Prefabrication for Standardized Construction of Dwelling Houses, ECE, Geneva, January 1950 (HOU/19).

(2) See HOU/Working Paper No. 97 Add 8 (c).

comparable dwellings in traditional construction produced in these countries. With large-scale expanding demand, as in eastern Europe, a sector of industry is being created which makes the minimum demand on traditional skills; this new sector will be able to produce dwellings in large numbers, in shorter time and in the long run at no greater cost, other than traditional construction. It is necessary at the same time to realise that the rationalisation of site construction will also lead to significant cost reductions.

60. France and the Netherlands have set up a substantial sector of their housing industry where the trend is towards full prefabrication and this development is continuing. Owing to the heavy capital expenditure in static plant and equipment, as well as transport and handling, it is virtually impossible for development of full prefabrication to achieve any real success without intervention on the part of governments; it is necessary to ensure that there is a sufficient scale and continuity of effective demand to amortise the heavy investment. For this reason the results obtained in eastern European countries in their large-scale developments in full prefabrication will be particularly instructive. In other countries, such as Austria, Belgium, Finland, Italy, Portugal and Spain there is little development of new methods of house construction. Their housing policy is based on a rationalisation of traditional building, developing mechanisation to the full and using standardized components.

61. The wooden house comes into a special category. In the Scandinavian countries, Austria and the USSR there are considerable resources of timber, and for rural and suburban housing a long tradition of wooden houses. Wood lends itself particularly well to prefabrication and the resulting components are light and easily transportable. There has been a considerable export of prefabricated wooden houses from Northern Europe since the war. Sweden and the USSR are producing prefabricated wooden houses to supply a considerable proportion of their demand for rural houses and for the smaller isolated communities. In the USSR large quantities of highly standardised timber components and fixtures are being made, for supply to a large proportion of the houses in rural areas, when the walls will be built of local materials using local labour.

62. Parallel with the development of prefabrication there have been many examples of "rationalised" methods of site construction using, for example, poured concrete for walls with large sectionalised shuttering for repetitive use. The "no fines" concrete technique developed in several countries, with production organised on

these lines, shows definite cost savings over traditional construction under suitable conditions. It would be surprising if this were not the case since many of the mechanical adjuncts which contribute to the efficiency of manufacture of concrete units in factories are available for concreting on the larger building sites. Batch mixing, cranes for distribution of concrete, vibrators for consolidation and specialised formwork are all to be seen on a well organized building site. Smaller works can be supplied by ready-mixed concrete from large central batching plants. It would seem, a priori, that the possibilities of in situ concrete construction have by no means all been explored.

63. Finally, in nearly all countries there is a general trend of evolution in the traditional sector of the industry whereby such factors as greater use of machinery, better organization of work, new and improved materials, all tend towards increased productivity; in a few countries such methods have resulted in a decrease of housing costs in comparison with the general rise in costs over the same period of time.

Mechanization

64. For the reasons set out in the first part of this chapter it is convenient to consider mechanization of handling and of processing separately. Earth-moving operations are performed by mechanical appliances on the majority of large building sites throughout Europe. Owing to the fact that the machines are the same as those used for public works, which is a highly developed sector of the industry, there is no likelihood of any serious hindrance to the highest degree of mechanization. The small project on a small site presents greater difficulty and the situation will often arise where it is uneconomical to use a large machine. In several countries there is, therefore, the special problem of the small site for which a solution remains to be found. In eastern Europe there has been an interesting development for mechanizing work on dispersed building sites. Machines are organized in mobile groups, capable of dealing with the whole complex of operations, which move from site to site. The same need is met in some western European countries by sub-contractors who undertake specific mechanized operations.

65. For material handling in general the tower crane, either fixed or mobile, is becoming universal in the great majority of European countries for larger building sites. This type of crane deals simultaneously with horizontal and vertical handling. From the extent of increase in use, which appears to be continuing, there can be no doubt that it provides a satisfactory solution of the problem of

material handling on the building site. Sufficient data are not yet available to determine at what point in the scale of building operations it is profitable to use a tower crane. In Czechoslovakia and the USSR methodical studies are in progress to develop the type of crane most suitable to handle the various prefabricated building elements which figure largely in the building programmes in those countries.

66. For vertical transport there is a wide range of power-operated hoists for larger buildings and a great variety of small mobile hoists and winches for the smaller sites. In many European countries vertical handling of materials is virtually 100 per cent mechanized though there are some where the smaller sites are still without mechanical hoisting equipment. Details are lacking but it appears that there is considerable diversity in the development of hoisting devices. In some countries, for example,small hoists are operated by small petrol or diesel internal combustion engines. In others electrical equipment is more general.

67. In the majority of European countries there is progressively increasing mechanization of horizontal transport. The nature of the developments are diverse, including such devices as conveyor belts, fork-lift trucks, mechanical barrows, concreting skips, monorail skips, and special barrows for handling batches of bricks or building blocks etc. In Belgium, the Netherlands, Sweden, the United Kingdom and Western Germany the needs of the small builder on the small site are receiving attention and there is a tendency for the production of light, multi-purpose machines.

68. Bulk delivery and storage of cement on building sites is already common practice for large projects in at least half of European countries. It is a practice which is increasing and, without doubt, will continue to increase. A possible hindrance is the fact that the bag of cement has been a convenient and reliable unit of measurement, the capacity of many concrete mixers having been designed on the basis of the number of bags of cement required for a full mix. The implication is, therefore, that a reliable measuring device is now needed at the mixer or at the cement storage hopper. Several countries report that bulk delivery of cement is not making rapid headway on small projects.

69. Bricks account for a considerable proportion of the volume of material to be handled on the building site and, being in small units, are costly to load and unload. If tipped the breakages become serious. In Finland, Czechoslovakia and

the United Kingdom the delivery of bricks in packages or containers is being developed. The packages or containers are made up at the brickworks and are not broken until they reach the bricklayer's working place. Packages of 50 or 60 bricks are regarded as convenient for the purpose. In Finland the practice of delivering bricks in this way is virtually universal; in Czechoslovakia it has attained 21 per cent of all deliveries for a major ministry and is rapidly increasing; in the United Kingdom it is emerging from the stage of pilot development. The experience of Czechoslovakia shows a saving of 10 man/hours per 1,000 bricks handled on site due to packaging, and a reduction of breakages up to 35 bricks per 1,000. In Czechoslovakia it is proposed to investigate the packaging of roof tiles by similar methods.

70. Turning next to the mechanization of processing, in almost all European countries the operation of concrete mixing is virtually completely mechanized or is rapidly approaching that point. The degree of mechanization of the whole process depends upon the scale of operations. In many countries all large sites are already equipped with complete batching and mixing plants. For operations of medium size there is a tendency to standardize on a type of mixer with a dragline scoop for aggregate, so that the feed can conveniently be operated by one man. Accessory operations are mechanized to varying extents but there is a high degree of mechanization on large projects. Bar-bending machines, and mechanical vibrators for placing concrete are the rule rather than the exception.

71. Shuttering and formwork practice varies considerably. In Sweden and the United Kingdom, metal shuttering and adjustable props are gaining ground. In other countries, as for example, Austria, wooden shuttering is used but it is gradually becoming rationalised, in that it is made up in large panels capable of re-use and giving a clean concrete surface not requiring plastering.

72. Ready-mixed concrete, supplied to a guaranteed specification, batched at large central batching plants and distributed by truck-mounted mixers, is gaining ground rapidly in Finland and the United Kingdom. Within a limited radius of operation this appears to be a useful and economical development and is applicable equally to the smallest or largest sites. Ready-mixed mortar for masons and plasterers, mixed at central plants, is normal practice in Finland and Czechoslovakia and is to be further increased. It may be assumed that this would essentially be a process for lime mortars. Where cement or gypsum plasters are added this appears to be a site operation owing to the limited working time of the

mix. In a few countries mortars are mixed mechanically on large sites, but rarely on small ones. Pumps for distributing mortar, which can also be adapted for mechanical plastering have been developed and are in use in Czechoslovakia. This is a field where considerable inventive capacity has been applied over the last three decades but, hitherto, without any conspicuous success.

73. In the field of powered hand-tools there seem to be great differences in the stage of development. Only in the Netherlands, Czechoslovakia and United Kingdom has there been considerable progress, although the practice is reasonably well established in other industries. In the Netherlands a range of electrically driven hand-tools at 42 volts has been developed. In view of the stringent safety conditions required for building sites this is of some interest.

74. In Finland, Sweden and Austria there has been a considerable development of heating devices for building in winter. Oil-fired steam generators and oil-fired stoves for drying new buildings are used. The economics of winter heating for building operations have been studied in Finland where heating may involve an additional cost of 2 to 6 per cent on building operations under adverse weather conditions.

75. In the majority of western European countries the growth of mechanization of building operations is hampered to a greater or less degree by difficulties in raising the necessary capital. Smaller contractors experience the greatest difficulty; large contractors, however, where large permanent installations are envisaged, are hindered by lack of continuity of business which introduces an element of speculation in amortization. Belgium, the Netherlands and the United Kingdom are the only countries in western Europe where it seems that the mechanization of the industry is proceeding on an adequate scale through the operation of normal commercial arrangements, and without any external intervention. In Portugal and Spain, which are not themselves producers of mechanical equipment, the incidence of import duties is a handicap to mechanization of building. The contrary condition exists in Austria, already a considerable producer of equipment, where import duties on heavy building machinery are relaxed. Only in Italy and Sweden has the fear of unemployment been found to be a hindrance to mechanization and in Sweden this attitude has already been largely dispelled.

76. In Sweden a government loan has been extended for the acquisition of building machinery, available only to contractors or contractors' organizations. Loans are made up to 80 per cent of the purchase price of the machine, with interest orginally at 4 per cent and subsequently raised to 5 per cent, and amortization over four years. Considerable use has been made of this facility. In two countries contractors' organizations established arrangements for the acquisition of machinery. In Belgium groups of contractors have set up pools of machinery which they hire to their members; in Italy the national association of contractors has established a finance institute through which their members are able to obtain short-term loans to acquire equipment and tools.

77. Little information is available on arrangements for maintenance and repair of builders' machinery. In many western European countries the larger contractors, many of them with an interest in public works as well as building proper, have highly organized repair and maintenance workshops as a normal adjunct to their business. In Hungary there is an interesting arrangement, in which all major items of machinery are controlled by large organizations, which hire to the contracting organization. The hiring organizations have workshop facilities and carry out major repairs and rebuilding; day-to-day running repairs are made by the contracting organizations. This appears to be a logical solution of a problem which is always present where machinery is used on a considerable scale.

<u>Organization of the process of production</u>

78. It is convenient to consider the production process in three phases: establishing the project and preparing designs and estimates; a preparatory phase in which the execution of the work is planned i.e. where arrangements are made for assembly of labour, materials and machinery; and an operational phase during which construction on site proceeds.

79. In all European countries the basic pattern is the same. The investor instructs a design organization to prepare plans and estimates for the project. In western Europe the design organization is normally modest in size, consisting of architects assisted by specialist engineers, and often surveyors who prepare the preliminary estimates. In eastern Europe design functions are grouped in large organizations (project institutes), who prepare the detailed drawings, specifications and cost estimates. An exception to this method of working happens only where, as is sometimes the case in western Europe, the building enterprise is also the investor, and building is on a speculative basis for sale. Then the building enterprise is

responsible for the design functions, either by employing an architect direct, or by including a design organization as part of its own staff. In the USSR there are a certain number of state institutes which produce type projects, covering not only the formal design of dwellings, but also the methods of carrying out the work. The function of the local project institute is then to develop the type project to suit local peculiarities of geography or climate. In western European countries when the preliminary design and estimate is prepared it is submitted to the investor for agreement. The design is then finalized and in many cases detailed bills of quantities are prepared. Contractors are invited to tender on the finalized design, a specification, and a bill of quantities. In theory the element of competition in tendering is relied upon to control price levels. In practice, under modern conditions, it breaks down when a large proportion of the work is carried out by sub-contractors who may or may not themselves be invited to tender. Often the sub-contract work is allotted on a lump sum basis to a nominated sub-contractor.

80. In eastern European countries the project institute has the task of preparing detailed estimates of cost, which are built up on the basis of nationally or regionally established costs of operations, taking standard unit costs for materials, labour and transport, adjusted as required for local conditions. The investor, furnished with a complete design and cost estimate, then approaches a building corporation which is expected to agree to undertake the work at the amount of the estimate. Some adjustment of the estimate may be necessary and provision is made for arbitration if agreement cannot otherwise be reached. An exception to this method is found in Czechoslovakia, where some of the larger national building corporations have their own project institutes and are therefore responsible both for the designs and for their execution.

81. Many studies have been made of the productivity of house-building in Europe. Committees have been set up in many countries, and official bodies have been created to advise on measures to increase productivity. Two points in particular have figured in the recommendations of nearly all these bodies: first, that design should be complete in the fullest sense of the word, before inviting the builder to tender or to commence work; it has been emphasized repeatedly that the competent builder is unable to organize his own share of the work in the absence of complete details of what is to be done, and secondly, that the divorce

of function between design and execution is to be regretted, but that it is difficult to avoid it when competitive tendering is the basis of the contract. The argument is that the contractors' knowledge of the build-up of costs cannot be brought into play at the design stage. It would seem on the face of it that the eastern European pattern of the project institute, with all the essential participants under one roof, should favour the production of complete design and cost information so that the contracting organization when it takes over is able to plan its operations in detail. Figures are available showing significant increases in productivity since this form of organization was introduced, and this seems to be one of the contributory factors. As to the second point, where in Czechoslovakia some of the project institute functions have been absorbed into the large building corporation, there should be complete co-ordination of function and it will be interesting to know the outcome of this change of pattern in due course. In France, the Netherlands and the United Kingdom there have been important recent developments when all parties to the preliminary stage of design and preparation of a building have been brought into a working team. This has been carried out on a pilot scale up to the present but the results are considered to be encouraging.

82. In Belgium and Spain considerable efforts have been made in the sphere of state controlled housing to simplify and rationalize the administrative and technical procedure leading to the preparation of tender documents and to define the extent of the drawings and information which should be made available to contractors. In Italy there have been difficulties imposed by administrative machinery in issuing permits, licences and the like, in which state and municipal regulations have been involved. It has apparently been difficult to adhere to any time schedule in view of the administrative complications and a drastic change in the national administrative machinery which was hardly within the realm of practical politics. Building in general and housing in particular are normally controlled by a complex series of rules and regulations emanating from the state, from municipalities and public services, to an extent which is not true of other industries. It is a question whether this may not be one of the factors retarding the technical development of the industry. The first element in organization is a strict time schedule of operations, and if administrative procedure makes this impossible it would seem that there is a case for some change in the system.

83. Arising from studies aimed at increasing the productivity of the building industry, there has been an almost unanimous recommendation that before starting

work on site the whole operation should be planned in advance. Site drawings should be prepared showing how the work is to be laid out and where materials are to be stored. Time schedules should be prepared for the various stages of the work; and from these detailed programmes should be drawn up for the recruitment of labour and supply of materials. It would seem that reliable methods should be devised to ensure that the time schedule is maintained during the progress of the work. In most countries this planning operation is the task of the contracting organization. From first principles it is clear that this body should be in possession of full information from the design organization, if the planning is to be accurate and comprehensive. In Belgium, Portugal and Spain such operational planning is compulsory for housing in the public sector. In several other western European countries there is no element of compulsion but it is normal practice with the larger and more progressive firms; yet it is not general throughout the industry. There is good reason to suppose that where this is the case there are wide variations in productivity within the country concerned. In Finland, Spain and the United Kingdom, where national productivity organizations have been set up, particular attention has been given to operational planning; the industry itself has been encouraged to create research and training facilities to further it. In the Netherlands and the United Kingdom specialists in industrial management have been made available to contractors to advise on their operational planning. The general picture in western Europe is one of keen awareness of the importance of operational planning, and of considerable progress already made, yet the practice is far from universal and is hindered by lack of suitably trained personnel. In Finland, Belgium and Portugal, where the rise in housing costs has been kept in check, it is significant that special attention has been given to operational planning.

84. In eastern Europe, where major building operations are in the hands of large national corporations, the functions of operational planning are emphasized and are carried out by project departments in the corporations themselves. In Poland an interesting point emerged. Operational planning was allocated to the project institutes at one stage, but experience showed that there were considerable difficulties and a lack of reality in the programmes drawn up. Subsequently the planning and programming of operations has been taken over by the contracting corporation who have set up special sections for the task. In USSR state project

institutes have been made responsible for development of large-scale type projects, and for these type projects the site organization and methods of carrying out the work are laid down by the institute. This is exactly the reverse of the previously cited case. The general picture is one of a high degree of organization and significant increases in productivity. It may be remarked at this point that surprisingly few detailed surveys of productivity in house-building have been carried out on the national scale. Such limited published data as are available show wide variations in productivity for comparable work by different builders over the same period of time. In one national survey in the United Kingdom, it was revealed that the greatest contribution which could be made to the national housing programme would be to raise the level of the worst sites to the average.

85. Efficiency of site work depends on four main factors:- control of costs; efficient deployment of labour; productivity of labour in terms of human effort; and supervision. Although cost control is regarded by industry generally as a vital function of management, it is significant that in the building industry there is only one example in Czechoslovakia, of an organized section of cost accounting. This is an outcome of the heterogeneous character of the industry. Costs as such are the prerogative of the building contractor; are rarely disclosed; and are not part of the pool of general knowledge in the industry. In most countries a proportion of the larger firms have efficient costing systems which are essential to the conduct of their business. For medium and small firms, however, the methods of costing vary from mere adequacy to the most rudimentary.

86. A large proportion of building site works is carried out by teams of workmen and the performance of the team is at least as important as that of the individual. A major problem of arrangement is to balance the strength of the team to the requirements of the actual job, and this assumes particular importance where machines are used, since the machine regulates the speed of the whole operation. In industry generally much thought is given to the balance of working teams, and time and motion studies are widely used. There is little evidence of the use of time and motion studies in building operations. In Czechoslovakia and the Netherlands standard times for various operations are established nationally by time and motion studies; the subject is included in special courses of training for building management which have been set up in some countries.

87. A variant is the method of assigning certain limited types of work to specialist sub-contractors, who can achieve high productivity by organizing balanced teams for repetitive work. This is the practice in eastern and western European countries though the methods of applying the principle vary. In Poland it seems that specialist sub-contracting may have been carried too far and there is now a trend to bring a larger proportion of the work to the control of the general contractor, though the principle of organizing sections of work in labour groups is still followed. One of the worst features of lack of continuity of demand and existing methods of contracting is the dispersal of skilled teams at the conclusion of a contract.

88. It appears that payment by results in some form or other is still the principal method of obtaining a uniform output of work. Eastern European countries apply the method of piecework at standard national rates and, in addition, special rewards are offered for particularly meritorious work. Information is scanty on the methods adopted in western European countries. Finland and the Netherlands have applied picework systems, with nationally agreed rates, applicable mainly to the proportion of work on site which is amenable to measurement. It is noted in Finland that high piecework rates lead to reductions in overall building times and in real cost. The United Kingdom has adopted a system of bonus payment as national policy, related to measured output in certain cases. It was found in a survey that the higher bonus payments resulted in a reduction of labour cost, but only where the bonus was directly related to output. The subject of payment by results is complex and in many countries there are strong arguments for and against which have to be respected. It would seem, however, that in one way or another the system is a stimulus to increasing productivity. A problem often arises in establishing piece work rates for new or improved methods of construction. It would seem on the face of it that scientific time and motion studies would be the correct solution.

Training of personnel

89. The next question which arises is the training of personnel. At the professional level can be included architects, engineers and those of graduate status who have qualified for managerial positions in contracting organizations. The normal pattern is of architects working mainly in design organizations, either privately or on the staff of public bodies, though a small proportion of architects

are in the direct employment of the larger contracting organizations. Engineers, either civil or structural, with a smaller proportion of mechanical and electrical engineers, work in collaboration with architects in the design organizations; a large proportion of them, however, are employed directly by contracting organizations where they perform the higher functions of management.

90. In the United Kingdom the contractors' organization provides a diploma for men trained primarily in management. Actual figures of the number of men in the professional status in the various countries are rather meagre but it is interesting to record that, in Czechoslovakia, Finland, the Netherlands and United Kingdom the ratio of the annual intake of professional men to the total constructional labour force is not very dissimilar and in the 1957-58 period it ranged from 1:300 to 1:700. In Finland and Czechoslovakia where technical development of the industry is proceeding rapidly the figure seems to be in the region of 1:300 to 1:400.

91. Two points emerge with great clarity. In a large proportion of western European countries there is difficulty in applying modern methods of site organization owing to lack of trained personnel in the "production engineer" category. In Finland there are regular courses of instruction, of four-years' duration, for engineers of this kind. In Czechoslovakia there is a four-year course for production engineers from which a very large number of men graduated in 1958. In the sub-graduate category - junior designers, draughtsmen and surveyors - there are regular courses of instruction at technical schools and colleges in several countries. In a number of western European countries there are special courses of instruction, mainly organized by the industry itself, in higher functions of management embracing modern technical ideas on the subject. These are intensive but of short duration.

92. There is a specialized type of man attached to the design organization who undertakes the physical supervision of work on site on behalf of the investor: in Italy the geometra, in Spain the aparejador and in the United Kingdom the clerk of works. These men receive their own courses of training in technical schools. Their main task in the traditional sector of the industry is to assist the builder to interpret the frequently vague instructions he receives from the design office.

93. In many countries there is difficulty in applying modern technical methods owing to the lack of supervisors with suitable training at general foreman level.

At the same time, in nearly all countries there are regular training courses in technical schools for foremen. Without detailed knowledge of syllabus and numbers of men taking the courses it is not possible to make any definite comment. It seems, however, that the courses of instruction may have been set up when the industry was traditionally based, and have failed to keep pace with the march of events in the technical field. In Finland and Czechoslovakia, great attention is given to the training of men in the foreman category; special schools have been set up for the purpose and large numbers of men go through the schools. In other countries the industry itself has organized special courses of instruction, with short courses for older men, to deal specifically with the higher degree of technological development which the industry is undergoing.

94. In many western European countries entry to the industry is by apprenticeship based on craft training. In most this is supplemented by courses of instruction in technical schools on a part-time basis. In Belgium, France and Italy the intake of workers in the skilled trades has been insufficient and the normal channels of entry do not provide sufficient men for the national housing programmes. In these cases it has been necessary to set up vocational training courses. In France it is reported that a six months' vocational training course, with carefully selected entrants, has produced men who, on passing into the industry, quickly become skilled workmen. The problem of vocational training is one which has received much attention in the ILO and considerable aid has been given to a number of countries.

95. Although the same type of training facilities exist in most European countries, at all levels, the scale of training varies considerably; some countries are making rapid progress. The broad conclusion is that the technical development of the industry in any country is controlled by the number of technicians who are being trained in modern methods.

Trends in the development of building materials

96. The factors influencing development of building materials in European countries are complex. Predominant, particularly in the traditional sector of the industry, are local resources in raw materials. The fact that the usable clays are almost universal accounts for the strong position still retained by the brick and the clay block in all countries where there is sufficient fuel to burn them. Where particularly workable clays exist as in Italy, France and

Germany, there is a corresponding manufacture of more elaborate products of complex shapes and size in the form of blocks and interlocking roofing tiles. Timber of excellent quality for building is found in Northern Europe and has influenced development in the region.

97. The raw materials for cement manufacture are almost universally available and, consequently, cement production is strong in all European countries: cement has the particular characteristic that it is made in very large plants, under conditions of close control, and demanding a high order of technical skill and knowledge. The infinite variety of concrete products which are based on cement, however, do not require enormous technical resources and thus in all countries there has been a progressive expansion of the use of concrete products and this is continuing.

98. The state of industrial development in different countries exerts an important influence. It is only natural that thriving metallurgical industries will seek outlets in the field of building both for the metals and their by-products, and thus in such countries there is a tendency for light metal sections to replace wood both for carpentry and joinery. In addition the great strides in research on subjects such as corrosion of metals make available a wide range of light metal sheet coverings for building exteriors in interesting shapes and colours.

99. In some cases the rapid development of entirely new materials in the industrialized sector of industry leads to a powerful invasion into the building industry. Plastics are typical of this process; in the form of electrical insulation and glues as bases for paints, they have already effected a transformation, and the process continues.

100. Climate also exerts a strong influence on the trend of development. Thus in Northern European countries there is a natural tendency to produce light materials of high thermal insulation as, for example, the lightweight concrete so strongly developed in Sweden. This trend is favoured by the fact that European reserves of "fossil" fuels are not unlimited. The contrary condition exists in Mediterranean countries where massive construction, with a high thermal inertia, is more satisfactory for comfort and for the local living habits.

101. Certain countries have an urgent need to develop their export trade and, consequently, find it necessary to conserve their resources in materials of which they have traditionally been important producers. This has happened in the case

of timber, in Norway, Finland and Yugoslavia, which now find it important to study closely the economical use of timber in building in the same way that has been necessary in the importing countries.

102. In Czechoslovakia and the USSR there is a considerable expansion of clay brick production and gains in productivity in the process. There is a trend in several countries for the brick to be replaced by the larger, hollow clay block for wall construction and this is very highly developed in Italy. In some cases the blocks are designed to "break joint" as a barrier to rain penetration. In Italy, Austria and Czechoslovakia specially designed hollow clay blocks, with grooves into which reinforcement can be placed, are made on a considerable scale for prefabrication of floor beams on the building site. Also in Austria, Czechoslovakia and Spain similar blocks are produced for making pre-stressed concrete floor beams. In Spain there is a strong tradition of building up centering for floors, stairs and vaults in light, hollow clay blocks. This is highly developed and much used but so far as is known, there is no parallel elsewhere in Europe. Its present wide use stems from a shortage of timber for shuttering for concrete, but there is a long tradition behind it. There seems to have been no significant development in the use of clay roofing tiles. In the USSR there has been an important development in the use of ceramic tile facings as a substitute for cement renderings, which had been found to be somewhat deficient in frost resistance.

103. In almost all countries there have been considerable developments in lightweight concretes. This has particular emphasis in those countries where large prefabricated concrete units are being developed, since the potential saving in weight is considerable. Foamed slag from steelworks is being developed as concrete aggregate in the USSR, Czechoslovakia, Western Germany and the United Kingdom. Expanded clay is important only in Czechoslovakia but has been produced elsewhere on a pilot scale. Important experimental work is in progress on the production of concrete of structural quality with lightweight aggregates. Where suitable natural aggregates are available these are also being used. Volcanic rocks, diatomaceous earth and minerals such as Perlite and Vermiculite which latter are expanded by heat to produce materials with high thermal insulation. In Czechoslovakia investigations are being made on the manufacture of lightweight concretes from metallurgical slags other than from ironworks. In Czechoslovakia

and the United Kingdom pulverised fuel ash is processed to make a lightweight concrete aggregate. This is likely to be a developing industry owing to the wider use of pulverised fuel in large electrical generating stations. Furnace clinker is an important lightweight concrete aggregate and is extensively used in some countries. Where suitable clinker exists in quantity it provides one of the cheapest building materials for internal walls and partitions and, with suitable technical control, it can be satisfactory. The production of lightweight blocks and slabs has been highly developed in Sweden. Three main processes have been used and these are licensed for manufacture in several other countries. They depend on foamed, autoclaved, cement mixes and foamed lime-pozzolana. It may well be that the cold winters in the country of origin have been a powerful incentive to the development of strong walling material with the property of high thermal insulation. In several European countries the normal hollow concrete walling block has gained some ground at the expense of brickwork. The adoption of a block of modular dimensions in Belgium has been a contributory factor. The overall picture is one of considerable development in the field of lightweight concretes and where, as in eastern European countries, there is an expanding demand for housing these materials are likely to be increasingly important.

104. The conception of a machine-worked, natural stone block of modular dimensions is the natural outcome of the development of modern machinery for extracting and working a suitable grade of natural stone. For the process to be economical three conditions are essential. First the stone should not be too hard to be worked efficiently by fast operating machines; secondly, whilst not too hard, it should be sufficiently durable for use in permanent buildings; and finally it should occur in accessible, deep beds which enable it to be extracted easily by mechanical equipment. This process is operating in two western European countries: in the United Kingdom on a comparatively small scale and in France where several groups of quarries are being used on a larger scale. The speed and cost of laying the blocks is considered to be satisfactory, using "labour only" subcontractors. In the USSR the method is being extensively studied and production expanded. It is calculated that when fully developed it should be cheaper than brick production and should require less fuel and power. Part of the economy of the process will hinge on finding a suitable outlet for the quarry waste. In the USSR the mechanised production of decorative, natural stone facing slabs is being investigaged. This

has been highly developed in Italy where large deposits of suitable stone exist.

105. Cement production is being considerably increased in eastern European countries with an expanding demand for housing. The general trend of technical development appears to be a steady and progressive improvement of the rate of hardening and of ultimate strength, and greater uniformity. Metallurgical cement is made in Belgium, France, Western Germany and the United Kingdom but does not gain ground appreciably in comparison with the Portland type of cement. This, like foamed slag development, depends on collaboration with the steelmakers. Given favourable conditions the economics of the process would seem to be beyond dispute. Special cements are increasingly available, such as low heat cement for mass concreting in dams and the like, sulphate-resistant cements for industrial use and in soils where sulphates are destructive to normal cement, rapid hardening cement especially devised for precast concrete product production where the economics of the process depend on rapid re-use of moulds. In Belgium the use of chemical accelerators and improved formwork for <u>in situ</u> concrete construction has resulted in highly economical working using normal cement. In the USSR, where cement has to be distributed over very long distances, studies are being made of the process whereby cement is transported in bulk as clinker, the final grinding and introduction of additives being carried out at centres of use. Wet or dry grinding may be adopted under suitable conditions. It is considered that a grinding plant may operate economically at a scale of production of about 30,000 tons per annum. This process has previously been used in France, particularly in connection with large hydro-electric installations, where cement was needed in large quantities in inaccesible localities. The overall picture is of continuous technical development, where the cement industry keeps abreast of the continuously expanding consumption of concrete products.

106. In the USSR and the United Kingdom there has been expansion of production of calcium silicate bricks and walling blocks.

107. In many countries the use of pre-stressed concrete in building is expanding and consequently the use of high-strength steel for reinforcement is increasing.

108. In Belgium and France there has been considerable investment in production of corrosion-resistant light steel sheet, in the form of continuously galvanized strip, and plastic covered sheet. Also in electrically galvanized and enamelled sheet. In consequence of these developments steel sheet is being increasingly

used as a facing material in light panels on elevations and for internal use. Light steel sections continue to develop for windows and frames and door frames. Alloys of aluminium are increasingly used in several western European countries in sheet form for roof coverings and for facings in light wall panels. A wide range of sections are also being developed for windows and frames and for light framing in wall panels and partitions.

109. There is rapid development and expanding use of plastics in housing. In many countries plastic coverings have been extensively used for electric wiring and, indeed, in some countries there has been a complete transformation from rubber and cotton insulation to plastic. In several countries there has been extensive use of plastic piping for cold water services and in Czechoslovakia plastic pipes are also being used for hot water services, and plastic components for central heating installations. Plastics are extensively used for sanitary services and for waste pipes and there have been considerable developments in cheap plastic pipes for sewage disposal (pitch fibre).

110. Plastic laminates are extensively used for roof coverings, either flat or corrugated, for decorative wall linings and for partitions. Transparent sheet is considerably used for roof lighting. There have been major developments in the use of plastic floor coverings in France and the United Kingdom, where a very high proportion of all new housing is finished in this way. This is due mainly to the competitive price at which the material is marketed. The use of reinforced plastic as structural material is developing fast in several countries but, up to the present, has not been used for housing. Subsidiary developments arising from the wider use of plastics are in the manufacture of plywoods and of reconstituted wood products, where plastics provide a glue of great strength and durability. In some western European countries plastic-bonded plywood has become a light structural material of high durability, lending itself particularly well to pre-fabrication of building elements. Plastics are increasingly used as a base for paints; in particular, in some western European countries, the use of plastic-based, water emulsion paints has become frequent. Plastic-based paints are of particular value for painting over cement products, and other building materials which have always been destructive to traditional paints.

111. In the majority of European countries there has been a considerable increase in the production and use of thermal insulation. This is a natural outcome of the tendency to reduce the weight of housing elements and interest attaches particularly

to light insulating materials. Amongst the types of material which are being increasingly used are: fibre glass and slag wool; wood fibre boards; pressed wood-shaving slabs bound with inorganic binders; expanded plastics; and expanded rubber.

Trends in typification and standardization

112. First there is a problem in terminology which needs to be resolved. In normal usage in the United Kingdom, for example, a type plan is often regarded as one prepared by way of example of the kind of plan which meets certain requirements. It is used in a far less restrictive sense than a "standard". In the general European context as used in this enquiry the type plan has a more specialized meaning. It indicates a plan for a building, or section of a building, which is evolved to meet a particular set of conditions or a particular method of construction. For the period of its validity it is accepted in its entirety and is not susceptible of variation beyond prescribed limits. When a plan is prepared and issued by way of illustration or advice, and no more, it will be referred to in this section as a "model" plan.

113. In terms of the completeness with which the conception of standardization of planning is exercised it is possible to distinguish several ways: the first in which type plans are established and followed in detail in important sectors of the housing field; the second in which "model" plans are issued by way of illustration and advice, and where certain rules are laid down for sizes of rooms, standards of accommodation and equipment and heights of rooms; and additionally where model specifications are issued covering the quality of materials and components, and the requirements for workmanship on site. Without exception, one or other of these methods are applied in all European countries in the sectors where housing is subsidized by governments, or entrusted to non-profit making organizations for the erection of low-cost houses.

114. The eastern European countries, to a greater or lesser extent, have adopted the method of typification of planning wherever possible. This applies to the industrialized and traditional sectors alike. Thus in USSR in 1957-58, 83 per cent of all new projects conformed to type plans, with a saving of 20 per cent in cost where the typified designs are compared with individually prepared projects. In Czechoslovakia in 1957 nearly 80 per cent of dwellings were erected in accordance with type projects, and there was a progressive improvement by reducing non-habitable space and increasing amenities. In Poland type plans are formulated for

dwellings to be erected by series production, and type projects accounted for 36 per cent of production in 1958. The remainder of the dwellings follow individually prepared projects but standards of area and equipment are defined and are obligatory; consequently, they have something of the force of type plans. In Hungary in the industrialized sector type plans are formulated for building elements and complete assemblies in sections of buildings. In the industrialized sectors in Czechoslovakia and the USSR the plans of dwellings are typified together with the prefabricated components of which they are composed. Catalogues of components with specifications relating to assembly are then published for the guidance of the organizations preparing detailed projects. Where national type plans are established, the local project organizations have the task of designing the foundations and works below ground to suit site conditions and, for traditional building, they may adjust the type plan for local resources in materials, transport and skilled labour.

115. In the majority of western European countries some variant of the second method outlined above is followed in all state-aided or housing authority projects. In Belgium, France, Ireland, Netherlands and the United Kingdom the responsible Ministry publishes model plans and lays down minimum areas for habitable space and standards of accommodation and amenity. It is noted in the Netherlands that the minimum areas are normally exceeded by 10 per cent. In Ireland 80 per cent of local authority housing and 75 per cent of grant-aided private housing are built in accordance with the model plans. In Spain and Portugal maximum and minimum requirements are laid down for space and equipment in state-aided housing projects. In Spain model plans are published for rural housing but there is no guidance for urban dwellings or flats.

116. The picture which emerges in the public housing sector, either state-controlled or through non-profit making organizations, is that in the whole of Europe a certain degree of typification of dwelling plans is tending to emerge. In western Europe there is a measure of apparent freedom but, in fact, when the scale of accommodation is laid down, and when habitable areas are defined, the range of possible planning solutions is much reduced. This should assure that wasteful and unintelligent plans are rejected and it is the real advantage. The freedom which remains, however, is such that the advantages of close typification as a means of simplifying industrial production cannot be realized. Structural elements and

fittings and fixtures will inevitably be used in such variety that the advantages of large-scale purchase do not apply.

117. Modular co-ordination is assuming greater importance throughout Europe and the eastern countries have all adopted a basic module of 10 cm. Czechoslovakia has adopted a series of preferred multiples, Poland, the USSR and Hungary a preferred multiple of 40 cm. Several countries in western Europe have adopted a basic module of 10 cm. and a basic series of modules is being prepared in Italy. In Western Germany standards have been defined for modular co-ordination on a base of 12.5 cm and this provides the framework for many individual dimensional standards such as storey heights, space utilization, windows and doors. In Finland and the United Kingdom modular co-ordination is being intensively studied. In the United Kingdom a 4-inch module has been provisionally adopted. In France the 10 cm basic module is frequently used; the adoption of preferred multiples is still being debated. It seems that the modular principle is firmly established in the eastern European countries and Western Germany and is being applied in an important sector of the industry in those countries. In western Europe as a whole considerable study is being given to the subject, and application at present is in only a limited field. There must always be certain exclusions where the modular principle is adopted. Thus in Poland sub-multiples of the basic module are permitted for load-bearing structures, and in Belgium the operation of the basic module is excluded for thicknesses of floors and partitions.

118. The basic materials are standardized in the majority of European countries. These include cements, limes, reinforcing steel, bituminous materials for roofing and concrete aggregates. In this category the standards must necessarily relate primarily to quality; dimensional standards are not applicable. These are nearly all cases where strength, stability and fire-resistance are involved and the properties required by the designer must of necessity be controlled; in general the standards are almost universally applied. In the category of partly finished materials, such as bricks, blocks, roof tiles, floor covering materials, drain pipes and steel sections there is a high degree of standardization. Quality is still the main consideration but dimensions begin to be significant in certain cases. In the main the materials in this category are standardized throughout Europe, though the extent to which the standards are applied does in fact vary. Most countries require observance of the standards in the public housing sector.

119. For the more highly finished components such as doors, windows, stairs, cupboards, sanitary equipment, electrical equipment and heating installations, dimensions are of primary importance and to encourage cheap production the reduction in the number of sizes and shapes is important. The two elements of control of quality and limitation of pattern are often combined. In the eastern European countries standards have been prepared for a wide range of materials in this category, and in the fields where industrialized production is being organized the application of the standards is obligatory. In western Europe the tendency is for the application of the standards where they exist to be required in the official housing sector but not outside it. In one or two countries, for example the Netherlands and France, there is a certain measure of standardization by general consent amongst large users for a limited range of components. In general there is opposition on the part of the architectural profession in many countries to the limitation of freedom implied in acceptance of a limited range of standard articles, and standard windows in particular tend to be disliked. One effect of this attitude is that the range of standard articles may be all-embracing; and the standards so numerous that there is frequently no effective concentration of production.

120. In several countries national codes have been prepared covering such matters as computation of stresses, working stresses, heat and sound insulation, methods of use of materials and control of quality of workmanship. Typical cases are the Codes of Practice in the United Kingdom, the National Standards in Western Germany and the Codes in Czechoslovakia and Finland. The extent of application varies but, in general, there is the guiding principle that observance of the National Code will ensure compliance with building regulations.

121. The sector to which standards are applied is a confused subject. There is reluctance on the part of the architectural profession to accept limitation of freedom of choice, scepticism on the part of builders as to the practical utility of many existing standards, and opposition on the part of sections of the materials-producing industry. In some countries the process of standardization in the field of building has been operating for a long time, and the tendency is for a large number of unrelated standards to exist. In Hungary and Italy, for example, there is work in progress to review and revise existing standards on a more rational and co-ordinated basis. Where, however, a restricted range of standards has been deliberately selected and applied by a housing authority, as for example the Sociéti

Nationale du Logeonent (SNL) in Belgium and the National Housing Institute in Spain, the result in terms of cost reduction has been important. Two broad conclusions emerge: first, that standards vary in utility and scope and often are not interrelated; and secondly, that application can only be effective when the investor insists on the use of the standard.

Trends in design of dwellings

122. It has been shown that the technique of building in Europe is developing in many directions, but that reductions in cost of dwellings can only be achieved as a result of the cumulative effect of a considerable number of relatively small savings. The analysis points to the fact that design, considered in all its aspects, is likely to have more effect on costs than any other single factor in the complicated process of house-building. It is significant that government action in this field has tended to be consistent throughout Europe and on the whole it has been successful. The subject can conveniently be considered under the headings of the layout of the plan, the preparation of specifications and contract documents, and detailed design of the structure.

123. The trend towards typification of plans has been dealt with in a previous section. Dwellings have not yet reached the point where they can be considered as industrial products capable of being standardised in the strict sense of the word. The object of preparing type or model plans in most European countries was to improve the design of the dwelling in terms of overall dimensions, shapes and arrangement of rooms, better use of space and the reduction of unusable floor space. This kind of improvement accounts for a large part of the benefits which have been derived from the use of type plans in eastern Europe or from the repetition of certain types of plans reported by many non-profit making organizations in western Europe. It is not merely because they are repeated but because they are objectively better, more carefully studied and more adequately adapted to the purpose intended, that typical plans have been an important factor in cost reduction.

124. Government intervention in this field has been important. In many western European countries such as the United Kingdom, Ireland, Norway, Belgium, France and Spain, the national or local authorities responsible for housing policies have at some stage or another prepared, within their own department or with the assistance of private architects, sets of plans illustrating the possibilities inherent in the existing regulations and incorporating the best available knowledge on a rational

use of the limited space economically possible. The fact that the use of these plans is not compulsory is a consequence of the general administrative or economical arrangements in the country concerned; in fact their use is recommended and sometime imposed as a condition of obtaining financial help.

125. A similar process has been followed in most eastern European countries where, as already noted, special project institutes have been set up to design type plans for most kinds of buildings, including housing. It is interesting to note that type plans were not originally connected with any given system of construction and could apply equally well to the traditional and the industrialized sectors of house-building. The improvements thus achieved have been in some cases remarkable: in Czechoslovakia for instance the proportion of useful floor area to total living area has risen from 42 per cent to 52 per cent.

126. In some cases government policy has gone as far as to introduce and recommend particular types of dwellings which, although perfectly suitable, were either unknown or unpopular in the country. In other instances new types of internal arrangements of rooms, made possible sometimes by space heating or by the central location of artificially lit and ventilated sanitary facilities, have been the subject of experiment in research or planning institutes and gradually introduced into practice. Considerable savings have been achieved both in the internal circulation space (entrance hall, corridor, etc.) and in the external or common access; and through special arrangements, for example, for grouping more than two flats per landing, of serving several dwellings with one lift by balcony type access for stopping lifts at alternate floors. In the field of individual and terrace houses, considerable work has gone into simplified internal arrangements, improved design of staircases in relation to the structural frame and landings and reduction of frontage to save access roads and development of services.

127. Improved specifications and contract documents have been in most European countries the field of successful efforts by government departments competent in housing matters, or by government subsidized house-building organizations, or by research institutes. The great variety of specifications applicable to the same type of work, the imprecise wording of some of them, the fact that traditional specifications did not lend themselves easily to new methods and new materials, were all reflected in the high cost of building. In most European countries governments have realized the importance of the problem and have devoted serious efforts to its solution. Model specifications, simplified forms of contracts,

agreed methods of measuring work and estimates have been studied, tried and issued in almost all of them since the war. In a sense this action has led to greater results in those countries where the traditional system of letting contracts and of carrying out building operation are prevalent. Nevertheless in eastern European countries this necessary work of simplification has led to similar results even if these are more difficult to separate from the effects of the general technical policy.

128. Another factor has been detailed design. By this is meant here all those aspects of design which aim at providing the maximum comfort and satisfaction for the occupant for the minimum cost (both initial and maintenance) to the investor: e.g. thermal insulation, sound insulation and protection against water penetration, humidity and condesation. Thermal insulation has been of serious concern to many European countries, such as the United Kingdom, the Scandinavian countries, the Netherlands, France, Western Germany and the USSR. Apart from raising the accepted level of standards and regulations in this respect, governments have encouraged and supported the study of better and more economical ways of complying with the standards at the lowest cost. New and better ways of reducing sound transmission through the main structure of the house have been developed by public research institutes and brought to the attention of designers. Detailed design features intended to reduce or eliminate the risk of condensation in external walls, of water penetration through facing or roofing materials, the rise of humidity through the ground into walls and floors have been studied and their use widely recommended to the architectural profession in general. Following experimental work on improved design of sanitary installations (especially in connexion with simplified piping and ventilation), on natural and artificial ventilation and on smoke evacuation (shunt flues), on electrical installations (elimination of conduits, grouping of main risers), very often sponsored by public or governmental research institutes, regulations have been improved so that the economies derived from these investigations could be applied in practice.

The breakdown of housing costs and the trend of productivity

129. It would have been useful to complete the discussion of the technological development of the building industry in Europe with data comparable from country to country on the breakdown of housing costs and on the trend of productivity. Unfortunately, the data available are far from sufficient, either in quantity or quality. This last section is therefore confined to a preliminary analysis of the breakdown of housing costs in a substantial number of European countries and to presentation and brief analysis of the scattered data available on trends in productivity.(1)

130. At the request of the Housing Committee a questionnaire on the breakdown of housing costs was circulated to all European countries in February 1957.(2) Information was received in reply from fourteen countries and a preliminary analysis has been made of the data supplied. In addition, since a comparable breakdown of costs was available, data from three typical housing projects have been taken from the European Coal and Steel Community's (ECSC) first programme of experimental building sites: Bochum (Western Germany), Condé-sur-Escaut (France) and Heerlen (Netherlands).(3)

131. The main information requested was the breakdown of housing costs as percentages under the following heads:

- Materials
- Labour
- Plant and equipment
- Site overheads
- Builders' establishment overheads
- Profits, taxes and miscellaneous items.

The enquiry was divided into two sections: breakdown of costs for individual houses and for large apartment blocks. The request was for data on projects which could be considered reasonably representative of practice in the various countries at the time the information was prepared and, consequently, it cannot be regarded as a statistical sample. Despite the care with which the enquiry was

---

(1) See in this connexion HOU/Working Paper No.97 Add.8(d).

(2) See Document ME/44/57 Annex

(3) See "Premier programme de constructions expérimentales", European Coal and Steel Community, Luxembourg, 1957.

framed, there are many aspects where the figures are not, and cannot be, strictly comparable. The following analysis, assuming a reasonable measure of comparability, is mainly tentative and definite conclusions cannot be drawn from it. It does serve to show, however, that if comparability of data could be assured an enquiry of this kind would be rewarding.

132. The results are shown separately for houses and flats in Tables 1 and 2 where they are assembled in order of descending labour costs. Within each country, the trends are the same for flats and individual houses and it is not unreasonable to take all the results for the two groups as a composite sample. The following points arise from an examination of these tables:

(i) The cost of materials is in the region of 50 per cent of total cost, ranging from a minimum of 40 per cent (Austria, house) to a maximum of 63 per cent (USSR, flat).(1) Two-thirds of the projects fall within the range 45-55 per cent which can therefore be taken as representative within the limitations of the present enquiry. The tendency is for cost of materials to assume a slightly higher proportion of total cost in the eastern countries. From the necessarily limited information on the actual characteristics of the dwellings, it can only be said that without exception they are of massive construction and well equipped by modern standards. They vary considerably in the area and volume of space provided, but the method adopted in the enquiry, of breakdown by percentages, reduces the importance of this variable. It should also be noted that the wide variety of constructional methods represented in the sample may account for the varying proportions of materials in different countries. Prefabricated components which, according to the method of analysis proposed, are counted as materials delivered on site, increase the share of materials cost, although they do, in fact, incorporate a considerable part of labour.

(ii) The proportion of site labour cost varies from just over 11 per cent (Hungary, house) to 44 per cent (Austria, house); it would, therefore, be meaningless to show an arithmetical average. However, in nearly half the projects

---

(1) The housing project from the Netherlands, which shows an extremely high percentage of materials cost, can hardly be considered as representative in this respect. General information provided by the Government of the Netherlands shows that the normal breakdown is approximately 60 per cent materials, 25 per cent labour and 15 per cent for plant and overheads, which conforms to the general pattern observed.

the proportion is between 22 and 33 per cent, which can be assumed as a reasonable range. The percentage of labour costs is significantly lower in eastern than in western European countries.

(iii) The percentages of site costs other than labour are much greater in eastern than in western countries. It will be seen that the lower percentage of labour costs in eastern countries is often associated with considerably increased site and plant overheads, which reduces the margin between eastern and western Europe in respect of the other variables. A distinctly different pattern of development can be recognized in the two main regional groups and it would be of great interest if a more detailed comparison could be made. This, however, is not possible within the limits of the data at present available.

(iv) The different definitions currently used in the countries for the separate items of site and builders' establishment overheads, as well as for the allotment of plant and equipment costs, are such that detailed comparisons of these components of cost would not be significant. The comparatively high percentage of site overheads in most projects for which data are available in eastern European countries can be noted, especially in connection with non-traditional methods of house construction. On the other hand, the total of indirect costs (plant and equipment, site overheads and builders' establishment overheads) is significantly higher in eastern European (average 25 per cent) than in western European projects (average 17 per cent); half of them fall within this range.

133. It is doubtful whether the enquiry reveals anything further of significance in the realm of broad principle, and it remains to be seen what can be extracted from the details. It has been seen that there are marked differences in the percentage of cost due to plant and equipment used on site. Projects with a high percentage of plant and equipment cost have a low percentage of labour cost and vice versa. Taking into account that the figures analysed refer to projects coming from different countries and represent therefore widely different structures in the building industry and in economic conditions, it would not be justifiable to consider this variation as a true function of two variables. It is nevertheless interesting to note that, on the average and within the limit of 0 - 5 per cent equipment cost, labour costs are almost 10 per cent lower for projects where equipment costs are 1 per cent higher. This is in broad conformity with what is apparent on building sites almost everywhere, but the trend is so important that it merits more thorough study than is possible in this limited enquiry. Only a detailed comparison of actual costs, expressed in national currency and not in percentages would in fact allow a true correlation to be established between these two factors.

Table 1

Breakdown of Building Costs for Selected Sites
(multi-family dwellings)
(in percentage of total cost)

No.	Project	Direct costs			Indirect costs		
		Materials	Labour	Total	Plant & equipment	Site overheads	General overheads
1	Austria	40.0	41.5	81.5	2.0	2.5	14.0
2	UK (1)	44.7	41.0	85.7	2.0	4.1	8.2
3	UK (3)	44.9	41.0	85.9	2.1	4.3	7.7
4	UK (2)	45.0	40.0	85.0	2.5	4.0	8.5
5	Italy	49.2	32.0	81.2	3.2	3.8	11.8
6	Norway	48.5	30.7	79.2	1.8	19.0	
7	Spain	52.8	30.8	83.1	2.3	3.1	11.5
8	Greece	46.0	29.0	75.0	1.7	10.8	12.5
9	Czechoslovakia (2)	46.0	27.8	73.8	3.1	10.0	13.1
10	USSR (1)	53.9	27.0	80.9	3.5	9.5	6.1
11	Czechoslovakia (1)	52.3	24.8	77.1	2.5	8.9	11.5
12	Poland (1)	55.5	22.0	77.5	2.9	13.0	6.6
13	Poland (2)	52.4	21.5	73.9	3.7	15.5	6.9
14	Hungary (1)	46.8	21.3	68.1	5.0	13.1	13.8
15	USSR (2)	60.1	21.0	81.1	4.4	8.5	6.0
16	Hungary (2)	49.9	20.2	70.1	5.0	13.1	13.8
17	USSR (3)	63.3	18.0	81.3	5.3	7.5	5.9
18	Romania	60.7	14.0	74.7	4.0	13.8	7.5
	Averages	50.7	27.9	78.6			

Source: Information supplied by governments in response to questionnaire.

Notes: See next page.

FLATS

Notes to Table 1

1. Average of several sites, 4 storeys or more. No details.
2. 24 flats in six-storey block. Brickwork, concrete floor, normal equipment.
3. 105 flats in 3 six-storey blocks. R.C. frame floors and roof, precast concrete panel cladding. Tower crane.
4. 28 flats in seven-storey block. R.C. frame and floors, brick clad. Tower crane.
5. 330 flats in 16 five-storey blocks. Hollow blocks, R.C. floors.
6. Average of 3 sites comprising 196, 12 and 16 flats respectively. Two- to four- storey. Brickwork and R.C. walls, R.C. floors.
7. Six storeys with elevators. Brickwork, reinforced ceramic floors. No mechanization.
8. Five storeys. No details.
9. 40 flats in five-storey blocks. Highly prefabricated pre-plastered large panels. Portal crane.
10. Average of 2 sites comprising 48 and 64 flats each, four-storey. Brickwork, R.C. floors, highly mechanized.
11. 120 flats in five-storey blocks. Brickwork, precast concrete floors. Traditional "streamlined".
12. 73 flats in five-storey block. Brickwork, concrete floor. Well mechanized.
13. ditto.
14. 18 flats in three-storey block. Brickwork, R.C. floors, precast beams.
15. Average of 2 sites comprising 48 and 64 flats each, four-storey. Large masonry blocks, R.C. floors. Highly mechanized.
16. 13 flats in four-storey block. Brickwork, R.C. floors, precast beams.
17. Average of 2 sites comprising 48 and 64 flats each, four-storey. Large panels, R.C. floors, highly mechanized.
18. 216 flats in three-storey blocks. R.C. frame floors and roof, precast concrete panel cladding, tower crane.

Table 2

Breakdown of Building Costs for Selected Sites

(individual houses)

(in percentage of total cost)

No.	Project	Direct costs			Indirect costs		
		Materials	Labour	Total	Plant & equipment	Site overheads	General overheads
1	Austria	37.0	44.0	81.0	0.5	1.0	17.5
2	Ireland (1)	49.2	39.0	88.2	2.0	2.2	7.6
3	UK (1)	47.2	37.7	84.9	1.7	4.7	8.7
4	Ireland (2)	55.0	33.0	88.0	2.0	2.5	7.5
5	Greece	48.0	31.0	79.0	0.3	7.8	12.9
6	France	47.0	30.0	77.0	6.2		16.8
7	Spain	56.2	26.8	83.0	2.4	3.1	11.5
8	UK (2)	59.2	25.9	85.1	3.0	3.2	8.7
9	USSR	56.5	25.5	82.0	3.0	9.0	6.0
10	W. Germany	60.2	24.4	84.6	4.1	3.2	8.1
11	Hungary (2)	48.8	21.2	70.0	2.2	14.7	13.1
12	Hungary (1)	48.9	21.0	69.9	2.1	14.8	13.3
13	Romania	54.7	19.0	73.7	1.3	13.6	11.4
14	Netherlands	71.0	18.4	89.4	5.25		5.35
15	Hungary (3)	56.0	11.6	67.6	3.9	12.0	13.5
	Averages	53.0	27.2	80.2			

Source: Information supplied by governments in response to questionnaire.

Notes: See next page.

HOUSES

Notes to Table 2

1. No details
2. Two-storey traditional corporation house, siteworks included. No cellar.
3. 60 two-storey, semi-detached houses. Traditional. No cellar.
4. Average of 253 houses of different types one- and two- storeys. Traditional. No cellar.
5. No details.
6. 50 two-storey terrace houses. Traditional. 1/4 cellar. CECA project.
7. Single-storey, semi-detached house. Traditional. No cellar.
8. 28 two-storey, semi-detached houses. Highly prefabricated internal panels. No cellar.
9. Single-storey bungalow. Prefabricated timber frames and panels. No cellar.
10. 50 two-storey terrace houses. Traditional. ½ cellar. CECA project.
11. Single-storey semi-detached house. Semi-traditional. No cellar.
12. Single-storey bungalow. Semi-traditional. No cellar.
13. Average of 215 houses, detached or semi-detached, single-storey. Traditional. No cellar.
14. 50 two-storey terrace houses. Traditional. Full cellar. CECA project.
15. Single-storey, semi-detached house. Non-traditional. No cellar.

134. Data on the labour content of separate building operations or on total man-hours required on site expressed in terms of a complete dwelling or per unit of surface or volume are available for few countries. For fewer still are there indications of actual trends of productivity over a given period of time. Moreover, the figures available were not collected according to a common method or definition and cannot be considered at all representative or comparable.(1)

135. In Finland the steady decrease in labour requirements for house-building is one of the main characteristics of the evolution of building activity over the last ten years. The number of man-hours per m^3 has in fact decreased from 10 - 11 in 1950 to 5 - 6 in 1958. At the same time, the efficiency of dwelling plans measured by the relationship of total built-up volume to surface of floor space has changed from 5.5 to 4.5. The combined effect of these two factors has compensated the corresponding increase in the cost of building materials and the rates of labour.

136. For Sweden data are available on the number of man-hours of bricklayers, carpenters and general labourers required on site to build one m^3 of building. Over the period 1935 to 1950, the total of these three categories has ranged between 4.9 and 5.5 hours per m^3 although the relative importance of the different categories has varied according to the evolution of building techniques. These figures apply to 3- and 4- storey houses but a clear picture of the evolution cannot be obtained since the characteristics of the buildings (total floor space, ceiling heights, materials used in external walls and structural floors, etc.) have changed considerably. Similar figures were collected on a number of projects in three main towns: Stockholm, Göteborg and Malmo, during three periods: 1948, 1951 - 1953 and 1955 - 1957. The average figure for all sites in the three towns had decreased from 5.1 to 3.5 hours per m^3. The relative importance of labour by bricklayers, carpenters and general labour varied considerably in the three towns examined, but remained fairly constant over the period of time considered. Parallel investigations made by the two largest non-profit housing associations in Stockholm and Göteborg confirm this general trend. Another indication can be obtained from the figures collected every year in the month of August on the number of workers employed on building sites. Over the period 1950 to 1957, the number of workers present per dwelling unit decreased from 0.74 to 0.52, or, expressed in 100 m^2 of living space, from 1.28 to 0.80. These figures refer to multi-family dwellings and include all workers; bricklayers,

(1) The data presented in the following paragraphs have been supplied by governments, supplemented in two or three cases by official publications.

carpenters and general labourers are estimated to represent 80 per cent of the total. Finally, figures relating to the turnover per worker have been collected by the Association of Swedish Building Contractors. Expressed in 1950 prices and in index form, they show an increase of almost 70 per cent over the period 1950 to 1957. It is difficult, however, to appreciate the role of increased productivity alone in these figures since this period coincides with a considerable transfer of work from site to factory, the extent of which is difficult to estimate accurately.

137. In Poland detailed investigations were made in 1956 on the expenditure on materials, labour and machinery on selected house-building sites. The figures, expressed in man-hours per m^3 of built-up volume, ranged from 8.6 hours for traditional construction to 5.8 hours for heavy prefabrication. It should however be noted that in the case of prefabrication site labour represented only two-thirds of total labour requirements; the labour necessary for the manufacture of prefabrication components was estimated at 2.4 man-hours per m^3 of building. The figures collected are consistent with the estimates contained in the official standard price lists for building work prepared in 1949 and in 1955 and 1956.

138. In the USSR, data were collected on a number of house-building sites including traditional construction in brick, large brick blocks, large concrete blocks and heavy panels. The figures, expressed in man-days per m^3 of built-up volume, ranged from approximately 1 day per m^3 for the traditional house to 0.5 day per m^3 for the heavy prefabrication. A day means eight working hours; the dwellings have a habitable floor space of 43 m^2 and a conversion factor of 5 should be applied to express these figures in terms of hours per m^2 of habitable floor area. Better results still have been obtained recently on an experimental building site where through a considerable reduction in the weight of the load-bearing panels only 0.37 man-days per m^3 were required.

139. In Norway figures were collected on four contracts of multi-family dwellings comprised in three- and four- storey blocks, and ranging from purely traditional construction to highly prefabricated building. The number of man-hours required on the building site for the three traditional contracts amounted to 2,600 - 2,700 hours (of which 500-600 comprised labour by sub-contractors) or approximately 30-35 hours per m^2 of gross floor area. For the non-traditional type of construction the total man-hours on site were 930; the number of man-hours required off site for the prefabrication of components are estimated at 200 - 300 per dwelling.

The fact that the contracts were let at different times and that the flats considered differed in area makes straight comparisons impossible. However, figures previously collected on several building sites showed that the number of man-hours per m^2 of gross floor area ranged anywhere between 20 and 35 hours for traditional brick construction, to which another 6-8 hours should be added for work done by sub-contractors. Similar figures were obtained for four person dwellings in timber houses. The range of variation of man-hour per m^2 is still greater in the results of an investigation carried out in 1949-1950 by the Housing Directorate on two-person 1½ storey timber houses with basement. The sample average was 28.7 man-hours per m^2 although the total range varied between 13 and 52.

140. In Czechoslovakia the number of man-hours per dwelling, measured on different building sites ranging from brick construction to medium sized brick blocks, was comprised between 1,340 and 967 according to the type of plan. Expressed in man-hours per m^2 of gross floor area these figures vary between 17 and 15 hours approximately. Similar investigations carried out on plans incorporating the widest range of technical solutions, including the latest development of large panel construction, show that man-hours per dwelling unit range from 1,500 for the G.58 system (large panels) to 2,300 for the traditional brick house. Labour expenditure on site has however decreased considerably, from 1,740 hours per dwelling for the traditional house to 440 hours for the latest type of heavy panel construction.

141. In France a sample investigation carried out on the basis of information freely supplied by contractors on a number of building sites incorporating both traditional and non-traditional methods of house construction showed a range from approximately 1,050 to 2,300 man-hours per dwelling. Expressed in terms of hours per m^2 of useful area it ranges from 19.4 to 41.5. If one site where the labour required was particularly high is eliminated, the average of the sites investigated is between 1,250 and 1,300 hours per dwelling, or approximately 25 hours per m^2 of floor area.

142. In the Federal Republic of Germany investigations carried out in the early 'fifties by the Institut für Bauforschung on 12 building sites showed a range of 21.1 and 35.5 man-hours per m^2 of useful floor area, the average value being around 25-28 man-hours per m^2.

143. In the United Kingdom, several investigations were carried out in the post-war period to ascertain the level of productivity in the building industry, and to

measure the results obtained by the introduction of non-traditional [illegible] of house construction. The figures available show that a traditional [illegible]-storey house of the type currently built by Local Authorities required on the average 2,600-2,700 man-hours on site in the late 'forties; more recent figures seem to indicate a decrease to about 2,100-2,200 man-hours per dwelling. Expressed in terms of habitable floor space, these figures represent an average of 25 to 30 hours per m^2. It should however be noted that one of the main conclusions arising from these studies was that the range of variation between the best and the worst site was extremely high, of the order of 1 to 3. Similar figures collected for non-traditional systems of construction show, for the best of them, a total labour expenditure of approximately 1,500-1,600 hours per house, or 18-20 hours per m^2.

144. The investigations carried out by the International Council for Building (CIB) under the aegis of the ECSC in five countries of the Community in 1955-1957 show a considerable range of variation of the total man-hours required for the erection of a traditional house designed along common lines with a total area of 92-107 m^2. If the Italian site, on which nearly 2,600 hours were required, is eliminated, the four remaining sites (Western Germany, France, the Netherlands and Belgium) show little variation around an average of about 1,600 hours, excluding heating installations. Expressed in terms of hours per m^2 of floor area, the labour expenditure was between 15 and 20 hours.

145. It is impossible to draw clear-cut conclusions on trends in productivity in different countries from the evidence at present available. There are clear indications that in some countries at least pre-war productivity levels have been attained or surpassed; in others, where the building industry was more severely affected by war conditions, this is a target yet to be reached. In quantitive terms, there appears to be a considerable range between the "worst" and the "best" site, at least in those countries where this range was measured. Average or typical figures should therefore be treated with great caution, unless the basis on which they have been established is clearly known. The need for co-ordination of efforts towards a better knowledge of productivity in building and for an internationally accepted definition of the main factors involved clearly arises from the uneven and incomplete character of the data so far available.

[illegible] general trend seems to be established. Assuming that the definitions c[illegible] and useful floor area are known and comparable, and that all man-hours on site have been accounted for, the lower and upper limits of the number of man-hours per m^2 of floor area are in the region of 15 and 40 respectively, with the great majority of what can perhaps be considered as typical cases in the 20-30 hours range. Although direct comparisons are not possible at this stage, it can be seen that the scatter is no greater than that observed between sites in the same country.

Distr.
RESTRICTED

HOU/Working Paper No.97/Add.5
1 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER V

THE APPLICATION OF RESEARCH

1. In this chapter it is proposed to limit the term research to something rather narrower than is sometimes used. It is taken to mean the pursuit of organized knowledge, obtained by scientific and objective methods, on a specific range of related subjects or phenomena. The emphasis is on the use of scientific methods and organized knowledge. As a practical point it is convenient to distinguish what is often described as fundamental research where the object is to elucidate the basic principles and natural laws which govern the behaviour of matter and of animate objects. This kind of research has as its immediate object the widening of the field of human knowledge, and application is a secondary consideration. Sometimes at the level of the practitioner in industry there is a tendency to decry the importance of fundamental research, but it is, in fact, the essential feature of any real advance in technology, though there may be delay before the applications become evident. Applied research, or industrial research, on the other hand, has normally a definite practical objective, but it is still founded on scientific method and demands organized knowledge.

The special problem of the building industry

2. It is generally recognized that in many of the newer industries there is a tight link between research and application. Indeed, it is not too much to say that they are based firmly on research. Aeronautics, electronics and plastics are typical examples, and most developments in the electrical industry are never far removed from their research background. Progress is rapid and continuous. The industries are continually finding new products and new outlets for their products. The reasons are simple; the newer industries work at a high technical level; the designers and producers are closely integrated and the whole tendency is to look forward to fresh development. Furthermore, and most important, these newer industries are developing within a relatively narrow scientific field.

3. The building industry, together with agriculture, is one of the oldest industries in all countries. It is deeply rooted in traditional practices, distrustful of innovations and a large proportion of its personnel work at a low technical level; factors such as beaux arts and craftsmanship assume and exert more importance than scientific technique. Such an industry is slow to see where a programme of research can be useful; it is reluctant to spend money on research for which the advantages are not immediately apparent; and it is equally reluctant to apply the results of research when, as is so often the case, a change in material, organization or method is indicated.

4. Another difficulty stems from the fact that building in general and housebuilding in particular impinge on such an extremely wide field of science. Designers alone are affected by current research in many sciences, and it would be physically impossible for any one person to be a master in more than one or two of them. Consequently, there is a trend towards specialization in particular fields, and this must inevitably continue as knowledge becomes more profound. Happily, the specialists are usually vociferous advocates of research in their own fields of activity and are not slow to apply the results.

5. Next there is the vital question of the interest of the user, the occupant of the dwelling. In the past he has been unorganized, and unable to formulate his needs articulately. He has depended on the investor, through his technical advisers, with governments holding a watching brief in matters of health and safety. Conditions are changing, however, and the occupants of dwellings in many countries are forming associations for furthering amenities in dwellings which already are providing a stimulus for active research into their needs and preferences.

6. Finally, there are many matters where governments are vitally concerned. At certain stages there must be priorities in allocation of investment of capital, in distribution of labour and materials and in the interplay of a number of divergent factors which make up the national economy. Decisions have to be made on questions of national policy, and the tendency is to apply scientific criteria to these decisions. Consequently, at many points it is found that governments are compelled to sponsor research programmes and to enforce the application of their results.

The main types of building research

7. Owing to the diversity of the fields of research relating to building it is neither possible nor desirable to attempt any hard and fast classification. There are certain trends, however, which are common to many countries and certain groups of subjects follow these trends.

8. One of the first subjects to attract and create a considerable body of scientific research was that of the physical and chemical properties of building materials from the point of view of manufacture and use. Such research has been carried out for several decades and a substantial and orderly fund of knowledge has been created. Since manufacturers are vitally concerned, there has been little difficulty in obtaining financial support, and the general outlook of the industry is moving towards a greater concentration of research. This is perhaps accelerated by the competition of new materials which, since they are new, are more likely to be founded on research. Large manufacturers have their own research departments and smaller firms become members of research associations which organize co-operative laboratories. Since the industry itself is interested in research at first hand, there is no substantial opposition to the application of research and practical benefits are not long delayed.

9. Parallel with research on building materials there has been a large amount of scientific research on the strength and stability of building structures. Latterly this has been expanded by extensive research on soil mechanics. The demand for this work is due to the fact that the professional body of users, the structural engineers, work at a high level of technical competence. They are able to state their requirements and can participate and interest themselves in the research; they are eager to apply the results as fast as they are forthcoming. In some instances it could almost be said that practice moves faster than research. The manufacturers of basic materials, such as steel and cement, are equally alive to the value of research and in many countries they support it strongly. There is, moreover, an element of competition between materials. Reinforced concrete vies with structural steel; prestressed reinforced concrete competes with both; light alloys enter into fields where steel was long predominant; and light cold-formed steel sections are widely used. All these factors in combination account for a lively demand for research and for the absence of delays in its application.

10. Financing of research in this category is generally aided by the manufacturers of the basic materials, but the engineering profession, who collectively make up the largest body of users, do not normally dispose of sufficient funds to make more than a token contribution. Contracting enterprises benefit less directly, so that in some countries they give financial support to structural research but, more often, do not do so on any considerable scale. There exists a gap to be filled in many countries, and this is met by financial support from governments, in their capacity of large users, or by setting up government-operated research establishments.

11. There are certain fields of activity where public health and safety are concerned, and where building is subject to control by the State or by municipalities. Examples are sanitation, fire protection and fire resistance. In these fields of activity there is an element of compulsion and regulation which, to some extent, is a deterrent to the formulation of research programmes, but, on the other hand, it ensures application. Manufacturers of materials and appliances are vitally interested and will support and do support research, but there remains a background of topics where it cannot be said that any one section of the industry benefits directly. In the case of research into problems of fire resistance and fire protection, the insurance offices are vitally interested, and in some countries they have provided research establishments, or have contributed largely to them. Being commercial organizations, they have often ensured that the cost of the work is largely recouped by fees paid by the industry for tests and special investigations. In view of the incidence of regulations, which themselves should be based on scientific research, it seems reasonable to assume that this is a field where governments must assume the responsibility for ensuring that the necessary work is done, though not necessarily conducting it as one of their direct activities.

12. Up to this point, three distinct groups of research have been considered. They have the common characteristics that there is a substantial section of the industry interested in the formulation of research projects and equally interested in the application of the results of research. Moreover, the financing of such research presents no insuperable difficulty. The reason why this is the case is the very simple one that the sections of the industry intimately concerned normally work at a sufficient level of technical competence to appreciate the need for research, and are able to apply the results without any intermediate process of interpretation.

13. An important and very diffuse group of research subjects falls under the heading of user requirements. Examples are artificial lighting, methods of heating, heat insulation of buildings, natural lighting, sound transmission, ventilation and use of space. Each subject becomes abstruse and at research level is conducted on a scientific plane. In the case of artificial lighting and heating there are many specialists, and the firms who manufacture and instal the equipment work at a high level of technical competence, organize research programmes and are prepared to contribute to them. The investor, through the medium of his professional advisers, has to discriminate between the competing claims of the specialists and, in addition, to deal with the wide range of subjects where there are no commercial interests to

foster the necessary research, nor to apply the results. Owing to the diversity of topics few, if any, of the participants attain the technical competence to formulate research programmes or to apply the results directly. Frequently governments themselves have set up research organizations which frame the research programmes as well as carry them out, though essentially with the collaboration and support of the professional bodies concerned.

14. There still remains the need for a process of interpretation, intermediate between research and practice, since the practitioner does not attain the technical standard of the research worker. This problem of interpretation of research is common to many countries and can be dealt with in a number of different ways. In the first instance there is a need for the research institutions themselves to go some distance in the direction of interpretation of research to practical requirements. A normal arrangement in some European countries is for work to be published in three forms: first, as research papers for the information of scientists working in the same field; secondly, as technical papers at the level of the professionally qualified practitioners; and thirdly, as bulletins or information sheets for the use of works foremen or leading craftsmen. The disadvantage is, of course, that a lot of additional work is involved in this kind of process and much of scientists' time is taken up which might be better spent in research proper.

15. The dissemination of documentary information is only a partial solution of the problem, and the fact has to be faced that in building, as in other industries, the full application of scientific research will only become possible as the technical level of the participants is raised. In spite of all the handicaps there has been a large amount of research in the last few decades on the user requirements of dwellings, and much of it has found its way into current practice. Two elementary subjects can be used by way of example.

16. Research has enabled conditions of thermal comfort to be defined with sufficient accuracy for design purposes in countries with cold or temperate climates, and knowledge is advancing to the point where tropical needs can be expressed quantitatively. Parallel with this, knowledge of methods of heating and computation of heat losses has advanced to the point where any desired conditions of thermal comfort can be provided. This includes the information necessary to compute the heat losses for any conceivable combination of building elements. In view of the importance of economising in fuel consumption in many European countries this is an important factor in national economy and is of immediate concern to governments.

17. Similarly, research has provided a quantitative background for the assessment of acceptable noise levels in human environment, and a fund of knowledge of the insulation value of building components, and of the ways in which noise is transmitted through a composite structure. Modern life tends to make the reduction of noise increasingly important, and such problems as the siting of airports and noisy industries become urgent and have to be dealt with on a scientific and objective basis.

18. In a final group come the problems of the physical production of buildings. Various factors in production technique have for long been the subject of scientific research in industry generally but, because of the existence of a large number of small firms working at a low level of technical development, the building industry in most countries has lagged behind. Large firms, particularly those working in the public works side of industry, are moving with the times and are able to use modern production technique and to state their requirements for research. The position of the medium and smaller firms is more difficult. They are not able to formulate their requirements for research nor are they technically competent to take advantage of the accumulating pool of general knowledge. In some countries measures are being taken by national federations of building enterprises to organize research on productivity problems; research organizations have in some cases been set up by governments.

19. As with the previous group of subjects, there is the intermediate stage of interpretation of research results which is necessary where an important section of industry is working at a low technical level. The application of existing knowledge is at least as important as the conduct of new research. Typical subjects where the building industry has yet to absorb the scientific method are cost collection, cost analysis, cost control, time-and-motion and method study, organization of the production process, sociological aspects of labour relations, development of machinery and mechanical processes and the organization of work where machinery is used. As in the previous group of subjects, it seems reasonably certain that a full application of research will only become possible as the technical competence of the industry is raised.

<u>Methods by which the results of research are applied in practice</u>

20. The most certain and satisfactory way in which research can be applied in practice is when the results appear in the form of standards, regulations and codes of practice and are written into specifications. The process is automatic and the

person who fails to observe the standard or the regulation does so at his peril and, in effect, puts his limited knowledge into opposition with the accumulated experience and scientific work which has gone into their preparation. Standards for materials and components are based on an extensive background of research into the criteria by which their properties are assessed and, equally, into the standard methods of testing by which such properties are evaluated. Regulations for calculation and design of structures spring directly from scientific research into the strength and stability of building structures.

21. For example, the design of buildings to resist wind pressures was originally based entirely on empirical rules which had accumulated over a long period of time and which bear little or no relation to reality. Both the magnitude and the sense of the forces assumed were far from the truth. In the 1930's the science of aerodynamics made great progress, and research was directed into the field of building with the result that it became possible for the first time to produce a rational basis of design which, in many countries, has been written into the national codes.

22. To be effective it is essential that codes and regulations should be set up in a framework such that revision is sufficiently frequent to enable new knowledge derived from research to be incorporated without undue delay. Failing this, rules and regulations will rapidly become restrictive. Since building regulations have the force of law, it devolves on governments to ensure that the process of framing them is supported by the necessary research, and that the results of research are duly embodied.

23. There are various ways in which the findings of research are incorporated into practice in European countries in the sphere of detailed methods of construction and use of materials. The establishment of national Codes of Practice covering all building operations has been achieved in United Kingdom. The codes cover aspects of design, of choice of materials and of workmanship and represent a large volume of work which devolved very largely on research organizations. In other countries a similar result is achieved by the issue of standard specifications by housing authorities and by the publication of standard details of construction. In some countries type plans, details and specifications are prepared in large design organizations and it can be assumed that in their preparation the results of research are taken into account. In work of this kind governments exercise a

preponderating influence, inasmuch as they control a large sector of the housing industry and have the responsibility of ensuring that the results of research are incorporated in codes, specifications and types, and of organisingresearch in fields where a sound scientific basis of knowledge is lacking.

24. In a number of European countries Building Centres have been established. These often take the form of non-profit making organizations, supported financially by the industry, which have the object of providing up-to-date information to investors and their professional advisers on the choice of materials and methods for the solution of specific problems. These organizations are an important link between research and practice and where successful, they handle a large volume of information. They have the great advantage that they are well informed on the latest state of research, and can give a considerable amount of information on application without taxing the research organizations themselves. Indeed, they are an important element in the function of interpretation of research which has been noted as a major problem. It is interesting that a similar function is exercised in the United States by the regular publication of compendia, as a commercial venture, where the latest technical information on a very wide range of products is set out in a convenient form. This kind of information is almost indispensable in a busy design office.

25. The results of research are disseminated in a mass of literature published by the research institutions themselves, by learned societies and sometimes by government institutions connected with housing. One of the difficulties not always appreciated is the attitude of mind of the scientific research worker. He is by nature dedicated to the factual and precise record of his studies, and any departure from strict scientific accuracy is to be deplored. Unfortunately so many of the researches in progress are of long term, and the ultimate conclusions may not emerge for years. In the meantime the practitioner knows of the work in progress, and requires the best solution of his problem in terms of the information available at a particular moment of time.

26. This is one of the gaps which it is difficult to bridge. The scientist is capable of providing the best answer on the information available, but is so conscious of its limitations that he hesitates to do so. It is extremely important that the scientific data on which research is based should be published for the benefit of other scientists working in the same field. It is equally important that the

ordinary practitioner can find the practical lessons to be learnt from research, and the pattern adopted by a number of countries of publishing research results in a form suitable for different technical levels has much to commend it. The learned societies play an important part, in that research results can be communicated in the form of papers read and a forum of discussion provided. Indeed it sometimes happens that the discussion is as informative as the paper itself.

The use of statistical methods and the role of operational research

27. One of the most striking developments in industrial technology in the last decade or two has been the application of statistical methods to industrial problems. In the field of building, where the range of variables to be considered is particularly wide, the use of mathematical statistics is in many cases indispensable for a programme of scientific research. There are scattered references in European building research to the use of statistical techniques for isolated phenomena such as the evaluation of new methods of house construction, productivity in a particular sector of house-building, sociological investigations, quality control of specialized methods of construction, and for the investigation of certain aspects of dimensional coordination as a basis for standardization. Housing, of all subjects, since it is repetitive and carried out on a large scale and since certain large sectors are under official control, would appear to be an ideal subject for "operational research", which might well yield important results more quickly and surely than could be obtained by other methods.

28. It may be desirable at this point to define the concept of operational research in the particular sense in which it is intended here. An industrial organization, or a department of government, having a programme of work to be carried out in a particular field, carries out that programme in stages according to its plan, but with sufficient statistical control at each stage to enable a scientific and accurate assessment to be made of the results achieved. On this basis, improvements can be carried into the next stage with a high degree of certainty that higher efficiency will result. The environment necessary is a strong link between research and administration, and in practice this is a difficult condition to obtain. Public Housing Authorities, Municipalities with large housing programmes and government departments carrying out housing projects should benefit greatly from operational research in the sense indicated above. The essential feature, however, is that the statistician should be consulted at the start of the operation when the

programme is first laid out. If he is not given the opportunity to consider the plan, the result is inevitably a further mass of uncorrelated data from which no positive conclusions can ever be drawn.

The organization of building research in Europe

29. From the limited information available it can be said that all European countries have building research organizations operating in one or other of the recognized fields of activity. The methods of organization, however, are so varied that no generalizations are possible. In a considerable sector the various branches of the industry have organized their own research activities and support them financially either entirely or with assistance from government subventions. In some cases research organizations are set up at the instance of governments and supported financially by governments but operating as free and autonomous units. In others the research organizations are set up and operated directly by governments though expenditure may be recouped in part by fees paid for services carried out on behalf of firms and individuals. In a few countries where government research organizations exist they are placed directly under the control of the ministry or department concerned with housing, building or public works. In some this is not the case and statutory bodies are created, or research is controlled by departments responsible for general technical or cultural development. The lack of any uniform trend suggests that research has to be fitted into the general pattern most suited to the state of technical development within a country and that no common denominator exists.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add.6
5 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE
(Item 6 of the provisional agenda
of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

CHAPTER VI

SUMMARY AND RECOMMENDATIONS[1]

1. This concluding Chapter consists of a summary of the main features of the enquiry and of recommendations concerning steps which might be taken at both the national and the international level to promote the development of the building industry and reduce housing costs. No attempt is made to provide a systematic summary of the whole report, and attention is focussed primarily on the lessons which can be learnt from Chapter IV on the technological development of the industry.

2. The Chapter falls into two parts. The first consists of the summary of the argument, bringing out at appropriate points such conclusions as can be drawn. The main topics covered are the rôle of the four main participants in and the process of production of dwellings, including the structure, organization and integration of the industry in the widest sense of the term; the special problem of the one-family house and the small contract; trends in the technical avolution of house-building, distinguishing between the various degrees of industrialization and bringing out the crucial importance of the pattern and organization of demand; the consequences of trends and policies in increasing productivity and improving quality; and the application of research. The second part brings out the rôle of governments and also the limits to effective government action;

(1) This final Chapter should be regarded as more provisional than the others. It was the subject of extensive discussion with rapporteurs during a meeting held in Geneva on 20/21 April. The points covered and the general form of the paper were agreed by the rapporteurs but in the time available it was not possible for them to see the actual text.

and the action or further enquiry which appears necessary at the international level. In this second part there is inevitably some repetition of points brought out in the summary but it appears useful to indicate comprehensively the actual and potential scope of government policy in this field. For convenience, the specific forms of international action or enquiry which appear necessary and which have emerged from the enquiry are summarized at the end.(1)

SUMMARY OF THE MAIN TRENDS

The participants and stages in the process of production of dwellings

3. It is possible, as discussed in Chapter III, to distinguish four main stages in the process of the production of dwellings: initiation of the project, design, preparation and organization of production and execution of the project. This survey has shown the desirability of closer collaboration and integration of all four stages.

4. The initiation of the project is the task of the investor. It involves the study of housing needs in the locality, which determines the amount of accommodation of various kinds; the relation of the project with transport and other services; and the arrangements which have to be made for finance of the operation. The general form of the project will need to be discussed with the design organization. The essential thing is that the outline of the project shall be firmly established and that at a given stage, after discussion with the designer, there shall be no further variation. Emphasis must be placed on this aspect since, subsequently, the whole sequence of operations depends on thorough and complete organization at every stage, and the introduction of variations is inevitably the cause of serious increases in cost.

5. The traditional structure of the industry and the way in which the demand is communicated to it have resulted in a divorce of function between the group of operations comprised in design and control, and those of organization and execution of building work. In general, the functions are carried out

(1) This final Chapter should be regarded as more provisional than the others. It was the subject of extensive discussion with rapporteurs during a meeting held in Geneva on 20/21 April. The points covered and the general form of the paper were agreed by the rapporteurs but in the time available it was not possible for them to see the actual text.

separately and independently in place and time. The disadvantages are primarily that design has to be carried virtually to completion in the absence of the intimate knowledge of factors affecting costs of construction which is the prerogative of the contractor alone. The condition is imposed and perpetuated by the system of competitive tendering, despite its advantages in other directions, whereby the contractor cannot be appointed until the design is complete. There has been some interesting tentative developments where the contractor has been brought into the design team in France and the Netherlands, and on a smaller scale in the United Kingdom. An objective assessment of the results obtained would be of great value.

6. The eastern European countries have a different organizational pattern. The functions of design and price control are collected in project institutes, and those of manufacture and erection in contracting organizations; the divorce of function still exists but the contracting organization is known from the beginning of the design stage, so that its advice can be obtained at all times. An exception is that in USSR certain of the larger contracting organizations have their own project institutes. An objective assessment of the results obtained with this pattern of organization would be equally valuable, including full information on the methods of attaining a high tempo as well as good quality.

7. In many countries emphasis has been placed on the importance of having complete information available at the stage where a project is handed over to the builder. All the necessary drawings, specifications, bills of quantities and contract documents should be finalized. It seems that this is an ideal which is not realized in many countries of western Europe, but considerable progress has been made in the public housing sector in some countries where contractual procedure has been rationalized and simplified with significant effects on reduction of housing costs in these sectors. In the eastern European countries the problem is met by a high degree of typification of designs and specifications which are applied in the traditional sector equally with the more industrialized production.

8. There has been emphasis in most European countries on the necessity for planning and programming building operations. Time schedules must be prepared for the introduction of machinery, the delivery of materials, the recruitment of labour in various categories and the attendance of the various specialists and sub-contractors. The correct balance of labour at all stages is important

and, where machinery is used, there is a major problem in adjusting working teams to the output of the machines. An organization must be set up to ensure that the time schedule is maintained and to make the necessary adjustments when there are departures from the schedule. There is a general appreciation in western European countries of the importance of these organizational problems and in many of them the larger and more technically developed firms do, in fact, organize their work in this way. In a few countries there has been an element of compulsion to do so in the government-controlled housing sector, but many countries emphasize the difficulty of adequate planning and control of building operations due to shortages of suitably trained personnel. This is clearly one of the major points where technical evolution depends on training a corps of organizers and supervisors capable of applying modern industrial techniques.

9. In industry in general it is axiomatic that costs can only be lowered by a cost-consciousness at all stages of the production process by the setting up of carefully prepared cost targets for all operations, and by reliable systems of cost accountancy such that deviations from the targets can be detected sufficiently early to enable corrective measures to be taken. It is one of the major handicaps of the building industry that costs as such are only known to the contracting organizations, and that only the larger and more highly developed firms have efficient costing organizations. With the medium to smaller firms costing ranges from the rudimentary to the non-existent. The position is complicated by the traditional structure of the industry where control has been by prices which are often built up in a form where the real cost of alternative methods of carrying out an operation are concealed. An attempt has been made in the United Kingdom to apply price control at the design stage and this offers appreciable advantages, at least over methods of designing divorced from costs and prices.

10. The fact that at government level knowledge is vested in prices and not in costs has made it difficult to obtain effective comparisons on an international level of the costs of various technical methods and processes. It is suggested, therefore, that a pilot investigation covering both traditional and non-traditional construction on as far as possible comparable housing schemes in selected countries should be put in hand, in which expert cost accountants would seek a reliable base for cost comparison between countries. It is evident that if a fair basis of comparison can be found, much benefit will be

derived for all the contributing countries, if for no other reason than that it is obvious to a skilled observer that some things are done much better in some countries than in others and that what is needed is the knowledge of how they do it.

11. Mechanization of site building operations is proceeding rapidly throughout Europe. Earth-moving and vertical handling of materials are completely mechanized in many countries. The mechanization of horizontal handling is proceeding rapidly and many different solutions exist. The problem of the small project on the small site is a somewhat difficult one and the trend towards full mechanization lags in this sector. The tower crane, fixed or mobile, appears to have become almost universal in European countries and interesting studies are in progress in eastern Europe to relate the capacity of the crane with the method of construction in terms of effective loads to be handled. This brings up with some force the important fact that, as the industry becomes more mechanized, detailed design has increasingly to be formed and modified in terms of the equipment which is to be used in construction of the building. The importance of integration of design and construction increases all the time and for this reason the tentative experiences where it has been achieved in a few western European countries will be of the utmost importance. An objective assessment of the results obtained and the difficulties experienced is awaited and, assuming that the results are favourable, it will be an important means of reducing housing costs and expediting the whole process.

<u>The special case of the single-family house and of the small contract</u>

12. It appears that in certain European countries housing developments in the public housing sector have been confined to large groups of apartment dwellings. The need is felt, however, for large-scale development in the form of single-family dwellings and experience is lacking on the methods of organizing such projects. In other countries the main development has always been in the direction of large groups of single-family dwellings organized in large contracts. Because this has always been normal practice it has not been regarded as a special problem and has not been the subject of special literature. In fact, the experience and knowledge exists and the problem is essentially one of exchanging information which in this case could probably best be done by direct contact between the countries concerned.

13. It is likely that the greatest fund of information on the development of the single-family house as a group operation is to be found in the United Kingdom and in western Germany. In the former, for example, the majority of large local authorities have great experience of all aspects of the problem. The points to be emphasized are town-planning, including community sizes and the essentials of community development; layout on site to preserve amenities and to prevent monotony; typical plans and the introduction of variants; the judicious use of development in semi-detached and larger groups of dwellings; sizes of contracts giving the best results; organization of contracts and technical handling of work on site. In all these aspects there are many possible solutions and many pitfalls to be avoided.

14. The nature of the demand is such that there is in all European countries an urban sector where housing projects are larger, suitable for large contracting organizations, and where there is scope and opportunity for a high degree of technical development. Parallel with this, however, there is a substantial sector, equal or greater in size, of rural houses and of individual suburban dwellings, where the contracts to be let are small and where, in the main, they are handled by small contracting organizations who are likely to work at a lower level of technical efficiency. This leads to a duality in the industry of large designing and contracting organizations, working at a high level of technical efficiency on the one hand and a large number of small dispersed organizations, firmly entrenched in tradition on the other. The problem is to raise the technical efficiency of the smaller organizations and to achieve this it may be necessary in many countries to exert a more intensive effort.

15. At the design stage the obvious solution is the adoption of type or model plans, and simplified specifications and forms of contract. Since the use of standard components should, at any rate in theory, enable the small project to benefit from large-scale production, it is clearly important that their use should be insisted on to the limit. In countries where the range of standard products is insufficient, it is desirable that the deficiencies should be made good with the special case of the small project in view. In view of the large amount of housing falling into the category of small projects it may be desirable in certain cases for governments to ensure that investors are kept informed of trends in type plans and standard products and of the advantages inherent in their use.

16. At the erection stage there are certain directions in which the small project can benefit by some concentration of effort. Bulk purchase of basic materials is normal for large undertakings but virtually impossible for the small unit. It is possible that the case could be met by co-operative purchasing organizations which might require government financial aid, at any rate in the initial stages, since the low level of capital investment is one of the characteristics of the small building enterprise.

17. The mechanization of building operations is another field in which the small project is at a disadvantage. The larger operations such as earth-moving are often dealt with by specialized sub-contractors who can move from place to place and, where these are not available, some co-operative organization may be the solution. In eastern Europe the trend is for the work of this kind to be carried out by mobile organizations. For handling of material within the site the trend is in the direction of the development of small multi-purpose machines for the small site and this is in evidence in several countries. Even when the machines are available there remain problems in financing their acquisition and of instructing the small operator on the problems of organization of work consequent on introducing machinery. Government encouragement in the fields of development, financing and dissemination of technical information is desirable in many cases.

18. Bulk delivery of materials benefits the large site but there are difficulties in applying the principle on the small site. Cement is a typical case where in many countries bulk delivery is universal for large sites but rare on small ones. There is a problem in scaling the method down to the needs of the small site and of financing the acquisition of the necessary containers, and this is a subject where investigation and pilot experiment may be profitable, but it may well fall within the province of the manufacturing industries who have developed the method for the larger sites.

19. Ready-mix (transit mixed) concretes can contribute to the solution of the problem of the small site equally with the large one. Materials are bought, handled and batched in bulk to unvarying standards of quality. Developments are rapid in a few countries where they may well become universal within a few years. The assessment of results and dissemination of information might benefit those countries where the method has not yet gained ground. The same considerations apply to the distribution of ready-mix mortars for masons and plasterers though,

in fact, there are certain technical complications which make the problem less simple, particularly for the small site.

Trends in the technical evolution of the house-building industry in Europe

20. The trend of technical evolution in the house-building industry in Europe falls into two main categories. In the first there is a spontaneous evolutionary process by which the conventional site processes become more highly organized, more mechanized, and in which an increasing proportion of component parts of the building are manufactured on a large scale in factories. In the second, which is the pattern mainly adopted in eastern Europe, a substantial sector is created in which the maximum possible amount of construction is carried out in factories, reducing site assembly of factory-made components to a few relatively simple operations. In western Europe, in a limited number of countries, important developments in factory production of dwellings are in progress, but they do not represent more than a small proportion of the total housing programme.

21. The main advantage of large-scale factory production is that a substantial sector of house-building capacity is created which will make the minimum demands on skilled building labour and which will be largely independent of the weather, and where full output can be maintained through the winter months. This is a condition particularly applicable to those countries where there is an expanding demand for houses, and where it can be foreseen that the demand will remain certain for a long period of time. Studies which have been made of factory production of houses in western Europe point to the conclusion that to be economical the factory-made components should be produced complete with finishes, services and points of attachment for fixtures and fittings. This arises from the fact that the major item in the labour cost of houses is in finishings and fittings. The limited amount of information so far available on costs of production of housing by factory methods points to the tentative conclusion, supported by considerations of basic principle, that, in the foreseeable future, there will be no revolutionary reduction in housing costs but that savings in the region of 10 to 15 per cent may ultimately be achieved.

22. In the evolutionary process of technical development there is a tendency for a larger proportion of finished components of dwellings to be made by large-scale production in factories. These developments have resulted in the main from the enterprise of manufacturers, and their introduction has not been systematic. The trend is likely to continue and is desirable because it benefits the small project equally with the large one, and may be one means of

equalizing the difference of technical development between small and large organizations. The criterion which has influenced the development of an increasing proportion of prefabricated components and fittings has been the savings in cost which they have offered. Their use demands a certain discipline, in that choice is restricted to the range of articles available.

23. The analysis in Chapter IV of the main components of house-building costs shows that materials account in most cases for between 45 and 55 per cent of the total. When the degree of prefabrication increases the proportion naturally falls and labour costs are proportionately reduced. The range of variation of labour costs is greater than that of materials, since only half the projects examined fall within the area 22 to 33 per cent. Variations in the other elements of building costs (plant and equipment, site and buildings establishment overheads) could not be examined separately. It can be reasonably assumed, however, that overhead labour costs are frequently associated with high plant and site overheads.

24. This preponderance of materials in the cost of dwellings arises primarily from the large size of a dwelling in comparison with many products of other industries. Consequently, the greatest emphasis needs to be placed on reduction of material costs by skilful planning, avoidance of waste and by continuous study of the problem of reduction in weight of materials. There are possibilities of substitution of massive materials by lighter ones, but the tendency in many cases is for the substitutes to be too costly for use in low cost house construction. There are, however, many cases where new materials in the shape of floor coverings, pipes, sanitary fittings and the like have enabled cost reductions to be made under appropriate conditions.

25. The rapid development of new materials and components for building and of improved ways of using existing materials gives rise to two problems which should repay further investigation. One is an examination of the economics of using new materials or improved forms of traditional materials, particularly within the context of weight reduction; the other is the devising of ways and means for the investor or his professional adviser to find the most suitable combination of materials and components in a particular situation. This is dealt with in various ways in different countries, sometimes by the preparation of "information sheets" in a common format which can be indexed and filed; sometimes through organizations which have been created in a number of countries,

known as Building Centres, where an investor or his architect can obtain up-to-date and reliable information on the most suitable materials or components for particular purposes. The volume of enquiries dealt with by organizations of this kind indicates the real need which they meet. Such organizations are frequently non-profit-making but obtain financial support from manufacturers. It seems likely that such a dissemination of what is basically catalogue information would be valuable at the international level and indeed steps in this direction have already been taken by the CIB. It may well be, however, that further efforts could be made.

Trends in the direction of increased productivity

26. The survey has shown that technical developments in the house-building industry are considerable. Improved design, organization of operations and mechanization have had an appreciable effect on levels of productivity and costs. There remains, however, another almost over-riding consideration, usually described as the human factor. Productivity of labour has been investigated in detail in some countries and there are published reports of surveys which show that within a country, or within a district, there are wide differences in the level of productivity for similar classes of work. In some western countries use has been made of variants of payment by results, which are universal in eastern Europe. The use of scientifically operated time and motion studies is rare, but their value in setting up agreed rates should be great. In addition, time and motion studies are vitually indispensable for certain gang operations using machines in order to attain a correct balance of labour.

27. In addition to monetary incentives there have been many improvements in the conditions of work in the European house-building industry. Much of the more physically arduous work on the building site is now done by machinery and this has been an important factor in maintaining production. Holidays with pay, payment for working time unavoidably lost by bad weather, canteens and cleaning facilities on building sites, revision of regulations for safety at work and a variety of social services have tended to close the gap between working conditions in the building industry compared with industry in general. There remains, however, in countries with a liberal economy the major problem of discontinuity of demand, with the result that labour is dispersed at the conclusion of a project, leading to a high rate of transfer of labour between employers and uncertainty of employment. There are also strong tendencies in some countries to seasonal

variations in employment, and seasonal shifts of labour from building to other industries. The conclusion is that lack of continuity of demand is the major factor causing the house-building industry to be at a disadvantage in comparison with other industries as regards security of employment of labour. This is a matter which can be dealt with fully only by action at government level.

28. It has been shown that such productivity measurements as have been carried out on the building site reveal considerable variation between the "best" and the "worst" inside a country or even on a particular site. When average figures are available, however, they appear to be grouped around 20 to 30 man-hours per m^2 of floor area. Quantitative indications of the effect of one single factor on the number of man-hours required on site for any given operation are scarce and rarely comparable. There is no indication of any significant reduction so far (taking both the site and the factory in combination) as a result of the introduction of non-traditional methods, although site labour is considerably reduced and also overall building time. The lack of comparability of data so far available derives from the fact that the methods used have varied widely. Since in many cases these methods have not been fully described, it is not always clear whether the data available relate to averages, to selected samples or to well or badly organized sites. There would appear to be scope for international agreement on methods of collecting and expressing productivity data, and this is a point which the Housing Committee may wish to consider.

<u>The problem of maintaining and improving the quality of dwellings</u>

29. In all European countries there has been marked and continuing improvement in the quality of dwellings over the last few decades and certain minima have come to be accepted as the norm for all sections of the population. The fact remains that the higher quality now demanded has increased the cost of dwellings and indeed if all recommendations were brought into effect the total cost increase would be unmanageable. The increasingly complex problem for the investor is to find a mean between what is desirable on the one hand, and what is possible on the other. Quality in a dwelling is a vague term but it can be considered in its essentials as a complex of requirements for amenities, for aesthetics and for workmanship.

30. Research has provided quantitative criteria for the range of human needs and methods of quantitative design of buildings which enable the needs to be satisfied; but it cannot foot the bill. Physiological and social studies lead

to formulation of requirements for minima of space and methods of using space. Physiological studies enable sanitary and hygiene standards to be laid down. There is a wealth of information on desirable conditions of daylighting and of admission and exclusion of sunshine which affects orientation and fenestration of dwellings. The standards of comfort for heating are generally recognized for the different countries, and the methods of providing the heat and reducing heat loss by thermal insulation are known. There is a general phenomenon in most European countries of rising energy costs which makes the problem of heating and heat losses an important one. It is becoming axiomatic that increased expenditure on thermal insulation of buildings can be equated with fuel savings over a short term of years but the investor has to pay for the insulation and the occupant derives the benefit in the form of a reduction in cost of heating. It is sometimes difficult to persuade the investor to approach this problem in a way which ultimately may be to the national advantage and it is the task of governments to set the standards at a suitable level. Provision of certain minimum facilities for cooking and storage depend on national living habits and customs. The ordinary householder can appreciate at once the advantages of clean, convenient equipment. Smooth, clean surfaces are required for walls and floors, and modern trends in decoration open up interesting possibilities for imaginative treatments which enable monotony to be avoided without materially increasing costs. With this requirement must be included ease of cleaning of all surfaces and the minimum of cracks and fissures which may harbour dirt and vermin.

31. The aesthetic quality of a human environment is clearly of major importance, but can hardly be examined in this enquiry. It is fortunate that high aesthetic values rarely, if ever, derive from expensive accessories and finishings. Europe can show many groups of dwellings which remain grim and uncompromising though dotted with trees and children's playgrounds. But there are others which are imaginative and human from their inception. Aesthetic satisfaction derives from an investor who is sympathetic to aesthetic quality and a designer who possesses the talent of imagination coupled with human sympathy. It seems to be one thing which can rarely, if ever, be attained by government action.

32. Quality of workmanship is always at odds with high levels of productivity and minimum costs. Much can be done by simplicity of design to avoid intricacies of detail which call for much time and craft skill on the site. There is a tendency in some countries in dealing with new methods of construction in dwellings

to tolerate imperfections in workmanship which would be quite inadmissable with conventional methods of construction. Badly fitting components, rough and irregular surfaces, unpleasant and clumsily covered cracks at the meeting points of structural elements are all to be seen from time to time. It is usually considered that faults of this kind will be eliminated when the production process is fully developed but it may often be a long time before the point is reached.

SOME RECOMMENDATIONS

The effects of government action and methods of administration of housing on the technical development of the building industry

33. In most European countries a considerable proportion of housing development is partly or wholly under government control. In some cases, as in countries with a planned economy, the governments fulfil the rôle of investors, designers and contractors. In many western countries governments support housing development by loans or subsidies and in the public sectors they are able to exercise a large measure of control. Consequently government action may materially aid or hinder the technical development of the housing industry.

34. The survey in Chapter IV has shown that technical development in the industry is highly dependent on housing demand. In particular continuity of demand is a prerequisite for higher efficiency and cost reduction in many directions. Large-scale development of factory production is impossible unless the conditions can be established of scale and continuity of operation sufficient to amortize the considerable investment in machinery and equipment. The survey shows clearly that progress in this particular field does, in fact, depend on government intervention to ensure continuity of demand, and in the two countries in western Europe where large-scale developments are in progress government support has been provided. In eastern Europe the governments are providing the investment in machinery and equipment for the large-scale of factory production of dwellings and by virtue of the fact that the developments are part of a national plan the essential feature of continuity is assured. Thus the creation of a new sector of house construction, where the aim is to carry out the highest possible proportion of the work in factories or workshops, requires intervention by governments. In a liberal economy means of ensuring a sufficient scale and continuity of operation have to be assured and this necessarily involves government action. In a planned economy these conditions are automatic.

35. The survey has shown that, parallel with large-scale factory production of dwellings, there is a progressive evolution in the industry towards the incorporation of new materials, new methods of construction and higher standards of design and organization. This is a complex process in which many factors are involved. Here again it is clear that continuity of building operations is desirable if progress is to be made quickly, and in a few countries of western Europe there

have been major projects organized to enable continuity of building operations to be given a working trial. Since a radical change of administrative procedure is necessary to attain this condition of continuity in a liberal economy it can be achieved only with the support of governments. In the interests of technical progress and reduction of costs it is desirable that the results of the trials already made should be assessed, and that governments could encourage and, if necessary, promote further developments of this kind. In countries with a planned economy the necessary conditions are fulfilled and, already, significant advances in productivity have been attained.

36. The survey has shown that the mechanization of the housebuilding industry is proceeding fast in all European countries and that it has been an important factor in combating the general rise in housing costs. In a few countries mechanization has been considered adequate through the normal channels of commerce, but in many of those with a liberal economy the industry has found difficulty in obtaining the necessary finance for the acquisition of machinery and equipment. Government loans have been made in some cases at moderate rates of interest to enable contractors to purchase equipment. In view of the growing importance of mechanization this is another case where governments can contribute by ensuring that the latest developments are made widely known and, where necessary, by assisting the industry to obtain finance. In a few countries the incidence of import duties and taxes are a handicap to mechanization of the housebuilding industry and governments might consider whether revisions are desirable. As has been shown earlier the small contractor working on a small site gives rise to special problems.

37. This survey has shown that there is a progressive evolution in the use of factory-made components for dwellings, due primarily to savings in cost by large-scale production, and that this is a process which benefits the traditional sector and the more industrialized sector alike. Large-scale production, with its resulting economies, depends on the reduction in the number of sizes and shapes of products and to achieve this the processes of typification and standardization are essential. Much has been done in this direction in European countries but there are difficulties in obtaining sufficient observance of the standards in some of the countries with a liberal economy. Governments in many countries have gone far to enforce the adoption of standards in the sector of housing which they control; this is a case where consistent government action

is needed in all countries to promote the preparation of good standards which do in fact limit excessive variation in shapes and sizes, and to ensure that the standards are observed in housing under government control. In many countries a system of standards has been devised. In others certain standards have emerged over the years in which there is a lack of relation of dimensions, and at some stage revision will be necessary. Modular co-ordination, which is developing rapidly throughout Europe, may provide the framework for relating dimensional standards and governments will have an important function in promoting and assisting these developments.

38. The survey has shown that cost savings can be achieved only as a result of a large number of technical improvements, many of them small in themselves, and that a major factor is avoidance of wasteful planning and design of dwellings. Governments in most European countries have done much by preparation of "type" or "model" plans and by rationalization of specifications and contractual procedure. Continued efforts by governments in the preparation of types and models, and in the enforcement of their application, is important.

39. In many countries the evolution of the industry to a higher technical plane is hindered by severe shortages of suitably trained personnel, particularly in the functions of higher management of building operations and of scientific organization and control of work. Some have already set up courses of training to meet this need. Since technical development is largely conditioned by the personnel available, special emphasis should be laid on training for the building industry. Governments, through their control of educational policy, have a particular responsibility to the house-building industry, which is in a state of rapid technical evolution. The training of operatives was initiated in most countries at a time when technical conditions were relatively stable and methods were devised to produce a succession of craftsmen following a fixed pattern. With rapid changes in materials and technique there has appeared a continuous demand for operatives with new skills. The expansion of housing programmes has often overloaded the normal methods of training and special arrangements have had to be made. Governments have the responsibility of revising methods of training to meet changing conditions, and in some cases it may be necessary to break away completely from the normal pattern.

40. The house, as opposed to many industrial products, is the subject of a complex of rules, regulations and administrative procedure. Central governments,

local authorities and statutory undertakings all may exercise control in certain spheres and at certain stages. To some extent this must be regarded as inevitable, but where administrative processes interfere with technological development they can be a real cause of maintaining an unnecessary high level of cost. Governments should keep administrative procedure constantly under review with a view to simplification and rationalization. This is a case where an international enquiry might be instituted on a limited scale into the pattern of building regulations and administrative processes and, in particular, the methods by which new techniques are admitted into current practice.

41. A part of the administrative machinery which may weigh particularly heavily in certain cases is the question of payment and settlement of accounts. In many countries the public authority is a large investor and equally has the reputation of being a bad payer. It does not default but it often happens that the whole process of scrutiny of accounts, of checking and counter-checking, which are desirable in the public interest, can be prolonged unreasonably, with the result that the contractor is compelled to make a surcharge to cover himself against the interest on capital tied up unnecessarily. Although the investor is often unaware of the fact, he may actually be incurring an unnecessary expense on this account. Simplification and rationalization of procedure in these matters may often be rewarding and the impetus to do so will often need to come from governments.

As has been shown in Chapter V, in all European countries governments play an important part in formulating research programmes and organizing and financing building research institutes. House-building is affected by developments in a wide range of sciences, yet the industry works at very variable levels of technical competence. Consequently there is a considerable field of activity where the application of scientific research tends to lag and where its advantages and possibilities are not realized. It is in this field that government intervention is most useful, either in setting up establishments directly or indirectly operated by governments, or by providing a stimulus so that the industry itself can organize its own research. In view of the importance of the inter-play between research and practice as a means of raising the technical level of the industry, there are clear advantages in many countries in securing conditions in which the industry itself assumes a major responsibility for its research programmes. The tendency is for the administration of housing to be closely associated with scientific research and in many European countries the executive departments concerned with housing are responsibile for the activities of research organization. The fact remains, though it is rarely admitted, that administration and research do not always work well together in harness. Governments have therefore the task of finding ways and means of bridging the gap.

Possible forms of international action or further enquiry

For convenience the main recommendations made in this Chapter concerning possible forms of international action or further enquiry by, or under the aegis of, the Housing Committee, are now summarized briefly. These recommendations do not necessarily relate to possible work by the Housing Committee. Some of them would require the active collaboration of non-governmental international organizations; others might more appropriately be pursued by other international organizations.

(i) There would appear to be scope for international agreement on methods of collecting and expressing productivity data on building. There would also appear to be a real need for a pilot investigation covering both traditional and non-traditional construction in as far as possible comparable housing schemes in selected countries in different parts of Europe, in which expert cost accountants would seek a reliable basis for cost comparison between countries (see in this connexion HOU/Working Paper No. 101);

(ii) the problems arising as a result of the changing relations between the main participants in the building process have been analysed in this report. It would be valuable to assess, with the help of the governments concerned, the experience in certain countries in which the building organisation has been brought into the design team. On a more general plane, further enquiry would appear useful into experience so far in integrating design and construction, particularly as a result of or associated with the growth of mechanization; this might be done on a case-study basis. In any investigation of this inter-related series of problems, the active co-operation of the international non-governmental organizations concerned would be essential;

(iii) there are various aspects of the field of standardization and modular co-ordination which require further action, follow-up or supplementary enquiry. Reference is made in this connexion to document HOU/SMC/Working Paper No. 8, which sets out as a basis for examination by the forthcoming ad hoc meeting on standardization and modular co-ordination recommendations which might be made to the Housing Committee. The suggestions put by the rapporteurs to the ad hoc meeting are not reproduced here but whatever conclusions may subsequently be reached by the Housing Committee should be regarded as part of or related to the conclusions drawn from the present enquiry;

(iv) a major conclusion is the importance of education and training of personnel for the building industry at four different levels: professional, management, supervisory on the site and the building crafts. There would seem to be ample scope for international exchange of experience in this field primarily through the Specialized Agencies and in particular the ILO (see in this connexion HOU/Working Paper No. 99, Annex, pages 19 and 20).

(v) direct exchange between countries which have special experience in particular fields and those seeking further information on a particular subject would appear to be useful. One example is the building of single-family dwellings;

(vi) there would appear to be scope for an examination of the economics in different countries of using new materials or improved forms of traditional materials, particularly in the context of weight reduction; it should also be possible to promote greater dissemination at the international level of the kind of information made available in some countries through Building Centres, with, it is suggested, the assistance of the CIB (see in this connexion document HOU/Working Paper No. 101);

(vii) there may be scope for an international enquiry on a limited scale into the pattern of building regulations and administrative processes and, in particular, the methods by which new techniques are admitted into current practice (see in this connexion document HOU/Working Paper No. 101);

(viii) this enquiry has been concerned with government technical policies in relation to cost reduction in the whole of Europe but special problems arise in this field in less industrialized countries. Reference may accordingly be made in this connexion to the current work of the Housing Committee, and in particular the recent decision to promote seminars on on selected topics (see in this connexion the provisional agenda of the Housing Committee's eighteenth session, E/ECE/HOU/81, Item 11 (i) (a));

(ix) throughout the whole enquiry the scope for international co-operation and interchange of information in developing government policies designed to reduce the cost of building has been brought out. The discussion has been largely on the basis of Europe as a whole. There would also appear to be ample scope for co-operation and exchange of information between groups of countries with problems in common. The Housing Committee should be in a position to intensify its efforts in this field."

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add.8 (a)
28 May 1959

ENGLISH only

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

NOTE ON FLUCTUATIONS IN DANISH BUILDING ACTIVITY AND THE PROMOTION OF WINTER BUILDING(1)

prepared by Mr. N. SALICATH (Denmark), Rapporteur

In this note an account is given of efforts made in Denmark to extend building activity throughout the year. This problem is generally posed as one of winter building; in other words, measures taken to counteract climatic obstacles to building in the winter months. It is also related, of course, to wider efforts to achieve a fuller utilization of the production capacity of the building industry. In the past the main objective of promoting winter building has often been to relieve winter unemployment. The main consideration, however, in the present note is to reduce housing costs. The point of view is taken that the approach should be to a certain extent the same as to other forms of waste and lack of efficiency in building. Like in the other work aimed at promoting the efficiency of the building industry, the purely technical questions are only one aspect of the problem; the organizational aspects in the widest sense, including pre-planning of the building process of the individual building project, co-ordination of all the contributing forces, the financial and economic conditions for a smooth building rhythm etc. are at least of equal importance. Accordingly, purely technical problems associated with winter building will be mentioned only where necessary to give the background.

It should be made clear at the outset that the basis of achieving a higher utilization of existing production capacity is a production programme of a size which will enable the continued full utilization of labour and the other production resources throughout the year; otherwise the result of winter building may be to delay unemployment from the winter period to the good part of the building season.

---

(1) Owing to its provisional character, this version is being circulated in English only. New material will be added and revisions made as necessary in the final version.

There are countries in which the adjustment of seasonal fluctuations in the building industry has made greater progress than in Denmark. This is true for example in Sweden and several eastern European countries where more or less regular winter building is carried out during hard but fairly constant winter conditions. The rather regular commencement, duration and character of the winter - frost with little downpour and often without wind - have facilitated the extension of winter measures in these countries. The problem is very different in countries with constantly variable winters - where measures taken often prove to be either insufficient or superfluous - and with rain, wind and slush as the predominant features of winter. Denmark is a characteristic example of such a climate, and this note must therefore be expected to have special interest to countries in which similar conditions prevail.

Seasonal Fluctuations in Building

In Denmark, as in some other countries, activity in the building and several other industries is characterized by considerable variations of a seasonal character, i.e. variations which in principle are of an annually recurring rhythmical character. The variations manifest themselves among other things in considerable annual recurring fluctuations in the rate of unemployment and employment.

Average Seasonal Unemployment in Denmark 1947-50

	Number of members contributing to the unemployment funds on January 1 1952 (in thousands)	Seasonal Unemployment: In terms of workers employed throughout the year — Number of workers employed throughout the year	Seasonal Unemployment: In terms of workers employed throughout the year — Expressed in percentages (total unemployment equals 100)	Seasonal Unemployment: Expressed in percentages of the number of members of each occupational group
Agriculture	37.7	4.7	12.6	12.4
Excavation	74.8	10.9	29.4	14.6
Building	55.1	5.0	13.5	9.1
Industries and trades (other than building)	327.7	10.7	28.7	3.2
Transport by land	36.8	2.5	6.8	6.8
Transport by sea	7.3	0.3	0.9	4.7
Other trades	114.8	3.0	8.1	2.6
Trades and industries	654.2	37.1	100.0	5.7
of these:				
unskilled labour	243.5	25.4	68.6	10.4
other labour	410.7	11.7	31.4	2.8

With the monthly unemployment rates of organized workers within various trades and industries as the basis, the above table shows seasonal unemployment, here defined as the difference between the average annual unemployment and the lowest unemployment in the year.

It appears from the table that the building industry accounts for about 14 per cent of the total seasonal unemployment among organized workers, whereas the number of workers in this industry represents only about 8 per cent.

Apart from agriculture and excavation the building industry shows relatively the highest seasonal unemployment.

Seasonal unemployment in other trades and industries is concentrated first and foremost in the stone-working industry, the pottery industry, the glass industry, and the chemical industry and is to a certain extent caused by fluctuations in the building industry. Seasonal fluctuations in the building industry are consequently of great importance to others than the workers directly employed on the building site. The direct and indirect contributions of the building industry to seasonal unemployment may be estimated at about 50 per cent of total seasonal unemployment among all organized workers.

The seasonal unemployment does not, however, occur in the same degree within the different building trades.

The highest seasonal unemployment occurs among bricklayers and bricklayer's assistants, whereas it is somewhat lower as regards carpenters. Joiners, plumbers, pipe fitters, and electricians in the slack season of the building industry have a possibility of obtaining employment in other fields and have therefore substantially less seasonal unemployment.

Painters have until recently had a very high seasonal unemployment, but in recent years it has been greatly reduced. To a certain extent this can be ascribed to a very active propaganda on the part of the painters' organizations, but the development has also been greatly encouraged by provisions introduced a few years ago in the Landlord and Tenant Act, according to which certain shares of the rents were set aside for internal maintenance, including painting, white-washing, and paperhanging.

Reference is made to Appendix 1, concerning the monthly employment rates of the building trades 1954-59.

Seasonal fluctuation of employment cannot be completely evaluated from the variations in the activity of the building industry. There are differences for example between the seasonal unemployment of the individual building trades and there are difficulties in singling out one trade as representing the building industry.

Monthly surveys of investments in building would be a better expression of movements in the economic activity of this section, but in Denmark investment surveys are made only once a year. The number of <u>completed</u> dwellings is of slight value as the basis of a description of the trend of economic activity (a great number of completed dwellings may be attributed to the fact that they were nearly, but not fully completed shortly before the winter season - and a small number may be attributed to the fact that final completion does not take place until just after the end of the season).

Surveys of the volume of building under construction - which also include building sites on which work has stopped in the winter period - are of no value either. Surveys of the volume of building begun in winter does not either give a reliable expression of the volume of winter building, partly because the work may be reported as started, even if it is not actually continued during the time which follows.

Causes of Fluctuations

The causes of fluctuations must primarily be sought in the climatic conditions, which make it difficult to carry out building during the most unfavourable winter months, without advance measures which increase expenses.

As regards Denmark, it is not only cold and snow, but equally rain, wind and lack of light which make building in the winter months difficult.

Furthermore, the wide climatic variations characterize not only the course of a single winter, but also the interrelationship of the different winter seasons.

Long periods of constant temperature conditions occur rarely in the winter period, as greatly varying temperatures with frequent freezing point are characteristic of the Danish winter. By way of example it may be mentioned that the average number of freezing point occurrences in the month of February is about 30. Very low degrees of cold are relatively rare; on an average there are only 12 days every winter with temperatures lower than 5 degrees centigrade below zero. The time of the first frosty days also varies greatly from year to year.

This means that the necessary measures must be taken and advance planning made early and at a time when it is not at all certain that such measures will be necessary to the full extent or will prove to be sufficient in the coming winter season.

The seasonal fluctuations are hardly exclusively attributable, however, to the present technical and economic difficulties connected with maintaining work on the building sites throughout the winter months.

In the course of years a traditional attitude has arisen within the Danish building trades which, virtually irrespective of weather conditions of the individual years, causes building work to stop in the first winter months, November and December, and work to resume in the spring months, March and April.

This traditional attitude towards winter building, apart from the real difficulties connected with building in the winter months, is to a certain extent due to the unpredictable course of the winter which was described above.

Other factors, however, have also contributed to creating this traditional attitude. It may be mentioned for example that the previous relatively slow increase of housing demand did not make the full utilization of the productive capacity necessary. It should also be remembered that the simple technique previously employed with modest mechanical equipment on the building site made a production lull of 2 or 3 months a year less economically strained.

In this connexion it may be mentioned that the smaller sizes of the individual building projects and the ineferior technical standard of the houses in the years before the last World War resulted in an average building time of 9 to 10 months for the construction of blocks of flats, which was fairly compatible with the traditional winter standstill. Another cause of seasonal fluctuations is the lack of joint management of the whole building process, which makes a common effort within all trades considerably more difficult.

Moreover, the advantages connected with winter building primarily benefit others (contractors, artisans, workers, unemployment insurance funds etc.) than those who finally have to pay the extra expenses (the owner of the house, the tenants).

The wage systems of the building trades may also have a certain influence. The system predominantly used in Denmark is payment at piece-work rates. In principle this form of payment will encourage workers to greater efforts than payment by the hour. In this respect the system has, however, the drawback to the workers that they will not get higher wages for a certain piece of work, even though it is carried out under the more difficult conditions in the winter. To the contractors, on the other hand, the system has the advantage that they need not pay increased expenses for wages connected with the lower output in the winter.

In this connexion it might be noted that the Danish unemployment relief is relatively high compared with many other countries (it is up to 35 per cent of full wages); obviously the size of the relief may in some degree influence individual needs to seek continued work in the more difficult winter season. It may also be mentioned that in Denmark it is usual among workers that both husband and wife have employment. It is obvious that this will mitigate the effects of a building worker's winter unemployment.

In the opposite direction is the influence of the Danish taxation system. The Pay-As-You-Earn system according to which the tax is retained at the time of payment of wages is not used. The tax is paid regularly throughout the year irrespective of whether the worker has actually work at the time in question.

Finally, the extent of seasonal fluctuations should probably be seen in connexion with the general employment level of the country. For a number of years Denmark has had a relatively high unemployment level (on an average 10 per cent a year for all trades), and this fact probably influences the attitude to seasonal unemployment. The volume of building in a given year will be automatically reflected in the extent of winter employment, irrespective of what efforts are made in other ways to promote winter building. The decisive influence of uncertainty about continuing employment possibilities for the workers' attitude to winter building - as well as to their attitude to all other measures aimed at promotion of a more effective production - should be emphasized. It is often emphasized by representatives of the workers that they cannot be interested in working under the unpleasant conditions in the winter if the result is only to shift unemployment to the summer period.

Background of Efforts to Promote Winter Building

As a result of the greatly reduced building activity during the last World War there was in Denmark, as in most other countries in Europe, a large accumulated housing demand which required the full utilization of the production capacity of the building industry.

The work started to increase productivity of the building industry, naturally included the question of promoting winter building. This was all the more well-founded as there was often a peak production in the summer months. By means of winter building there was a possibility of a real increase in production, without an additional peak load with the consequent danger of inflationary pressure.

According to the latest calculations made on the basis of the seasonal unemployment 1948-57, the seasonal loss in the building trades for organized skilled building workers and the bricklayer's assistants may be estimated at about 5,000 workers employed throughout the year, a loss which corresponds to 14 per cent of the total seasonal unemployment mentioned in table 1.

To this must, however, be added the seasonal unemployment among the organized unskilled labourers who excavate and do concrete work in direct connexion with building. It is possible to make only a very rough estimate of this group owing to the structure of the Danish unemployment statistics. Furthermore, some workers employed in the building trades are unorganized, especially in the rural districts. A number of small master builders should also be included in the total supply of labour in the building trades. The seasonal unemployment of these groups may be estimated at the equivalent of about 2,500 workers employed throughout the year, so that the total seasonal unemployment amounts to about 7,000 or 8,000 workers employed throughout the year. This corresponds to the number of workers required for the construction of about 10,000 dwellings, which is equal to about 50 per cent of the number of dwellings constructed in a year in the postwar years. To these figures must also be added the unemployment and seasonal fluctuations within the part of the industry which as mentioned above is dependent on the building trades, an unemployment which it is not possible to indicate in reliable figures.

Economic loss resulting from winter unemployment in the building trades includes the following factors:

a) Workers' lost wages as a result of unemployment.

b) Employers' loss by idling, consisting of a reduced and irregular production with less intensive utilization of plants and capacity.

c) The owner's loss as a result of an extension of building time over a period which is longer than technically necessary.(1)

---

(1) The workers' lost wages may be roughly estimated at 1,500 - 2,000 Danish kroner per worker, or a total of about 130 million kroner. The similarly lost gross profit of the building firms may be estimated at about 50 million kroner. The owners' increased interest expenses etc. as a result of the extended building period is of a magnitude of about 10 million kroner, to which is added the loss resulting from delayed letting of the dwellings. From a social point of view must further be added the economic drawbacks as well as others which result from a lower output and a smaller turnover generally.

The estimates of the total figures in connexion with winter unemployment are of course rather uncertain. They show, however, that by a complete elimination of winter unemployment (which is of course theoretical) it would be possible to obtain economic savings amounting to about 200 million kroner, which corresponds to 1/5 of the annual investments in new housing in the recent years, or about 4,000 dwellings annually.

Another consequence of winter unemployment is the increased expenses for unemployment relief by the public authorities. These increased expenses may be roughly estimated at about 30 million kroner annually, an amount which is transferred in the form of taxes from other consumption sectors to the unemployed building workers by way of compensation for lost wages.

It should be restated that the basis of the views expressed in this account is that if a building programme of such a size is to be carried out the full utilization of the production capacity is ensured throughout the year. If this is not the case, a winter building programme means that labour is made available for the building industry which should be employed in other fields.

Is it technically possible and economically advantageous to build in the winter period?

The Danish National Building Research Institute, immediately after its establishment in 1947, took up the subject of winter building on its research programme. Supported by practical observations on sites during winter construction experiments in the years 1947/48 - 1949/50 the necessary basis was laid of ascertaining that irrespective of the Danish climate it is technically possible to carry out building in the winter period, and that the necessary measures are of such a kind that winter building would result in advantages from several points of view.

It was further ascertained that the measures which should be taken are normally of a relatively simple character and as regards most of them do not exceed what can be demanded according to general good building practices.

Without going into details as to the character of the individual measures which ought to be taken, the importance of two points should be specially emphasized; that the measures are taken in good time, and that all measures are carried out throughout the winter.

The requirement that winter building should be prepared in good time implies not only that the measures should be taken before there is a chance of the commencement of winter, but also that the measures should be prepared from the very start of planning of the building project. Regard should be paid to the choice of structures so that such are selected which can be built in the winter. All working operations on the site should be thoroughly planned beforehand. If the work on the site will have to extend over several seasons, the whole winter building should be prepared before the first winter. It is of decisive importance that there is close co-operation between the projecting technicians and the contractors in this respect.

To ensure that all measures can be carried out to the extent necessary throughout the winter, the necessary permanent equipment and materials (covering material, heaters etc.) should be ready from the start. In a country with unstable winters it will necessarily vary from year to year to what extent the apparatus is actually used.

When it is emphasized that rather simple measures are involved, it should be explained that the measures in connexion with housebuilding aim only at making it possible to continue outdoor building, so long as the temperature does not fall more than 5 degrees centigrade below zero. These measures should ensure that the completed work is protected, and while the work must stop under harder frost than mentioned, the work can be resumed at once when the temperature rises again to 5 degrees centigrade below zero or more. This limitation has been chosen, firstly because the expenses of winter building in case of lower temperatures will often increase so much that the measures will in most cases prove to be uneconomic - at any rate in case of normal housebuilding - and secondly, as previously mentioned, because there are only 12 days on an average during the winter in which the temperature is below 5 degrees centigrade below zero.

Winter building experience until now shows that the increased expenses connected with winter building, subject to the limitations mentioned above, may be estimated not to exceed 4 per cent of the amounts of the contracts for excavation, concreting, and bricklaying, i.e. the part of the building which is affected by the winter measures.

Of this amount, the fixed expenses connected with the preparation of measures which should be taken whether the winter proves hard or mild, are about 1 per cent of the building costs which are affected by winter building. The remaining 3 per cent are variable expenses which are incurred during the winter. More than half of the 3 per cent is for heating and ventilation during internal plastering.

Since the contracts which are affected by winter building amount to about 40 per cent of total building costs, which in turn amount to about 80 per cent of total costs of construction, it would appear that the increased expenses connected with winter building under climatic conditions and a building technique as in Denmark are very modest. These expenses should be compared with the economic profit which winter building gives the owner of the house. This consists in saved interest on building loans owing to a shorter building period and to a certain extent in earlier income, as the house can be put into use earlier.

As regards Sweden, more extensive and recently made observations on building sites during winter construction situated in the Stockholm area show that expenses twice as high as in Denmark should be expected. The expenses for drying in direct connexion with internal plastering again account for about 50 per cent of the increased expenses. The somewhat higher expenses in Sweden are accounted for by the somewhat colder winter climate in the Stockholm area which leads to higher heating expenses.

Measures taken by Public Authorities for the Promotion of Winter Building

The fact that there has been some uncertainty as to the economic advantages and disadvantages of winter building and the fact that the advantages do not always and chiefly benefit the same parties as those who have to pay the expenses, together with the traditional attitude towards winter building, make it difficult for winter building to be accepted as economically advantageous.

It has therefore been necessary for the public authorities to take an active part in order to bring winter building over the initial difficulties, but it is still uncertain if and when winter building will be able to hold its own. Measures which the public authorities have taken in order to promote winter building have consisted chiefly in: research work; administrative measures towards public and publicly subsidized building and building the commencement of which is dependent on a building permit; financial support of general educational and propaganda work, accompanied by special suggestions from the authorities to those in charge of building work; financing of a special advisory organization for winter building.

In the following special mention will be made of these various measures.

After the Danish National Building Research Institute had completed its winter building research, the Institute published a number of directives, reports and special papers on various technical and economic conditions in connexion with winter building. Reference is made to the list of litterature in the appendix of this note. All the publications have been prepared in such a way that they have aimed at a practical guidance of owners, contractors, architects and engineers etc.

In connexion with the intensification of the work for winter building, which started at the end of 1958, the Ministry of Housing has chosen about 10 building sites on which state buildings are erected, and it has been ordered that - besides the measures which are generally required - all known winter measures shall be taken. The work on these sites, which are considered experimental sites for winter building. is closely watched, and the aim is among other things to obtain a more exact knowledge of the economic conditions in connexion with the carrying out of winter building. A special report on the work on these sites will be prepared.

Concurrently with the educational work of the Institute, the Ministry of Housing, by means of its administration of Government loans for housing, provisions in force as to special building commencement permits and public building works, has been actively engaged in the promotion of the greatest possible winter building in these forms of building. Since 1950 the Ministry has with a few years' interval published appeals to the various parties of the building industry to support the seasonal adjustment of the building industry, chiefly by transferring certain repairs and maintenance work to the winter months, and by ordering state buildings in winter.

Realizing that winter building, in spite of efforts of the public authorities and the propaganda work carried out in several quarters, had not so far gained sufficient acceptance, the Ministry decided in the autumn of 1958 to intensify the work of promoting winter building. The background was among other things the very large building jobs which were ahead: in housebuilding, where a greater number of dwellings is required to meet the housing demand of those born in the years with a big excess of births and to carry out comprehensive slum clearance; in public building, where big building projects will be carried out among other things for schools and scientific research; and in private commercial and industrial building, where large investments in building are required, among other things in order to make the industries ready to meet the expected international competition.

A departmental circular of 5 December, 1958, contains a full set of rules relating to the measures which are taken by the Ministry of Housing with a view to the promotion of winter building. In certain respects these rules are, however, supplemented by additional administrative measures, which will be mentioned below.

As regards State-subsidized housing (building carried out by means of Government loans or State guarantees or working subsidies in cash) the position is as follows:

The efforts of the Ministry manifest themselves in the first place in the form of promises of public aid given at a rate which promotes an even distribution of building activity throughout the year. As regards some of the promises, they are further subject to the proviso that the building work must not be commenced until a later time (late in the summer). Furthermore, it is a condition of the promises that the work shall be carried out as winter building. Whereas formerly this condition implied only that a few simple measures fixed in the agreement between the employers' organizations and the trade unions ("measures based on agreement") should be taken, it is now laid down that a number of other more extensive measures shall be taken. The details of these requirements (which do not apply, however, to one- and two-family houses) appears in Appendix 2.(1) The requirements have been worked out in co-operation with representatives of the employers' organizations and the trade unions and the Building Research Institute. Their aim is that such measures will enable the building processes to continue until 5 degrees centigrade below zero is reached.

In order to ensure the pre-planning of the building process in the winter period, it is also required that when the owner invites tenders for the building work in question, he shall make it a condition that the tenderer binds himself to undertake winter building, including the carrying out of the extensive winter measures, whereas the cost of the measures, demanded by the owner, must be fixed by an individual agreement.

As regards the State-subsidized housing, the Ministry further tries to make the winter building easier by means of financial benefits. Whereas the expenses for the "measures based on agreement" are supposed to be included in the approved costs of construction of the building project in question, all expenses connected

(1) Not attached to this version.

with the extensive winter measures may be entered in the accounts as a special item of expenditure(1). In order to partly offset these expenses from increasing rents to any appreciable extent, the State grants in the first 10 years' life of the house a subsidy for the payment of the interest expenses connected with the winter measures.

As regards housebuilding which is constructed without Government aid, the Ministry has appealed to the parties engaged in building to take extensive measures to a similar extent. It has further been suggested that before the commencement of the building work the owner shall secure all the necessary working documents and schedules. As regards the State-subsidized housing, this has been secured in advance by a demand for total planning before commencement of the building work.

For public building (the building of the State and the municipalities and certain other forms of publicly subsidized building), the same instructions are put through as for State-subsidized house-building, namely that extensive winter measures shall be taken, and that this shall be a condition in the invitation to submit tenders. As regards building works of the State, the owner pays all expenses connected with winter building, and it is recommended to arrange the matter similarly as regards other public building works.

As regards public building, it is further required that the working basis of the building work shall be ready in good time - not less than 1 month - before the commencement of work. The requirement as to the working basis implies that the main drawings, detailed drawings, description, and time schedule are completed, that all necessary negotiations with building authorities etc. have been completed, and that a plan has been made of how it is intended to carry out the winter measures. It is further assumed, that the owner or his representative, by negotiation with the municipal authorities, has ensured that water supply pipes and sewers have been laid and roads have been made or will be made in due time in relation to the time schedule of the building project.

---

(1) So far this has only applied to 2/3 of these expenses, but experience has shown that contractors and master builders were reluctant to undertake winter building if they had to pay the remaining one third of these expenses themselves. The owner therefore now pays all these expenses.

The requirement as to a complete working basis, which compared with normal building practice must be considered a rather far step, has been inserted in the departmental circular at the direct suggestion of the representatives of employers and workers of the building trades, who have called attention to the large rises in prices and delays connected with later alterations to the project which are often caused by a defective working basis. This measure, which on the whole creates the basis of a rationally planned course of building work, is of importance also in respects other than winter building and emphasizes what has formerly been said about the connexion between the efforts for winter building and for promotion of effective building generally. While this measure is compulsory only in the case of public building (and in case of State-subsidized housing by means of the requirement for a total project which was also in force previously), the Ministry has recommended that it should be observed also in other forms of building.

Both as regards public building works and such private building which are dependent on a special building commencement permit[1] in case of large building projects the permit will normally be subject to the proviso that the start of the work shall be postponed until a certain time in the late summer, but that on the other hand it shall be commenced within a certain short time-limit. (As mentioned above similar provisos often apply also to State-subsidized housing.) The purpose of this is to secure that the building work shall make such progress that excavation is completed before the slush of the autumn commences, and that the bricklaying or the assembling is started before the winter commences. As to the question of time for the commencement of building works, experience shows that the owner's interest in continuing with the work during winter increases considerably when the work has proceeded so far before winter that an appreciable part of the capital involved has already been invested, interest on the capital being paid also during a standstill. It is also evident that interest in protecting the work already done increases the longer the work has proceeded ahead of winter.

Finally it has been laid down that all repairs and maintenance works on State buildings must as a rule not commence until after the 1st of October. The Ministry appeals to the municipal authorities to observe the same rules. To all other owners and managers of residential and commercial properties it is recommended to postpone repairs and maintenance to the winter months.

---

(1) At the present time this applies especially to offices, shops, store-houses, and filling stations.

In connexion with the administrative measures aiming at promoting winter building, it should be mentioned finally that the institution, "Byggeriets Maskinstationer A/S" (The Machine Pool of the Building Industry Ltd.), which was founded a few years ago for the purpose of renting machinery and gear to owners or master builders, has bought this year a considerable number of winter boilers and heaters in order to meet the increased demand for them which is a consequence of the more stringent demands by the Ministry for winter measures.

With a view to making all parties engaged in building understand the necessity of winter building and providing them with knowledge of its practical aspects and in order to bring about the necessary change of mentality in this respect, the Ministry of Housing in co-operation with the employers' organizations and the trade unions took the initiative in 1952 in the setting up of "The Building Trades' National Propaganda Committee on Seasonal Adjustment", which included representatives of all the interested institutions and organizations. This central committee appointed a number of local propaganda committees throughout the country.

The propaganda work which assumed several forms, e.g. posters, stickers, films and lectures etc., was financed by equal subsidies from the employers' organizations and the trade unions in the building industry. This propaganda work continued until there arose a difference of opinion during the negotiations between the employers' organizations and the trade unions in the autumn of 1955 as to the carrying out of certain measures aiming at continuation of winter building. As a consequence of the differences of opinion co-operation in the central national propaganda committee broke up. After the discontinuance of the national propaganda committee there came a general weakening of the propaganda work in the local committees which continued their work.

Since it was realized, however, that the propaganda would not be very effective, and would also become much more expensive for the individual local committees, if it should be carried out only locally, efforts have continually been made to resume a centralized national propaganda. At the end of 1958 a nationwide winter building meeting was held, in which all the interested organizations of the building trades, representatives of the local propaganda committees, the public authorities and the recently established institution "Byggecentrum" took part.

"Byggecentrum", which was founded in November 1956 on the initiative of the Ministry of Housing in collaboration with the most important organizations of the building industry has as its object to carry out educational and propaganda work aimed at popularizing measures for the promotion of productivity in the building industry.

At the meeting it was agreed to let the central propaganda and educational work pass to "Byggecentrum". The work will now be financed by equal subsidies from the employers' organizations and the trade unions of the building trades.

In 1950, in continuation of its practical winter building research, the Danish National Building Research Institute established an advisory organization. Through the advisers the Institute placed its experiences in winter building at the disposal of interested owners.

As from the winter of 1951/52 the advisory organization was taken over by the Ministry of Housing. Since then the organization has been maintained by the Ministry, which has paid the expenses connected with the work of the organization. The advisers, each of whom has his local district, provide throughout the winter free advice and guidance to the individual owners, the projecting technicians and artisans and contractors on the preparation and carrying out of winter building measures.

Summing Up and Conclusions

As in a number of other countries, building in Denmark is one of the fields in which seasonal fluctuations make themselves most felt. This implies an inappropriate utilization of production resources and thereby checks the efforts to meet the housing demand to the greatest possible extent. It may mean losses to the owner and therefore to the tenants owing to greater costs of construction (greater amounts of interest on building loans, later putting into use of the house), in any case to the workers (lost wages), and to the employers (losses resulting from poorer utilization of the plants etc. of the building firms). In Denmark it has been estimated that by eliminating winter unemployment in the building trades it will be possible to obtain economic savings corresponding to about 1/5 of the annual investments in new housing or to about 4,000 dwellings annually. From a social point of view, the economic and other drawbacks which result from a lower output and a smaller turn-over generally should also be considered.

Unstable employment conditions are a deterrent in the recruitment of labour to the building trades and increase unduly migration of labour, which lessens possibilities of establishing a more permanent tie between workers and a single employer, desirable among other things in order to preserve groups that work well together.

Seasonal unemployment has also considerable effects on other industries, especially the building material industry. This results in a poor utilization of the productive resources of this industry. Altogether, the direct and indirect contributions of building to seasonal unemployment is estimated at about 50 per cent of the total seasonal unemployment among all organized workers. Large unemployment further affects the whole economy, resulting in a smaller output and a smaller turnover.

It will appear from this that the fight against seasonal unemployment is desirable both with regard to dwelling and other production and for economic and social reasons.

The causes of seasonal fluctuations in the building trades lie not only in the winter weather itself. Climatic causes depend not only or primarily on frost and snow, but rather on rain and wind and the unpredictable course of the winter. Causes of seasonal fluctuations are also to be found in the traditional attitude to winter building, which was easier to tolerate in periods in which the housing demand was considered to be less urgent. A number of other features which have been and to a certain extent are still characteristic of the building industry and its organization have also contributed to seasonal unemployment. Among other things may be mentioned: the lack of single management of all building processes on the site, which has made a concerted effort by all trades difficult; a relatively limited use of mechanical facilities which in itself compels a firmly prepared working system; the lower technique of earlier times, which in itself resulted in a shorter building period easier adaptable to seasonal fluctuations; the smaller size of the building projects, which also contributed to a shorter time for the completion of the individual projects. A number of social and economic circumstances also play their part, for example the general employment level affects the extent of winter employment in the building industry. Expectations and uncertainty as to the future employment possibilities may influence the workers to prefer work in the summer and unemployment in the winter. The wage systems in the building industry also play their part. The piece-rate system has the advantage to the contractors that they shall not pay increased wage expenses for slower work in the winter. The extent and the form of unemployment relief are also of importance. Finally, the fact that it is primarily others than those paying the expenses who obtain many of the advantages connected with winter building has made its general acceptance difficult.

Other efforts are made of course to increase productivity of the building industry. The question necessarily arises that winter building should be part of the effort of increasing productivity in order to meet the large existing housing demand and in order to counteract loss and waste from the winter unemployment. The advantage would be that it would be possible to obtain greater production without creating a peak load and inflationary pressure in the height of the season. The question of seasonal adjustment in this respect is on a par with the objective to establish greater mobility between the trades as well as geographically.

Experiences derived both from research and practice show that technically winter building can be carried out without very extensive measures and with the possibility of economic balance if the increased expenses are compared with the savings gained by avoiding a standstill in winter. As to technical problems, it is pointed out that winter building does not decisively change the choice of materials, structures, or working methods, apart from the fact that during projecting some regard should be paid to the choice of structures which can most easily be used in winter weather. This may be done among other things by the use of prefabricated building components. It should be emphasized that a wider use of prefabrication and standardization will promote winter building, as a greater part of the work will be transferred from the building site to workshops where the workers are more independent of the season.

Mechanization in itself will also promote winter building, both because the working processes are made easier and speeded up, and because the use of expensive machinery presupposes that it is effectively utilized throughout the time it is on the site. This in turn presupposes that the building process is fully planned in advance, an essential condition for the carrying out of winter building. It is also of decisive importance that this thorough preparation of the work is done in good time, right from the first stage of projecting, and that the work is planned in close co-operation between owners, projecting technicians, contractors, artisans and workers.

The purpose of planning is not, as it is sometimes maintained, only to get the roof put on before the winter. Allowance is not made for a better distribution of building activity throughout the year by trying to complete all bricklaying or assembling in the summer period. The building work should have reached only so far before winter that the excavation is completed before the autumn mosture, and that bricklaying or assembling has commenced. If the building work has proceeded relatively far, the owner's interest in winter building will be stimulated since he has already invested a great part of his capital in the work, and a great part of the structures has been made which requires protection.

The work should be closely watched all the time, and the necessary plants should be established on the site in advance. Experience shows, however, that in case of low degrees of cold (more than 5 degrees centigrade below zero) which happens only rarely, it does not pay to continue building work as regards ordinary housing. Everything should be prepared, however, so that the work already done can be protected and the work resumed at once in case of sufficiently high temperature.

An important factor is the workers' sympathetic co-operation. This depends in a high degree on whether they are given the best possible conditions to relieve the disadvantages connected with work in the winter. It is very important that their sheds are satisfactory, that it is possible for them to dry their working clothes, and that they have rainproof and windproof working clothes.

So far there has been some uncertainty as to the economy of the winter measures. The expenses connected with more extensive measures are normally estimated at being between 2 and 4 per cent of the amounts of the contracts which are affected by the work. The expenses for the permanent plant account for the one per cent, whereas the remaining 3 per cent is for variable expenses incurred in the course of the winter. More than 50 per cent of these expenses are for heating and ventilation during internal plastering. The use of building methods which do not require plastering seems therefore particularly advantageous for winter building.

Apart from these technical, economic and organizational factors, winter building is dependent on a number of conditions of a more general character. It is necessary that there is an even and stable financial basis. In connexion with the laying down of the general economic policy of the country and the drawing up of investment and building budgets, it must be ensured that there is a possibility for a sufficient continuity. Some long-term planning of building for some years ahead is also essential, both in order to secure favourable conditions in the building industry in the long run (among other things, the possibility of writing off as depreciation winter equipment in the course of a reasonable number of years), and in order to create confidence in future employment which is necessary in order to obtain the workers' sympathetic co-operation.

Active steps which have been taken on the part of the public authorities concentrate first and foremost on the following:

The Danish National Building Research Institute has undertaken rather extensive research into problems of winter building. Full winter building is performed at the present time on a few selected building sites belonging to the State with close observation also of the economic consequences.

Through its administration, the Ministry has attempted to promote winter building in various ways. In a departmental circular, issued in 1958, it has given a full set of rules as to winter building. Under these rules the efforts of the Ministry are concentrated on State-subsidized housing, public building and other kinds of building for the commencement of which a special public permit is required. Permits for new building are given at such a rate that a smooth building rhythm is facilitated. The permits are given to a certain extent subject to a proviso that the work shall be commenced within a certain period late in the summer. As regards some building it is required that more extensive winter measures shall be taken than formerly (aiming at a continuation of the building work until 5 degrees centigrade below zero). It is also required that the building project shall be thoroughly prepared, the whole working basis to be completed at least one month before commencement of the building work, a requirement which quite apart from winter building aims at promoting a rationally arranged building. It is also required that the owner shall request in the invitation for tenders that the tenderer shall bind himself to undertake winter building after the owner's directives. As regards State-subsidized housing, direct subsidies are given to a certain extent, partly by inclusion of the increased expenses in the cost of construction on the basis of which the loan or the guarantee of the State is calculated, partly by the granting of a subsidy in cash in settlement of the increased expenses. The rules of the State imply on the whole that normally the owner undertakes to pay all expenses connected with winter measures. This has been considered necessary to overcome the contractors' opposition to winter building, even if it is admitted that it should be possible for the contractors to cover a certain part of such additional expenses by savings which are gained.

The public authorities promote winter building also by giving financial aid for central educational and propaganda work. Such work is considered necessary for an effective campaign, which must be based on local committees throughout the country. Finally, the Ministry has financed a free advisory organization for all parties interested in building.

It has not yet been possible to record results of the increased efforts for winter building, which commenced at the end of 1958.

It has been difficult until now for winter building to be generally accepted, and this is one reason for the increased efforts described. Statistical material on this problem is uncertain, owing among other things to the relation between winter building and the general employment level. Although the efforts made for winter building may be the same from year to year, building activity may one winter show low figures if the total building of the year is at a low level and the winter that year is hard, whereas another winter may show high figures owing only to a high building level in the particular year, possibly combined with a mild winter. As regards the past winter there is a general impression, which is also confirmed by the winter advisers' experiences on the building sites, that a more sympathetic attitude to winter building is developing, even by those who have formerly given expression to scepticism. It is the general impression that there has been a considerable increase in the extent of winter building in the past winter.

The immediate aim of measures, partially through efforts of the public authorities, must be to overcome opposition and slackness so far shown. The owner's uncertainty as to the economic results of winter building makes it necessary - at any rate for the time being - to secure winter construction by administrative regulations. The long term aim must be to make winter building a normal part of every rationally arranged building project so that winter building may be carried out without public aid.

Average Monthly Unemployment Rates(1) of all Building Trades and of Bricklayers alone in the years 1954-58 January, February, March 1959

	All Building Trades (2) (3)						Bricklayers only (3)					
	1959	1958	1957	1956	1955	1954	1959	1958	1957	1956	1955	1954
January	16.9	27.0	24.4	23.0	19.4	15.9	32.4	50.0	41.8	40.2	38.8	27.5
February	14.2	27.8	21.1	30.9	19.1	22.3	27.6	53.6	34.2	61.9	37.3	48.9
March	9.3	27.9	19.4	26.1	22.2	17.4	16.4	57.4	34.4	48.4	49.3	33.6
April		16.8	11.6	18.4	8.9	2.8		30.3	19.0	28.8	13.1	1.9
May		5.3	6.2	5.7	3.2	1.1		5.8	9.6	5.1	3.6	0.3
June		2.5	3.9	2.7	1.9	0.6		1.7	5.6	1.8	2.3	0.1
July		1.6	2.2	1.7	0.9	0.4		0.7	2.6	1.1	0.6	0.1
August		1.5	2.5	1.8	1.1	0.4		1.4	3.3	1.6	1.0	0.1
September		1.6	3.4	2.3	2.0	0.5		1.7	4.9	1.9	2.3	0.2
October		2.1	5.9	4.5	3.4	1.3		2.1	9.2	3.5	3.6	0.6
November		4.2	9.9	9.4	7.1	3.4		2.8	13.6	10.4	8.1	3.1
December		11.5	19.9	16.2	19.6	8.4		17.3	38.6	22.6	40.0	10.1
The whole year		10.7	10.7	11.7	8.9	5.7		18.5	17.8	18.6	16.3	9.4

(1) Calculated on the basis of the weekly unreduced unemployment surveys.

(2) Includes plumbers, technicians, electricians, glaziers, painters, bricklayers, carpenters.

(3) Exclusive of unskilled labourers.

List of Literature

I. Publications by The Danish National Institute of Building Research.

(a) Directions which present the results of building research in a simple form adopted to needs of practical building and planning:

Direction No.:

1. Build All the Year Round.
2. Tentative Recommendations for Winter Concreting Methods.
4. The Winter Construction ABC-Book.
9. The Winter Construction ABC-Book, 2nd edition.
10. Artificial Illumination of Building Sites.
17. Winter Concreting.
23. Winter Construction.
29. SBI Concrete Calculator.

(b) Scientific reports on research made by or on behalf of the Institute.

Report No.:

6. Winter Construction, Experiments made by the Danish National Institute of Building Research in 1947-50.
11. Mortar Admixtures for Winter Construction.

Winter Concreting, Theory and Practice.
Proceeding of the RILEM Symposium.
Special Report prepared by the Institute.
Copenhagen 1956.

II. Other Literature.

Bertil Näslund: Building Construction in Winter, A cost study, published by: Statens nämnd för byggnadsforskning, Stockholm 1955.

Th. Galland: The Study of Unemployment Due to Winter Weather, International Labour Review, Vol. LXX VIII, No. 1, Geneva 1958.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.8(b)
19 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda for the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

COST GUIDANCE FOR HOUSING DESIGN

prepared by Mr. F. LEE (United Kingdom), Research Officer, in association with Mr. C. SWEETT (United Kingdom), Chairman, of the Cost Research Panel of the Royal Institution of Chartered Surveyors.

1. A feature of the system of placing building contracts in the United Kingdom is that the basic design and details of a project should be determined before the contractor responsible for its erection is appointed. Complete preparation of a scheme is necessary for the efficient working of the system of competitive tendering, and all major reports on building procedures since the war have deplored the lack, and stressed the importance of full and complete preparation before tenders are invited. (1)

2. Lack of preparation detracts seriously from the efficiency of the industry and undermines the efficacy of the system of competitive tendering. Tenders are strictly competitive only where they are compiled on an identical basis. It is noteworthy that contractors insist on complete and detailed tender documents where they are competing against other firms, but are content with less extensive data where contracts are negotiated. Lacking the full details of a scheme, a contractor when preparing his tender must make certain assumptions on how the scheme will be developed in detail, and must allow something in his tender to cover the extra costs involved in the interruption and dislocation of site operations caused by the issue of late instructions. These assumptions will differ between building firms, and tenders will reflect different policies of anticipating variations.

3. The need for the full development of a project before the builder is appointed may have adverse effects on the economy of the design. As there is a divorce between the design and the execution of a project, the architect tends to design in an economic vacuum, and has little reliable idea of the cost of a project or of any one design decision until either the approximate estimate is prepared or until tenders are received, once the design is complete.

4. As a result, the costs of any project may be excessive with rent levels too high for prospective tenants. Also, even where total costs are satisfactory, the lack of cost guidance during design stages may mean that money has not been concentrated on any desired feature of the design, e.g. on finishes and services rather than upon structure. This problem is particularly acute with multi-storey housing where the form of development permits wide variation in design. Investigations into the cost of multi-storey housing reveal an extraordinary wide range of costs, which can partly be attributed to different methods of solving design problems. (2)

Recommendations of the Cost Research Panel

5. The Cost Research Panel of the Royal Institution of Chartered Surveyors in their report to the Minister of Housing and Local Government, concluded that "the wide range of costs indicate that many schemes were costing more than they ought", and that, without detracting from standards of housing, "there was ample scope for reduction in the cost of flats". However, "present procedures are not adequate to ensure that savings are achieved through economic design". The principal recommendation to reduce the cost of high density housing was that "cost should be a planned factor, and should be closely watched from the inception of a scheme to its completion". This requires certain modifications to the client's procedures, and the adoption by the architect and quantity surveyor of a system of costing the project during design stage. (3)

6. If the architect and the quantity surveyor are to apply a system of costing, the client, in the case of public housing normally a local government authority, must ensure that adequate time is allowed during the pre-tender stages for thorough investigation of costs, and that the quantity surveyor is appointed at the briefing stage so that he may advise on costs throughout. Present practices frequently fall short of satisfying these simple requirements. (4)

7. Also, to ensure that a project is developed at a level of costs resulting in rents consistent with the resources of prospective tenants, the client should give the architect and the quantity surveyor a clear and unambiguous limit of cost, as a budget total, within which to design a scheme. It is surprising that only rarely do local authorities set their architect a cost limit for a project. (4). A certain measure of budgetary control is imposed by central government authorities by their power to withhold loan sanction for schemes whose costs exceed certain concealed limits calculated by the Ministry of Housing and Local Government. This method of budgetary control, however, is not adequate in itself to ensure economic

development, as firstly, it comes into effect only after tenders have been received and therefore usually too late to modify any design, and secondly, limits set by central government departments do not provide a valuable basis of financial control for the schemes of individual authorities with different housing problems and rent policies.

8. Two systems of costing a project during design stage have been evolved, Cost Planning and Cost Control. The flexibility of Cost Planning makes it more suitable for housing schemes. Each of the methods, however, has its own merits, and the selection of either must depend upon the nature of the problem facing the architect and the quantity surveyor.

9. For all forms of costing, cost advice is provided by the quantity surveyor, who by reason of his training and his experience of many schemes on which different architects and contractorshave been employed, is in a unique position to provide reliable guidance. A traditional task of the quantity surveyor has been to calculate an approximate estimate of costs during the early stages of a project. Systems of costing the design use the normal approximate estimating methods of measuring approximate quantities from preliminary sketches and pricing these at rates appropriate to the site, the type of development and the contractors tendering, to produce cost data to guide design decisions. Much of the basic data the quantity surveyor relies upon is obtained by analysing priced bills of quantities for many previous schemes.

<u>Cost Planning</u>

10. In principle, Cost Planning involves the thorough analysis and investigation of costs which are involved in any sketch design during the initial stages of a project, so that the important sources of costs are isolated, and so that the relative costs of implementing the design by variations of one feature through the use of different materials or forms of construction, may be investigated. In certain respects, therefore, Cost Planning involves a similar basic approach to costing as does marginal costing methods employed in manufacturing industry. (5). There are, however, many important differences which flow from the unique problems of costing architectural design.

11. The system of cost planning housing development falls into two stages. (6). The first stage involves the investigation of the cost implications of the basic site development. Normally a site may be developed by a large number of different combinations of high and low blocks of different design to provide the required number

of dwellings. Each of these combinations will have its own cost implications. The form of development adopted at this stage will play a large part in determining the final cost of the project.

12. The Ministry of Housing have studied this problem (7) to provide architects with guidance on this question, and the information they have published can be conveniently used at this stage of Cost Planning. Tables of costs were included from which the relative costs of dwellings of different areas, in blocks of different heights and designs, can be calculated: for example, a 790 square feet flat in a three storey block, sharing access with three other dwellings, £1,550: and a similar flat in a twelve storey block with a lift, £2,180. The tables of relative costs published by the Ministry provide a convenient statement of the effect on costs arising from variations in the basic design, such as increasing the height of the block, the area of a dwelling, making different use of access space, and introducing lifts.

13. This information may be used to gauge the relative effect on average cost per dwelling resulting from different forms of site development. In this way, the basic development and the preliminary sketch plans of a project can be prepared in a general framework of costing and cost guidance.

14. The second stage of cost planning becomes effective when preliminary sketches have been prepared. The costing problem at this stage is threefold; the determination of the probable final costs resulting from a sketch design, the isolation of sources of high cost involved in the design, and the examination of the possible alternatives open to the architect for the full implementation of the design.

15. The calculation of probable final costs is necessary to ensure that final costs keep within budget limits. In this respect the purpose of costing is similar to that of normal approximate estimating, but the calculation of probable final costs depends on the results of the examination of the sources of high cost and of the alternatives open to the architect.

16. The isolation of the main cost sources requires a detailed analysis of the estimated costs of the scheme; for example, the isolation from total costs of those for loadbearing crosswalls, intermediate floors, various staircases and forms of access, external in-filling panels, various forms of internal partitions, different forms and uses of internal finishes etc. The sources of cost will differ considerably between different designs and forms of construction, depending upon the technique of construction envisaged. The appreciation of the sources in preliminary sketch plans, requires a skilled and experienced appraisal.

17. The isolation of these cost sources enables the architect to judge whether his preliminary sketch plans are economic, or whether the design relies too heavily upon certain expensive components. For example, whether the combination to say crosswall and external in-filling panels, each with its own cost factor, enclose a given area most economically, or whether a more economic solution might be found by increasing the depth of the dwelling, thus reducing the area of external in-filling panels per foot super of the dwelling, and increasing that of crosswalls, (depending upon which was cheaper and on the secondary effects on other components).

18. The third aspect of the costing problem concerns the investigation of possible alternatives open to the architect for the detailed implementation of his design. This involves the fairly straightforward calculation of the relative cost of using one type of material or form of construction rather than another in the design; for example, the cost of a 'breeze partition plastered both sides' as opposed to a 'stud partition plaster board both sides and scrimming', or 'plaster board with setting coats both sides'. Occasionally, the use of one material rather than another has a secondary cost effect on other components, and the costing should bring this out. For example, the use of say 'in situ reinforced concrete floors' in place of pre-cast or hollow tile floors may alter the floor to ceiling height and so affects the cost of internal finishes, and depending on the type of in situ floor used may affect the structure and ceiling and floor finishes.

19. By the evaluation of probable costs involved in any of a number of alternatives, a 'market' is created wherein the architect can select any of a number of courses of action with full knowledge of its cost consequences, and of the final costs which would result from any combination.

20. In practice, these three aspects of the costing problem are treated simultaneously, in a document known as a 'cost study'. This is compiled by the quantity surveyor who measures and prices approximate quantities from the preliminary sketches. The prices are set at levels appropriate to the type of development, the site and the contractors tendering, and in this way the cost information brought to bear on the project is linked to the specific problem. (In contrast to the first stage of costing, where information used is of a general character; see paragraph 13).

21. From the cost study, the architect selects either of the alternatives open to him. These selected alternatives provide a 'cost plan' which governs the remaining pre-tender stages of the project, viz, working drawings and quantities. Working drawings are produced in accordance with the information contained in the preliminary sketches and the specifications on which the cost study was based, and therefore tenders tend to reflect the costs in the cost plan.

<u>Cost Control</u>

22. The second method of costing the design during pre-tender stages is known as 'Cost Control'. This is the method pioneered by the Ministry of Education for school development and has provided the discipline by which the cost per foot super of school building increased by only 15 per cent between 1951 and 1957 when building costs generally rose by approximately 30 per cent. (8)

23. In principle, Cost Control involves the setting of target costs for each 'element' in a building, and the continuous checking of costs during the development of working drawings, so that the cost inherent in each 'element' of the design as it evolves, do not exceed the predetermined limit. In its basic approach, therefore, cost control is similar to standard costing methods employed in manufacturing industry (9), but, again important differences arise from the exceptional problems of costing architectural design.

24. Cost control becomes effective when the preliminary plans have been prepared. The method falls into two distinct phases. Firstly there is the setting of target costs; and secondly, there is the checking of costs involved in the project as it evolves to compare against these targets.

25. In the setting of the cost targets, cost control relies upon historical cost data. Target costs are set for each 'element' of a building, by the analysis of a priced bill of quantities for a previous scheme which is, in as many ways as possible similar to the project under consideration. An 'element' is defined as that part of a building which performs the same function no matter how it is designed or constructed. Thus, for example, a roof performs the same function whether it is built of timber and tiles or of concrete and asphalt. The roof as such is the element. The main difficulty concerning elements is one of definition and demarcation. This is usually solved at the practical level by the arbitrary agreement of what is contained in each element at the start of the costing process.

26. With the data derived from an elemental analysis of a priced bill, a cost plan is compiled. Target costs are set for each element in the project, and adjustments are made to ensure that costs will be concentrated on desired items and so that total costs do not exceed budget limits.

27. When these cost targets have been set, the development of the design proceeds as normal to working drawings. As these become available, the quantity surveyor measures approximate quantities and prices these at levels appropriate to the site and the type of development. If these estimates exceed the target costs for any

one element, either the design of that element is reconsidered, or else, a further adjustment is made to another element. In this way, the cost plan is kept up to date, and continuously reflects the development of the project. After working drawings have been completed and checked against the cost plan, the project proceeds as normally to tender.

Cost Research

28. Cost Planning and Cost Control are new approaches to design. Although they have been cautiously and successfully adopted by several local authorities as part of their housing development procedures, they are by no means the generally accepted solution to the problem of providing cost guidance for housing design. Regrettably, many local authorities appear content to leave this problem unsolved.

29. Cost Planning and Cost Control represent the tangible results of research, and their development has doubly emphasised the importance of cost and operational research into building development. The methods of costing they provide still present several problems to be solved, which will be possible only with continuous and widespread trial. The success of these costing methods, however, depends in part upon a supply of reliable cost information such as that obtained by research projects beyond the resources of individual quantity surveyors' offices. The process of costing design by Cost Planning and Cost Control, provides a ready channel along which cost data produced by research may be brought to bear upon specific problems.

All-in Service

30. There have been other attempts along entirely different lines to the development of costing systems, to solve the problem of providing cost guidance during design stages. Broadly, these attempts have relied upon the appointment or the nomination of the main contractor by other means than the traditional system of competitive tendering, so that he may advise on costs before the design is complete.

31. This method has taken a variety of forms. In its extreme form, it depends on the "All-in Service". Under this method of placing contracts, the client approaches a building contractor directly, and the builder alone is responsible for all stages of development from the initial design to the completion of the project. A charge for 'professional fees' is normally included in the cost the client has to meet. The variations on this system include procedures where the architect is responsible for the preliminary design, and the builder responsible for the remaining stages of the process, including the development of working drawings; and where the architect (with or without a quantity surveyor) is responsible for all drawings and specifications, but throughout the early stages, the builder, who is already appointed, is on hand to give advice on costs.

32. Although the provision of cost advice is the main justification for the 'all-in service', it is not the sole explanation for their development. It is true that several clients have adopted these procedures in the hope for economies in design, but among the main reasons builders have offered these services is that it enables them to use their resources effectively by increasing their control over a project. The failure of many architects to ensure that their projects are fully prepared when tenders are invited means that the attempts by building firms to programme and plan site operations before work on site commences, are usually frustrated by the large number of variations which must be issued when all drawings have not been prepared or where they are altered.

33. Paradoxically, this situation has been aggravated by the increasing efficiency of many national building firms. Several contractors have invested substantial capital in aids to efficiency, which have taken varied form from new and imaginative systems of programming and controlling operations on site to tangible assets such as increased mechanisation. Any form of professional inefficiency like the failure to prepare a project prior to inviting tenders, means that much of this effort is abortive. Under the system of competitive tendering, contractors cannot be more efficient than the actions of the professional parties permit.

34. In building, as with many other industries, firms who have introduced extensive costing and managing techniques are concerned whether their more 'accurate' estimates and prices are undercut by inefficient firms who cost on a less trustworthy basis. With an ill-prepared project, this danger is greatly increased. In face of all these difficulties, building contractors have looked to the 'all-in service' as a method of introducing greater efficiency and of obtaining greater control over a project, to ensure that their resources are effectively used and that a return on their capital is obtained.

35. There is little doubt that within the limitations of the cost information and costing services of any individual building firm, that the early appointment of the builder to advise on design provides an initially satisfactory solution to the costing problem involved in housing design. However, cost is a complex matter, and its sources are varied. Design is not the sole influence on costs, and many further important, but probably less tangible factors must be considered.

36. The early appointment of the builder disrupts the traditional system of competitive tendering. In the long run, this may outweigh any economies which might result by the widespread adoption of 'all-in services' as a general solution to the costing problem of design.

37. On the practical level, it is doubtful whether a sufficient number of building firms could provide an efficient costing service. The evaluation of costs in preliminary sketches requires a different skill to that of normal estimating. It is true that a few large national building firms are fully capable of giving reliable cost advice during the design stage, and of investing the substantial capital involved to train and pay the necessary advisory team, but whether smaller firms are able to do this and to bear the substantial overhead involved through seasonal and cyclical fluctuations in activity, is another matter. In 1958, 75 per cent of the total national housing programme was provided by building firms employing less than 250 operatives.

38. There are more fundamental objections to 'all-in service' procedures. They strike at the very root of competitive tendering, and with their widespread adoption, competition between building firms would be considerably lessened and changed substantially in nature. This, in the long run, might ultimately weaken the incentive to efficiency and lead to a rise in building costs.

39. Under a system where the builder is appointed partly on his ability to advise on costs and without reference to the system of competitive tendering, there would be an increasing tendency among architects and clients to employ the same building firm for each of their projects. Architects like to employ only firms they know well, and have worked with in the past. This is already apparent in the method of selecting nominated specialist sub-contractors. (4). Early appointment of the main contractor would therefore tend to lead to rigidity in the industry, and this would inhibit the growth of smaller and probably more virile firms, such as the small family business from which originally most of the national building organizations have evolved.

40. Where the contractor takes a leading part in advising on cost at design stage, competition between building firms may tend to affect adversely the quality of design. With the extreme form of 'all-in service', this is almost inevitable, whilst with its variations it would become a strong possibility.

41. The traditional system of competitive tendering, where the architect alone is responsible for the entire design, restricts competition between builders to prices and, with restricted lists of contractors, avoids as far as possible any competition which might adversely affect the quality of work. (1)

42. Where builders play a greater part at design stage by advising on the cost implications of design, competition between contractors would hinge, in certain circumstances, upon the costs of building which they design in part or in whole. This would lead to competition which would lower quality. Builders would tend to compete with prices of building 'bought off the peg', or with poor design to undercut competitors and reduce costs. The extension of the area of quality competition would, especially in slack periods, be unfortunate for the building industry and for the honest builder, and would jeopardize the high standards of housing which have been achieved in recent years by strict professional standards.

43. Advice on the cost implications of design from any one individual building firm must necessarily and logically reflect the organisation and speciality of that builder. This may not be satisfactory architecturally.

44. Finally, the new position of the contractor with all-in services, would make the task of supervising and maintaining a high standard of workmanship on site more difficult.

45. There have been a few successful experiments with the appointment of the contractor during the early stages to advise on design. The results of these experiments require careful interpretation. The major problems and difficulties which would flow from the widespread adoption of the system of the all-in service have not been revealed. The projects concerned were negotiated against the general background of the traditional system of competitive tendering. If this background were removed and the nomination of contractors becomes the order of the day, then the full consequences of this system would be revealed. The results of these experiments do not provide a solution which is applicable to the wider field of building development, as they do not contain in embryo all the circumstances which would be existing if the early appointment of the building contractor were the normal form of building development.

46. Given a consistent demand, the system of competitive tendering for fully prepared projects, based on carefully selected and frequently revised lists of contractors, is the only guarantee to the healthy development of the building industry. This, coupled with a system of costing the design, is the most effective method of obtaining value for money in housing development.

Distr.
RESTRICTED
HOU/Working Paper No.97 Add.9
4 May 1959
Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Note by the Secretariat

Definition of terms used

In the course of preparing the enquiry into the Effect of Government Measures designed to Promote the Technological Development of the Building Industry and Reduce Housing Costs, and in particular as a result of discussions with the rapporteurs, the necessity has become apparent of defining with greater precision the principal terms which have been used, particularly with a view to finding their exact equivalent when translating into another language. Some of the more important terms, briefly defined, are set out below. An effort has been made to use them throughout the report in the sense described below, although there may be occasions when some tightening up of the drafting may be necessary, and this can be done in the final version. It is also intended, in the final version, to include the substance of the present note in the Prefatory Note to the whole enquiry (see HOU/Working Paper No.97). The principal terms used, together with the definition adopted, are as follows:

Housing needs or requirements. Number of dwellings required by a country to house adequately by reference to national standards, traditions and economic possibilities all sectors of its population. It is based on a number of objective factors, principally the quantitative housing shortage, objectively determined; current demographic needs; backlog replacement requirements; and current replacement needs. It follows that needs or requirements can be assessed only in relation to a situation in a particular country and are not comparable from one country to another[1].

---

(1) See in this connexion European Housing Developments and Policies in 1954, ECE, Geneva, August 1955 (E/ECE/209), Part II, section 3; and The European Housing Situation, ECE, Geneva, January 1956 (E/ECE/221), Appendix 1.

Housing demand. Effective demand, i.e. the number of new houses for which instructions to build can be given to the industry over any specified period of time.

The investor. The person or organization who initiates a project for the erection of dwellings. This may be a department of government, a municipality, a non-profit making organization, a commercial undertaking or a private individual.

The designer or design office. The complex comprised by architect, engineer and quantity surveyor, or groups of these categories, who prepare detailed drawings, specifications, estimates and contract documents on behalf of the investor.

The contractor. The person or organization who undertake the business of building the dwellings on behalf of the investor, acting on the instructions of the designer.

Types and typification. Type designs for dwellings or components of dwellings, together with the relevant specifications, which are representative of the best practice at any given period of time, and the use of which is mandatory and from which no deviation is permissable, except within certain specified limits which may be admitted to suit specific sites. Typification is the act of setting up type designs.

Standards and standardization. Standards are agreed definitions of:-

(a) functional requirements for materials or parts of buildings or for complete buildings.

(b) size, shape, properties and quality of building materials and components of building.

They are usually prepared by national organizations set up for the purpose, and their use may be mandatory or voluntary. Standardization is the act of setting up standards.

Model plans for dwellings. Model plans are plans prepared by way of example and advice, incorporating the best features of design, to suit various occupancies and conditions. Their use is never mandatory.

Traditional building. By traditional building is implied the basis of design, organization and execution of building which have come to be recognized as normal practice over a considerable period of time in any country or region. It is usually characterized by the fact that all operations follow a set pattern known to all participants in the actual building operation, and by dependence on skilled craftsmanship for interpretation of instructions and execution of work.

Industrialization of building. Continuity of production implying a steady flow of demand; standardization; integration of the different stages of the whole production process; a high degree of organization of work; mechanization to replace manual labour wherever possible; research and organized experimentation integrated with production.

Prefabricated building. By this is implied the transfer of varying proportions of the operations of manufacture and assembly of components of buildings from the building site to factories or workshops which may be independent of the site or associated with it.

Distr.
RESTREINTE

COMMISSION ECONOMIQUE POUR L'EUROPE

COMITE DE L'HABITAT

Réunion spéciale sur la normalisation et la coordination modulaire

(Point 3 (a) de l'ordre du jour provisoire)

HOU/SMC/Document de travail No 1/Add.23
1 mai 1959
Original : FRANCAIS

Note du Secrétariat

Le Secrétariat vous prie de trouver ci-joint les renseignements fournis par l'Autriche en réponse à l'enquête sur la normalisation et la coordination modulaire.

Distr.
RESTRICTED

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

Ad Hoc Meeting on Standardization and Modular Co-ordination

(Item 3(a) of the provisional agenda)

HOU/SMC/Working Paper No.1/Add.23
1 May 1959
Original: FRENCH

Note by the Secretariat

The information given below has been supplied by Austria in reply to the enquiry on standardization and modular co-ordination.

Distr.
RESTRICTED

ЕВРОПЕЙСКАЯ ЭКОНОМИЧЕСКАЯ КОМИССИЯ

КОМИТЕТ ПО ЖИЛИЩНОМУ ВОПРОСУ

Специальное совещание по стандартизации и модульной координации

(Пункт 3 (а) предварительной повестки дня)

HOU/SMC/Working Paper No.1/Add.23
1 May 1959
Original: FRENCH

Записка Секретариата

Приводимая ниже информация была сообщена Австрией в ответ на вопросник, касающийся стандартизации и модульной координации.

REPONSES NATIONALES

AUTRICHE

En vertu de la Loi autrichienne portant réglementation des normes techniques en date du 24 février 1954, Gazette officielle No.64/1954, le Ministère fédéral du commerce et de la reconstruction a conféré au Comité autrichien des normes (Osterreichischer Normenausschuss) le droit exclusif d'établir des normes techniques et de mettre en vente les feuilles de normes établies par lui.

Les normes autrichiennes de construction sont mises au point par 21 comités de normalisation spécialisés dans le divers domaine du bâtiment. Dans ces comités, les représentants de l'administration, des producteurs, des consommateurs et de la recherche scientifique collaborent sur un pied d'égalité. Toutes les normes doivent être adoptées à l'unanimité. Cette disposition, il est vrai, entraîne parfois certaines lenteurs dans les travaux d'étude, mais en revanche, la règle de l'unanimité offre aussi ce grand avantage d'amener ensuite les milieux intéressés à appliquer ces normes avec une parfaite bonne volonté alors même qu'elles sont à leur stade initial fondées sur le seul principe de la libre convention des parties, dépourvue de tout caractère obligatoire. Les autorités fédérales et provinciales compétentes peuvent toutefois, par la voie législative ou réglementaire, rendre obligatoires les normes autrichiennes, en tout ou en partie, ou les homologuer officiellement en leur accordant valeur légale. La déclaration qui rend obligatoire une norme a pour effet de lui conférer le caractère d'une prescription légale dont l'observation est obligatoire, soit dans tous les cas, soit dans des cas d'espèce définis dans les textes. En revanche, l'homologation officielle d'une norme en tout ou en partie n'implique pas encore son application obligatoire, mais l'admet comme moyen de preuve dans un litige soumis aux tribunaux. C'est une faculté dont il est souvent fait usage pour toute sorte de normes.

L'application obligatoire des normes n'a pas rencontré de difficultés, ce qui semble attester la compréhension du public pour les nécessités de la normalisation.

En ce qui concerne la coordination modulaire, l'Autriche prend part à l'étude du Projet No 174 de l'Agence européenne de productivité, consacré à la "coordination modulaire dans le bâtiment". Une norme portant la cote B 1010 relative à l'application du module de construction a déjà été adoptée en Autriche. Cette norme doit surtout fournir une base pour le développement ultérieur de la construction normalisée en Autriche, mais on se heurte ici encore à certaines difficultés, en ce qui concerne notamment le problème des tolérances et ajustements. Les tolérances parfois prescrites dans certaines normes autrichiennes datent d'une époque où ce module normalisé n'existait pas encore. Dans ce domaine, des solutions concrètes n'interviendront guère avant que l'étude déjà mentionnée de l'Agence européenne de productivité n'ait été achevée, car en matière de coordination modulaire, l'unification des différentes législations nationales par la voie d'accords internationaux paraît tout particulièrement indiquée. C'est aussi pour cette raison qu'en Autriche, les dimensions des briques n'ont pas encore été adaptées aux prescriptions de la norme autrichienne B 1010. Il est enfin difficile, pour les différents métiers du bâtiment (maçons etc.,), de s'adapter à cette précision du travail qu'exige l'application du module de construction.

En ce qui concerne les devis descriptifs, des efforts se poursuivent depuis des années en vue de les unifier et la "Arbeitsgemeinschaft zur Förderung der österreichischen Bauwirtschaft" (Union pour le progrès de l'industrie autrichienne du bâtiment) a tout d'abord publié des notices concernant les différents devis pour la construction en hauteur.

Pour tenir compte des exigences de la pratique, le Ministère fédéral du commerce et de la reconstruction, utilisant à cette fin la documentation technique existante telle que les feuilles de normes autrichiennes, mais aussi les"notices" de l'Union susmentionnée etc., a fait paraître un "Devis descriptif et quantitatif unifié" qui embrasse toutes les diverses catégories de prestations nécessaires dans la construction d'habitations et dont l'application est obligatoire pour les constructions subventionnées par le Fonds de reconstruction d'habitations (Wohnungs-Wiederaufbaufonds). Comme cette application a donné de très bons résultats dans la pratique, ledit Devis est aussi utilisé pour d'autres constructions d'habitations subventionnées sur fonds publics. Son adoption permet donc, dans tout le secteur de la construction, d'unifier dans une certaine mesure les devis descriptifs et de les rendre plus économiques, ainsi que d'encourager largement la normalisation des travaux d'exécution eux-mêmes.

Des efforts d'unification et de normalisation se poursuivent aussi en ce qui concerne les bâtiments construits par l'Administration fédérale des Ponts et Chaussées, tels que les édifices des directions de construction routière, les magasins de ces services, les postes de relais pour les travaux routiers d'hiver etc., pour lesquels le Ministère fédéral du commerce et de la reconstruction a publié des normes de surface.

De son côté, la Ville de Vienne applique avec un soin particulier les principes d'unification et de normalisation des projets dans la construction municipale d'habitations.

Pour pouvoir, avec les fonds disponibles, construire le plus grand nombre possible d'habitations tout en sauvegardant le niveau qualitatif de la construction, les services municipaux ont dû adopter certaines mesures d'unification qui touchent tant la conception des projets que leur exécution technique. La plupart de ces mesures d'unification n'avaient toutefois pas leur origine dans des considérations théoriques, mais résultaient de l'expérience que la municipalité de Vienne en tant que commettante a pu acquérir au cours de longues années.

C'est ainsi que dès le stade du projet, l'architecte est tenu d'observer certaines dimensions pour la hauteur des étages et la profondeur des édifices. Les dimensions des logements et de leurs pièces sont typifiées. La cage d'escalier, que celle-ci comprenne un ascenseur ou non, ainsi que le bloc d'eau, sont normalisés. Les projets doivent tenir compte de l'utilisation de pièces normalisées : fenêtres, portes, marches d'escalier, éléments de plomberie, etc.. Si des architectes indépendants de l'extérieur élaborent ces projets, les services municipaux d'architecture compétents en l'occurrence leur fournissent verbalement, par écrit et au moyen de croquis tous les renseignements nécessaires sur le régime d'unification, de typification et de normalisation adopté dont ils doivent obligatoirement tenir compte dans leurs plans d'habitations communales.

Les services commettants établissent parfois eux-mêmes, en collaboration avec des producteurs compétents, les dessins d'exécution des divers éléments de construction ou d'équipement tels que marches d'escalier, réchauds à gaz, éviers, etc. L'utilisation de ces éléments s'étend alors uniformément à toutes les maisons d'habitation construites. Le plus souvent, ces éléments et équipements normalisés sont commandés en grande série, au lieu de l'être séparément pour chaque chantier.

Au début, il fallait, chez certains producteurs d'éléments normalisés aussi bien que chez les entrepreneurs, surmonter des difficultés de démarrage. Il en était ainsi en particulier des entrepreneurs lorsqu'ils devaient monter sur le chantier des pièces préfabriquées qu'ils avaient précédemment produites eux-mêmes. Les producteurs aussi bien que les entrepreneurs voyaient tout d'abord dans la normalisation une menace pour leurs bénéfices. Mais les difficultés de cet ordre ont été surmontées depuis longtemps. Les intéressés ou bien comprennent aujourd'hui les avantages que leur offre la normalisation ou bien se sont résignés à l'accepter.

A l'heure actuelle, les résistances viennent d'un autre côté. De jeunes architectes le plus souvent encore peu expérimentés se sentent gênés dans leur liberté d'expression artistique par l'imposition de dimensions extérieures, de types de logement, de dimensions de fenêtre etc. uniformes et ils sont alors tentés d'en appeler à l'opinion publique contre cette unification et cette normalisation qu'ils présentent comme des mesures de contrainte nées uniquement de la prédilection qu'éprouveraient les fonctionnaires des services de construction municipaux pour les règlements.

Les diverses coopératives et sociétés de construction, etc. poursuivent elles aussi en matière d'unification et de normalisation des efforts analogues à ceux de la municipalité de Vienne.

Quant à l'application d'un module de plan dans la construction d'habitations, un essai pratique a été tenté sur l'initiative du Centre autrichien de producti- vité (Osterreichiches Produktivitäts-Zentrum) et l'on a, au treizième arrondis- sement de Vienne, à la Veitingergasse, construit un certain nombre de maisons types.

Une des entreprises autrichiennes, qui a conçu ces maisons typesconstruites en bois, a pu récemment obtenir une commande d'exportation très intéressante pour des maisons de bois préfabriquées, à dimensions basées sur un module de plan de 1 m 25. Les éléments préfabriqués peuvent former des maisons d'une surface de 100 à 200 m^2, à deux, trois ou quatre chambres à coucher, voire plus. Toutes les parois extérieures sont faites en panneaux de bois mesurant 1 m 25 x 2 m 50, munies d'un revêtement extérieur en "Heraklith" et intérieur en panneaux de plâtre. A l'extérieur, les parois reçoivent ensuite un enduit. Les parois extérieures du type comptant trois chambres à coucher peuvent être montées en quelque 35 heures de travail (soit 5 ouvriers travaillant chacun 7 heures). Sur ses parois extérieures, se montent à peu près dans le même nombre d'heures les fermes, également préfabriquées en bois. De cette façon, la maison est mise hors eau en l'espace de trois jours et les ouvriers peuvent poursuivre les autres travaux, parfaitement abrités contre les intempéries. Les membres inférieurs des fermes portent aussi le plafond, dont la face infé rieure plane reçoit un revêtement de panneaux de plâtre avant que soient montées les cloisons intérieures. Ces panneaux de plâtre peuvent donc être fixés au plafond sans égard à la pose ultérieure de ces cloisons. Celles-ci sont posées en dernier lieu.

L'application de cette méthode de construction, qui met en oeuvre des éléments préfabriqués, est subordonnée à l'observation d'un module de plan, car le plus grand nombre possible des éléments utilisés doivent, cela s'entend, posséder les mêmes dimensions. Si un tel système n'est appliqué qu'à un seul programme de construction dont l'exécution est en outre confiée à une même entreprise, le module peut être choisi librement. Autrefois, l'entreprise ici visée avait, pour les premiers types de ces maisons, utilisé un module de plan de 1 m, mais elle l'a ensuite, sur la demande de son commettant, porté à 1 m 25, de manière à tenir compte des dimensions adoptées pour les portes et les fenêtres. Mais si les éléments de construction préfabriqués doivent être utilisés dans plusieurs programmes de construction, il faut le concours de la normalisation et de la coordination modulaire et il faut aussi, tout au moins pour certaines méthodes de construction, définir le module de plan.

La normalisation est une méthode qui peut être adaptée aux derniers progrès de la technique et aux enseignements de l'expérience dans un délai relativement bref, alors qu'on ne peut, dans les divers pays, modifier aussi rapidement la réglementation juridique et technique de la construction.

Quant à la hauteur des étages, on a, en Autriche, compte tenu d'une proposition des organisations internationales, adopté quatre dimensions recommandées (2 m 80, 3 m 00, 3 m 20 et 3 m 40). La normalisation des portées libres entre murs porteurs, qui devra tenir compte des exigences nationales aussi bien qu'internationales, est actuellement à l'étude.

Pour encourager davantage encore la rationalisation du bâtiment et la normalisation des éléments de construction, la "Forschungsgesellschaft für den Wohnungsbau" (Société de recherches en matière de construction d'habitations), de concert avec le Ministère fédéral du commerce et de la reconstruction ainsi que le Centre de liaison des pays fédéraux, a abordé l'unification des dispositions tant techniques que juridiques des règlements de construction en vigueur dans les divers pays fédéraux. On peut donc espérer que dans l'avenir, les mêmes dimensions s'appliqueront, sur tout le territoire fédéral, à la hauteur des pièces, la largeur des escaliers, etc. Si les efforts poursuivis en ce sens donnent un résultat positif, d'autres éléments de construction pourront alors être normalisés également et trouver leur application dans tous les pays fédéraux, surtout dans la construction subventionnée.

Les résultats obtenus grâce aux efforts de normalisation sont dès maintenant assez considérables. A ce titre, on peut mentionner la norme autrichienne B 3201 relative aux briques, qui a eu pour effet d'appliquer à l'Autriche entière une seule dimension de brique. L'unification des dimensions s'applique d'une manière analogue aux principaux autres matériaux de construction, mais aussi à la fabrication de certains éléments tels que portes, fenêtres, installations sanitaires, ascenseurs, etc.

En outre, la réglementation des essais, des spécifications et marques de qualité adoptée pour certains produits a contribué, dans une large mesure, à la production d'articles de qualité soignée et toujours égale et à la réduction du nombre des types produits. Dans de nombreux cas, ce contrôle de qualité est réglé par des normes autrichiennes. L'attribution des marques de qualité relève en général des associations professionnelles compétentes de l'industrie des matériaux de construction (par exemple de l'Association des producteurs de blocs de béton), le matériau ayant été examiné à fond dans un institut d'essais et de vérification de matériaux.

En résumé, on peut dire que la normalisation a eu jusqu'ici des effets heureux. Il en est ainsi en ce qui concerne la rationalisation de l'industrie des matériaux de construction, le travail sur le chantier et l'accélération de la construction. En outre, la qualité de la construction s'améliore, et les producteurs, de leur côté, ont la possibilité d'agrandir leurs exploitations, de fabriquer pour stock et d'assurer à leur personnel une occupation plus régulière au cours de l'année. La normalisation a enfin eu des résultats favorables en matière d'unification des limites de charges et de dimensions ainsi que de sécurité, tant des édifices construits que des chantiers de construction.

En dernier ressort, la normalisation conduit ainsi à la réduction des dépenses de construction, ainsi qu'à un accroissement du nombre des logements construits et à une amélioration de leur qualité.

Conscients de ces faits, les milieux autrichiens intéressés prennent une part active aux travaux de l'ISO et au Projet No 174 de l'Agence européenne de productivité, consacrés à la coordination modulaire. Comme l'a expliqué le représentant autrichien à la réunion de l'AEP, tenue à Paris le 11 décembre 1958, et comme l'indique aussi une communication de l'Autriche à l'ISO, les conclusions auxquelles aboutira l'étude de l'AEP devront être prises en considération pour la réglementation définitive de la coordination modulaire et pour la normalisation des éléments de construction, fondée sur cette coordination. Il paraît en outre nécessaire que les divers Etats s'engagent à appliquer les normes dérivées de la coordination modulaire internationale de manière que l'élargissement souhaité des échanges de certains matériaux et éléments de construction susceptibles d'entrer dans le commerce international devienne une réalité. De toute façon, l'Autriche accueillera avec faveur tous les progrès que la normalisation et la coordination modulaire pourraient enregistrer dans l'avenir.

Distr.
RESTRICTED

HOU/Working Paper No. 97/Add.(a)
1 May 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

AUSTRIA

Relative importance of traditional and non-traditional methods of house construction

The population of Austria has not increased much during the past ten years and is hardly bigger than it was before the war, but mainly because of the enormous destruction caused by the war, Austria has had to face a serious housing problem. The almost complete cessation of activity in the building industry and the shortage of building materials immediately after the war, and then the very great rise in the cost of building materials in 1947-1951 and 1954-1956 aggravated the situation still further.(1) Nevertheless, the number of dwellings built since 1948 - i.e. approximately since the creation of the Housing Reconstruction Fund (WWF) - has rapidly increased and at the present time amounts in round figures to 35,000 yearly. There is marked concentration of building activity, particularly in housing construction, in the areas near the Federal capital and some of the provincial capitals.

House-building is financed mainly out of public funds. Most of the dwellings built (about 60%) belong to collective groups (local authorities, co-operatives and housing associations). This is a relatively high percentage for Western Europe and is explained partly by the fact that only local authorities and public housing associations can get loans from one of the big building funds, the BWSF. Private individuals must, therefore, become members of these housing associations in order to be entitled to loans. They can, however, in certain circumstances, still become owners of their houses later on.

The analysis of the structure of the building industry, which is given in Chapter III of this Report, shows that in Austria building work is carried on by a large number of small undertakings whose financial resources are, naturally, limited.

(1) See "Annual Bulletin of Housing and Building Statistics for Europe", Table 12.

From the information obtained, it would appear that the Austrian building industry very often uses traditional building methods. In many cases, however, new methods are also used, in order to meet the demand, which is very great, and to economise manpower and raw materials. Thus, instead of bricks, large hollow blocks, concrete or in situ concrete slabs are often used for the walls.

Wood floors have almost entirely been replaced by solid floors and, generally speaking, light-weight prefabricated concrete elements are being more and more commonly used.

There are at present more than 4,000 building firms in Austria, most of which have been established for the purpose of building new dwellings, repair work and upkeep, as well as for the construction of buildings other than houses. Few of these firms specialize.

Further, in the period immediately following the Second World War, certain efforts of a more or less experimental nature were made in Austria to improve non-traditional methods of building. Some of these efforts were directed towards solving the problem of temporary housing and resulted in technical solutions based on the use of light materials on a wooden framework. An interesting experiment was also carried out, on the initiative and with the help of United States economic aid services, in light-weight panel prefabrication.(1) This experiment has a special technical interest because of the effort made to rationalize and simplify building processes and was really intended to encourage the export of Austrian manufactures in the form of finished and semi-finished components which could be assembled to make one-family dwellings.

A certain number of firms have specialized in the construction of prefabricated houses of this type.

The very detailed statistics furnished on the production of building materials(2) reveal interesting trends in the use of new materials or new forms of traditional materials. Thus, for example, the production of hollow bricks rose almost sevenfold between 1948 and 1957, whereas the production of ordinary bricks rose only 2.3 times. It will also be noted that, though the building programme has steadily expanded, the number of roofing tiles produced yearly has remained almost stationary since 1953

---

(1) See "Das Fertighaus Mustersiedlung Wien Veitingergasse", "Der Aufbau", Vienna, December 1954.

(2) See "Annual Bulletin of Housing and Building Statistics for Europe", Table 14.

while the production of asbestos-cement materials continued to increase very substantially (2 million m^2 in 1953 against 3.7 million m^2 in 1957). Lastly, the big increase in the production of concrete blocks and prefabricated concrete parts will also be remarked.

Progress towards rationalization of building construction

(a) Technical qualifications of personnel

The technical training of the higher grades in the profession: architects and civil engineers, does not appear to raise any special problems. The Government's reply also mentions the quite advanced technical training given to building site foremen, especially those responsible for the organization of work.

Higher technical colleges (Universities) exist in Austria at Vienna and Graz. In addition, the Vienna Academy of Arts also trains architects. The exercise of the profession of architect, consulting or civil engineer must be officially licenced. This licence is granted each year to graduate engineers and to architects, who number from 60 to 80.

There are eight secondary technical schools (Higher Arts and Trade Schools) for the training of technicians, the course being a five-year one. In addition, for the training of specialized workers, there are eight schools for building workers, where a six months' apprenticeship is served (winter courses last for three seasons), and a special school for carpenters and stone-masons.

Various firms organize supplementary courses to complete the professional training of masons and polishers.

(b) Organization of house-building

The examination of housing schemes is the responsibility of the research departments of the various public departments or of architects or civil engineers who are very often also responsible for supervising the work. In certain cases the firms executing the work have their own research departments.

The documents describing the scheme generally include plans, detailed instructions for executing the work and detailed measurements on the basis of which tenders are obtained from contractors.

For practical purposes, the Federal Ministry of Trade and Reconstruction, working on the basis of various documents already published, particularly the Austrian standards already issued, has established standard quantitative specifications for the various services that have to be rendered in building dwelling-houses. These specifications must be complied with in the case of buildings subsidized by the Housing Reconstruction Fund and, because of the excellent results obtained, these specifications are also applied to all construction work that is officially subsidized and even to private house-building. Contractors are usually invited by public notice to tender for buildings erected by public authorities. The construction of subsidized dwellings or those built for a strictly private use is mostly done under private contracts concluded directly between the builder and the contractor. No action seems to have been taken at national level to ensure the continuity of demand or to encourage certain special building methods. Full freedom is thus left to private initiative in this sphere, it being understood that contractors may, in their tender, suggest solutions other than those specified in the call for tenders, the governing considera-tion being that of cost.

The granting of a bonus for the completion of work before the target date is hardly ever stipulated. Clauses prescribing penalties for delay are more common, although there is a noticeable trend to abolish these by careful planning of the work and fixing the time-limits for its execution.

The procedure for signing contracts and the provisions for the revision of unit-prices are covered by national standards but there appears to be a tendency to revert to fixed prices.

In the fixing of prices, allocation of work and the general contract terms, the following are the standards usually applied in Austria;

A 2050 Conditions for submission of tender

B 2060 General regulations concerning allocation of the work

B 2061 Fixing of unit prices

B 2110 General contract terms

B 2111 Contract terms for construction at unit prices

B 2112 Contract terms for work done under State control

B 2113 Conditions laid down in the contract for building-site machinery and equipment.

(c) Mechanization

The dearth of specialized building workers mentioned in the Government's reply might explain the trend towards greater mechanization. However, the information obtained seems to indicate that the operations which have been most highly mechanized are, in fact, those which can be done by non-specialized manpower. This observation, incidentally, applies to most European countries.

The manufacture of building-site machinery and plant appears to be highly developed and diversified in Austria. Some of these machines are even exported, but not, however, the heavier types. The public authorities have encouraged this trend, particularly by a system of taxation that encourages the purchase of material and by reducing Customs duties on imported heavy machinery. Contractors, for their part, have used mechanization to the greatest possible extent, and have often organized special courses for the technical training of their personnel.

As pointed out above, the biggest mechanization effort has, for the time being, been made in digging, excavation and earth-moving operations, generally. The relatively high level of wages makes it particularly worth while to mechanize these operations. Savings of some 60 to 70 per cent have been mentioned in the case of excavation work. The use of cranes and belt-conveyors is fairly widespread, as is also that of fork-lifts and trolleys, used mainly for making bricks and concrete blocks. The bulk carriage of cement, which at the moment is confined to large building sites, tends to become more and more common. The generalized use of tubular scaffolding and new rationalized types of wooden framework, which will likely mean savings of some 60% in materials and 25% in the manpower required for erecting them, will also be noted. Lastly, the specially elaborate measures taken to ensure the continuity of construction work during winter will be noted. Some of these installations provide for mobile and insulating protective casings, combined with hot-air generating plants using fuel oil which are installed at the foot of the building under construction. Most of the heating installations are, incidentally, being converted to fuel oil (both at the building site and the factory) because more and more petroleum is being produced in Austria.

(d) <u>Standardization</u>

Relatively few builders recommend the use of model plans in house-building. Standardization is applied mainly to finished and semi-finished building materials. Some specially big building firms and public housing bodies often insist on standardized materials being used in their jobs. The adoption of a basic standard of modular co-ordination is at present being considered.

In pursuance of the Law on Standards of 24 February 1954 (BGBC), No. 64/1954, the Federal Ministry for Trade and Reconstruction has given the Austrian Standardization Commission (ÖNA) the exclusive task of drawing up and disseminating Austrian standards.

The application of these standards has already had very important results. Thus, as a result of the application of Austrian standard B.3201 for bricks, bricks of one size only are now used practically everywhere in Austria. The same is true of the other principal building materials and the manufacture of certain components such as doors, windows, certain fittings, lifts, etc.

Further, by insisting on a certain specifically stipulated quality for various products and by prescribing measures for the control of such quality, a fillip has been given to the manufacture of similar products of like quality and to the standardization of many categories of products. Regulations concerning quality and its control are included in the Austrian standards (ÖNORM-Blätter). A quality mark is issued generally by an association of the industries manufacturing the article in question (for example, the Association of Concrete Manufacturers) after it has been verified in special laboratories.

In order to rationalize building operations even more and to encourage the standardization of building components, the Society for Research on House-building has undertaken, jointly with the Federal Ministry for Trade and Reconstruction and the Liaison Office of the <u>Länder</u> to standardize not only the technical, but also the legal, clauses in all building regulations in the <u>Länder</u>. It may thus be hoped that the same measurements will be made binding in future for the height of rooms, the width of staircases, etc. If these efforts succeed it should be possible for other building elements to be standardized and they could then be used all over the Federal Republic of Austria, particularly in the construction of popular dwellings.

With regard to modular co-ordination, Austria has collaborated in Project AEP 174 "Modular co-ordination in building" and an Austrian standard B.1010 already exists for preferential modular measurements in construction. This new standard is to serve as a basis for any new standardization measures adopted in Austria. Its practical application is, however, still meeting with certain difficulties, mainly because no international module has yet been decided on.

(e) (f) <u>Introduction of new materials and development of traditional materials</u>

The use of small prefabricated concrete components (floor joists and transoms, window lintels and ledges, steps for staircases) is very common. The need for the rational use of demolition materials and the shortage of bricks which marked the period immediately following the war, have induced builders to use ordinary <u>in situ</u>

concrete or rubble concrete. Later, fibreglass sheets ("Heraklith"), which serve both as a thermal insulator and for interior framework, were introduced. Other wall-building processes, including large hollow blocks made of wood fibre or shavings with a hydraulic binder ("Durisol" type), which are later filled up with ordinary or reinforced concrete, have also been introduced with some success.

Many insulating materials have come into common use, e.g., glass-wool sheets or boards, wood by-products, polystyrene moss, cork, etc.). Floor coverings made of organic materials (linoleum, rubber carpets) often take the place of the traditional parquet flooring in living-rooms. Plastic materials are also used for fittings or in the preparation of paint work done with paint sprays. The use of metal window frames and metal frames for interior doors tends to increase.

In the field of cement technology the use of cement silos has already been mentioned, especially on large sites. Concrete additives are also largely used, especially for work done in winter.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add.(b)
17 March 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

County Monographs

BELGIUM

1. Relative importance of traditional and non-traditional methods of house construction

In Belgium, because they are the principal customers, the State agencies and the officially recognized bodies responsible for the financing of housing exert a considerable though indirect influence on the organization of the housing market and even on that of the building concerns. Approximately two out of every three dwellings are built with the help of funds lent by State-approved public finance bodies.

Of the dwellings built with the help of grants or loans from public bodies, about one-fifth to one-quarter are built by corporations belonging to the category of local building corporations which are financed by the Société nationale du Logement (National Housing Corporation) [title hereinafter abbreviated to SNL]. A report prepared by the SNL has been submitted as containing a typical description of the methods employed in Belgium for the purpose of relieving the housing shortage.

In brief, the emphasis has been on economy in the planning stage, on standardization of building materials and components, on freedom for contractors to purchase in the cheapest markets, and on the highest possible degree of mechanization in the sector employing traditional methods. Non-traditional building techniques, involving more or less advanced prefabrication do not play a very important part.

While it is true that the use of prefabricated flooring elements and of light facing elements has been growing steadily, it cannot be said that the public authorities have given any encouragement whatsoever to new building methods. Taken as a whole, the building industry has therefore remained loyal to the forms which are most traditional in the craft.

2. Progress towards rationalization of building construction

(a) Technical qualifications of personnel

The problem of the vocational training of workers in the building industry is certainly one to which Belgian leaders are alert. For example, the Conseil professionel de la Construction, as part of its study of manpower problems, set up a vocational training commission which submitted its report early in 1958.[1] There are at present several ways of solving this problem, which has become more pronounced owing to the shortage of skilled building workers. For instance, efforts are being made to attract workmen or adult workers from other sectors to vocational training centres; a system of apprenticeship has been established under which persons are apprenticed to selected employers through the Apprenticeship Secretariat (approximately 1,000 young men took this training in 1956); and lastly, day, evening and supplementary courses have been organized in trade schools of various standards (nearly 1,400 students graduated from the building courses given during the school year 1954-1955 in trade schools throughout the country).

The report cited above discloses gaps in the present organization, and practical measures have been proposed to increase the number and improve the qualifications of the young workers who avail themselves of this training.

(b) The organization of house building

The SNL has made a considerable and sustained effort to simplify and standardize the technical and administrative documents relating to invitations of tenders. In particular, a high degree of standardization has been attained in the formalities observable in consultations with firms, in the form of the detailed and summarized quantity surveys and the nomenclature of the items appearing in these surveys, in the basic technical specifications and in the physical appearance of the documents. In addition, under the regulations of the SNL the contractor must prepare in respect of each project a plan of operations at the building site and a graph showing the timing of the various operations and the number of workmen effectively employed in each operation. This plan must be submitted to the SNL within two weeks of the receipt of the building licence.

---

(1) "The vocational training of workers in the building industry" (La formation professionelle des travailleurs de la construction), Commission pour la formation professionnelle, Conseil professionnel de la Construction, Brussels, 26 March 1958.

It is thought that these measures as a whole have helped to lower the building costs of projects sponsored by the SNL at a time when the general level of both labour and material costs was rising.

Since in the main the methods used are traditional and since the details of the construction of buildings approved by the SNL are well known, there would seem to be no real need to consult the contractor at the design stage in the case of small individual dwelling houses.

There is no approved system for cost accounting at the building site. Certain undertakings in Belgium use the piece-work method or grant output bonuses, but this is not a general rule. Indeed, a certain reluctance on the part of the building industry to employ these methods has been noticed.

(c) Mechanization

In Belgium, the building industry has always been highly mechanized, and there are many firms manufacturing the materials and equipment required by building contractors.

The position in Belgium is comparable to that in most other European countries: a normal evolution is taking place and the machine is progressively replacing manual labour as the economic situation develops.

In the mechanization of the building industry the decisive factor is the insufficiency of plans that will guarantee a continuous utilization of specialized heavy equipment for long enough to reduce the period of amortization to a reasonable length. It is for this reason that light mobile or many-purpose machines are manufactured in preference to heavy equipment.

Some manufacturers supply machines and equipment on a sale or hire basis, but the charges for hiring machines are often high since these charges must cover numerous risks. In some parts of Belgium, contractors form groups for the purpose of renting machines and equipment belonging to them, and they lend them to each other, on terms laid down in the renting contracts, as the need arises. The shortage of workmen trained to handle machines does not appear to be hampering the development of mechanization in the building industry.

The types of machine and equipment available are, in general, comparable to those used in other countries of western Europe.

The reply to the questionnaire adds that the data relating to the working of various machines are supplied by an organization known as the Bureau des temps élémentaires, and that they are very valuable.

(d) Standardization

(i) Plans for dwelling houses

The SNL has prepared model plans for low-cost dwelling houses in which the waste space is reduced to a minimum. These plans are not compulsory, but the builders are tending more and more to follow them fairly closely. Rules prescribing the maximum and minimum sizes of rooms exist (for extracts from these rules see table below).

Table 1

Size of rooms

(in square metres)

Description of room	Minimum	Maximum
Living room, separate from kitchen[a]		
- with dining recess	19	23
- without dining recess	13	17
Kitchenette	4	8
Kitchen/dining room	9	15
Living room with kitchen recess	16.50	19
Sitting room	7	11.50
Laundry and utilities	3	4.50
Principal bedroom	10	14
Single bedroom	4.50	7.50
Double bedroom	8.50	12

(a) For a family of five.

As a general rule, the habitable area represents not less than 75 per cent of the area of the dwelling in the case of one-family houses and 85 per cent in the case of apartments. Designs which do not respect the ratios represented by these percentages are considered wasteful of space.

The minimum dimensions in the above table are considered adequate in cases where built-in cupboards are provided.

Storey heights (floor to floor) are as follows:

normally recommended	2.50 metres (ceiling height 2.50 metres)
permissible	2.60 metres
special cases, excluding bedrooms	2.70 metres

In some of the model plans, the laundry and utility rooms are placed in the basement, the height of which must not exceed 2.20 metres. By the standards of some other western European countries this would be considered as a rather expensive luxury especially since two staircases (one exterior and one interior) may be included. In addition, if the laundry is placed in the basement, the house drains may be placed below the basement floor which, on a level site, would require very deep trenches for the general drainage system.

It is recommended that plans should conform to the module of 10 cm set up by the Institute belge de normalisation (Belgian Standards Institute).

Certain exceptions are possible, as for example in the case of the thickness of partitions and floors, where strict adherence to the module would be wasteful of material.

In the case of the under-mentioned parts of houses, contractors are recommended to conform to the prescribed dimensions:

door and window openings

staircases (number of stairs according to storey height)

(ii) Construction materials and components

So far as the principal building materials are concerned, standards are recommended by the SNL which, however, are not binding.

The dimensions of doors and windows are fixed by the SNL which also recommends the use of low-cost wooden frames with nailed joints.

Advanced standardization has in practice been an important factor in reducing the cost of dwellings built with the approval of the SNL.

(e) Introduction of new materials

Many new materials have been introduced into the building industry in Belgium thanks mainly to the initiative of the manufacturers and to competition. The following may be mentioned in particular:

(i) Plastics

The production of smooth and corrugated facings, wall facings with a plastic-coated impregnated textile or cardboard base, and insulating components of expanded polystyrene, has made considerable progress in recent years. Bakelised wood panels have also been perfected and used with success.

(ii) Metals

After heavy capital investment, various processes for the surface cladding of thin steel sheet to enable it to be used as interior or exterior wall facing have now been perfected and are being offered commercially in Belgium; in particular "skinplate" (plastic/steel combination), electrolytically galvanized steel sheet and enamelled sheet are now on sale. Parallel efforts have been made in the aluminium industry, which now produces a wide range of sheeting for exterior facings or roofing, shapes and sections for interior (doorframes) or exterior fittings and special sections for large-size prefabricated panels ("curtain walls").

(f) Development of traditional materials

Important changes have occurred in the use of large-size hollow bricks and concrete conglomerate blocks for masonry which is not exposed to view.

In recent years many factories have been set up for the manufacture of concrete components from lightweight aggregates of the "bims" type or aerated concrete blocks manufactured according to certain processes, some under foreign licence. In consequence of the competition between concrete parpen and ordinary bricks, which became possible because of the application of a common module and the adoption of functional standards by the SNL, the cost of bricks has declined, despite the great commercial demand for bricks.

Wooden frames with nailed joints, prefabricated on the site, the use of which is becoming increasingly general each year, leads to considerable economy in the use of timber.

Light materials in the form of large panels are being increasingly used as partitions, but so far panels measuring the full height of a storey have not been very widely used. A factory was recently set up for the manufacture of such panels.

Very definite progress has been made as regards frames and strutting for concrete blocks cast on the site, which, together with accelerators for setting concrete, enables concrete floors to be cast on the site, the cost of such floors being no higher than that of prefabricated floors.

In the cement industry a far-reaching concentration of firms has occurred in recent years, and there has been a thorough renewal of plant. The relative share of Portland and metallurgical cements in the total output of cement (4/5 and 1/5 of the total, respectively) has remained unchanged, while the volume of output followed fluctuations in the domestic market and in export demand.

The trend in the paint industry is towards the manufacture of emulsified water paints, especially synthetic latex paints and vinyl sprays, and towards that of synthetic enamels.

(g) More rational use of materials

There are no national regulations governing the stability and fire resistance of buildings. In Belgium, these matters are within the competence of the communal authorities. However, so far as concrete and steel are concerned, most of the municipalities apply the standards studied by the Institut belge de Normalisation (NBN 15 for concrete, NBN 1 for steel).

The stress per square metre is generally fixed by the contractor in the light of the use to which the building will be put. In the case of collective dwellings, the overstress is generally fixed at 150 kg per square metre.

At the local level the new building methods are generally subject to exceptions authorised by the College of Burgomasters and échevins. There are no national regulations prescribing the standards to be attained by these new methods. Building regulations are not revised periodically.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.(c)
17 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

CZECHOSLOVAKIA

1. Relative importance of traditional and non-traditional methods of house construction

It has been government policy to raise the productivity of house-building by the following measures:

- mechanization of processes wherever possible
- industrial organization of work at the building site
- continuous method of construction
- increased use of prefabricated units through introduction of standardization
- lighter-weight construction

Large building undertakings have been formed out of the multitude of small, unproductive and under-mechanized undertakings. The policy has been to develop a new building technique in which all the factors enumerated above are co-ordinated in a uniform programme.

Emphasis has been placed in Czechoslovakia on reduction in weight, a factor which often tends to be overlooked. Thus in five successive stages in the evolution of "industrialized" dwellings the total weight has been reduced by about 30%, which in itself represents a very important economy and would account for a considerable proportion of the increased rate of production recorded.

At the same time, house plans have been progressively improved in the sense that wasteful circulating space has been reduced whilst maintaining the area of habitable space.(1)

The proportion of housing produced in the "industrialized" sector is already significant. The target for the period 1956-1960 is for a total of 330,000 dwelling units, averaging 66,000 a year, but with a progressive increase in output so that in the later parts of the period the rate of building will be much higher than the average. The production of dwelling units in the "industrialized" sector is shown in the following table:

---

(1) See Table 4.

Table 1

Number of Dwelling Units Produced in the "Industrialized" Sector

Year	1953	1954	1955	1956	1957	1958
Number of dwelling units	371	603	1,760	3,027	5,531	9,712[a]
(a) Planned						

It would appear that at present the industrialized sector is providing 15 to 20 per cent of the total number of houses in the current programme, and additional factories are now under construction which will raise the productive capacity to nearly double the 1958 figure.

The emphasis in Czechoslovakia is towards gradual industrialization of the building industry, by means of which the output of the existing labour force will be progressively increased.

The importance of the efforts devoted to a greater industrialization of house-building and the impact of technical policies on the total output of the industry and on the general level of costs, are summarized in Table 2. The data concern only the construction of new residential buildings under the state house construction plan. The average price of a dwelling, as shown in the table, refers to gross dwelling costs, i.e. including expenditure on connexions to mains, landscaping, etc. The net average price of the dwelling is approximately 12 per cent lower. It should also be noted that the average floor space of flats in 1957 increased by 4.1 per cent compared with 1956 and amounted to 37.3 m^2; the reduction in the average price of flats was therefore attained with a simultaneous improvement of housing standards.

Table 2:

Indices of Dwelling Prices for Different Types of Construction

Classification	1956 Proportion of dwelling units	1956 Average price of dwelling in crowns	1957 Proportion of dwelling units	1957 Average price of dwelling in crowns	Index number of the average price of the dwelling (1956 = 100)
Czechoslovakia - TOTALS	100	99.9	100	95.7	95.8
1. Buildings erected to standard designs(a)	71.8	98.2	75.2	93.4	95.1
including T-13	35.5	97.7	28.4	91.9	94.1
T-15	15.4	99.0	10.3	89.0	89.9
Buildings erected to individual designs	28.2	104.4	24.8	102.9	98.6
2. Technology applied in construction(b)					
1st degree	19.0	107.0	24.3	101.3	94.7
2nd "	65.9	99.1	59.0	93.3	94.1
3rd "	13.9	100.1	10.6	94.9	94.8
4th "	1.2	98.3	6.1	98.7	100.4
3. Traditional method of organization of building work	71	100.3	81.5	96.2	95.9
Advanced method of organization of building work (stream-line method)(c)	29	99.1	18.5	93.5	94.3
4. Size of the residential building(d)					
up to 5 000 m^3	23.0	103.8	31.2	95.0	91.5
5 001 - 10 000 "	28.1	98.1	28.2	93.3	95.1
10 001 - 20 000 "	23.9	97.1	23.7	97.8	100.7
20 001 - and more	25.0	101.2	16.9	98.0	96.8

(a) Designs not prepared specially for a single building but for a large number of residential buildings are called standard designs. Such designs may, however, be adapted to the actual conditions of a given site. A design prepared without the use of any conventional document and intended for the construction of a single residential building is called an individual design.

(b) The first technological degree includes residential buildings erected entirely on the site, with the aid of brick or monolithic construction and the use of traditional materials, such as cement, bricks, small slabs etc.
The second technological degree includes the use of small prefabricated parts weighing less than 600 kilograms.
Residential buildings of the third technological degree are those built of brick, lightweight or reinforced concrete pieces, parts and panels weighing from 600 up to 2 000 kilograms.
Housing units of the fourth technical degree are assembled from large, complete, prefabricated parts and panels the weight of which generally exceeds 2 000 kilograms. In the fourth degree, only the construction of panelled houses, system G, was completed in 1956. In 1957, in addition, houses, system BA were completed, but cost more. Hence, the apparent rise in prices. As a result of changes in design and structure, and of the reorganization of panel production industry in 1958, prices will be considerably reduced.

(c) Advanced method of building work - stream-linedmethod - includes work carried out without any interruption between the individual production processes. All operations flow rhythmically, a constant number of workers being employed on each working process. The stream-lined method allows building work to be carried out on a production-line system, thus ensuring the rhythmic flow of the whole production process in its technological sequence. Thus, the stream-line method requires precise timing of transport, the uninterrupted supplying of workers with materials (according to the short-term plan), the introduction of mechanization and increased mechanization of all branches of building work.

(d) The cubic content is determined according to the definitions agreed in the ECE Housing Committee.

In 1957 the average actual cost of a dwelling after deducting profit was lower by 3.9 per cent. When the first technological degree was used, costs were on the average 0.5 per cent lower than the final prices, 2.9 per cent with the second technological degree, 3.3 per cent with the third technological degree and as much as 14.0 per cent with the fourth technological degree.

Table 3 shows that industrial building methods are also faster.

Table 3

Average Building Period Required for One Dwelling in New Houses Completed in State Construction Schemes in 1957 According to Size Operation

Size of building. m^3 of gross volume	Technological degree of construction	Average construction period for one building in months	Average construction period for one dwelling in days
2000 - 5000	1st degree	15.9	52
	2nd "	13.3	41
	3rd "	13.2	35
	total	13.7	44
10001 - 15000	1st degree	20.0	19
	2nd "	19.5	19
	3rd "	16.7	16
	4th "	9.0	7
	total	17.6	16
20001 - and more	1st degree	27.0	20
	2nd "	23.0	9
	3rd "	18.6	6
	4th "	13.2	3
	total	22.3	8

2. Progress towards rationalization of building construction

(a) Technical qualifications of personnel

Architects and structural engineers graduate from the respective faculties of the three state Polytechnics (technical universities) of Prague, Brno and Bratislava; two of these Polytechnics also have a separate faculty of "engineering economics". Approximately 150 architects and 1,000 civil engineers are qualified every year (1957 figures). In addition an increasing number of students attending a four-year building course at one of the High Technical Schools qualify as "production engineers" (from 950 in 1954 to over 2,800 in 1958).

Training of supervisory grades, as well as of skilled and specialized workers (welders, crane-conductors, etc.) is carried out either in boarding schools under the auspices of the Ministry of Building or in the building enterprises' working schools. Out of the 5,000 apprentices who have qualified every year at training courses during the last five years, an increasing number have taken bricklayers' courses (2,000 to over 4,000). It is also estimated that about 35,000 operatives and 15,000 technical and administrative clerks[1] follow every year the training courses organized by the building undertakings.

(b) Organization of house-building

Within the framework of the national economic plan, the task of designing and erecting buildings in general and housing in particular is shared among the following organizations:[2]

The State Committee for Building is the body responsible for the control of technical policies and for town planning. In each of the 21 regions there is a regional national committee, comprising a building department which is placed under the joint authority of the Council for regional national committees and the State Development Board. A similar organization applies to local committees. On the whole the organization responsible for the main technical decisions is heavily centralized, although there is a noticeable trend towards a certain degree of decentralization. The State Committee, which approves all major building projects, has also worked out a schedule of standard prices for every type of building operation and material, including transport.

The State project institutes are responsible for the design proper, and perform much the same functions as private architects or engineers in other countries. They are comparatively large organizations, employing from 200 to 500 people, including qualified professionals, designers, specialized consultants, draftsmen and subsidiary technical and administrative staff. The complete project worked out by these institutes includes a detailed estimate of the sale price, based on the standard rates referred to above.

---

(1) Representing over 10 per cent of the total labour force of the building industry.

(2) It has been considered useful to expand this section, in order to give a comprehensive picture of the organization of house-building in Czechoslovakia, which can be considered to some extent as representative of other Eastern European countries.

Actual building operations are carried out by different types of organizations: national corporations placed under the authority of the Ministry of Building; communal establishments organized by the national and local committees mentioned above; and co-operative establishments, which are part of the Federation of production co-operatives. The most important among these enterprises have their own project departments which carry out the detail design work required in connexion with the actual building production requirements.

National corporations are responsible for a major part of new house-building, which represents from 40 to 60 per cent of their total output; 20 to 30 per cent is devoted to public building other than housing, and the balance to small civil engineering work and industrial buildings in connexion with the development of new housing estates. Each region and each statutory city, having a central national committee of its own, has a corporation in charge of general construction; there are 23 corporations in operation, employing from 700 to 6,000 manual workers each. National corporations act as general contractors and are responsible for the whole building operation, although they sub-contract the execution of special work (earth moving requiring heavy equipment, central heating installations, special electrical installations, etc.) to specialized undertakings.

Communal establishments are mainly responsible for maintenance and repairs; not more than 15 per cent of their activity is devoted to new building construction, and this only in order to supplement the production of national corporations in local conditions. They comprise a large number of operatives specialized in the finishing trades (glaziers, painters, etc.) required for current maintenance work. Lastly, co-operative establishments employing a few dozen workers have sporadic activities in much the same field as communal establishments; their share in the construction of new dwellings is nevertheless negligible.

On the basis of the estimate prepared by the project institute, the investor seeks agreement from a building corporation to carry out the work accordingly. When this has been secured the estimate is binding for both parties; any further modification entails revision of the total price, but requires the approval of the project institu responsible for the original estimate. Provision is also made for arbitration.

It is for the technical department of the building corporation to prepare the detailed plan of the building operation. This includes: site layout with location of equipment and small site prefabrication workshops; schedules and specifications of work to be sub-contracted; detailed schedules of labour, materials and machinery requirements for each building operation; progress charts and cost targets for parts or the whole of the operation, etc. In the preparation of such operational plans, building corporations are greatly assisted by the adoption of uniform costing and accounting systems and standard labour and material-rates for each individual item of construction or building operation. (Separate costing systems exist for building and major civil engineering schemes). Time and motion studies are used to establish performance standards for new building operations; once adopted time standards, i.e. the time required to produce a technical unit of work, are compulsory throughout the country and are used as a basis for calculating piece work rates, accounting for 97.6 per cent of all wages paid in the building industry. The balance comprises either plain time wages, or wages with bonus, bonuses representing about 1 per cent of total wages. Reserves are also constituted out of the total wages paid, to a maximum of 2 per cent of the total, to reward extraordinary performances, special merits, etc. In addition competition between teams of workers is encouraged as a means of attaining economic and social objectives as part of the national plans of economic development, and in this connexion recognition, including special prizes, is given to outstanding teams or individual workers. Site supervision is entrusted to qualified staff members of the national building corporation. Technical inspectors representing the investor and the project institute responsible for the design also follow the progress of building operations and their compliance with quality standards. An amount varying between 0.4 and 1.5 per cent of the total cost is set aside for these expenses.

(c) Mechanization

The policy of the government is to aim for the highest possible degree of mechanization, rising progressively by stages.

Earth moving operations have been the first objective. Digging operations are 84 per cent mechanized at the present time (1958) and the aim is to reach 95 per cent. For earth moving operations of all kinds the present degree of mechanization is 69 per cent, which it is intended to raise to 85 per cent by 1975.

Horizontal transport of materials is already highly mechanized and the present degree of mechanization is in the proportion of 52 per cent for soil transport, 20 per cent for sand and gravel transport and 28 per cent for other materials.

Vertical transport is completely mechanized. Studies are being made of dismountable cranes to be produced in a series of 10, 20, 40 and 80 ton/metre.

It has already been noted that the different technological degrees of house construction are defined in terms of the weight of the largest element to be handled on site. This classification is of course intimately related to the type of lifting equipment required on the site: thus the second degree implies the use of a light tower crane, the third degree can be handled by a medium-sized tower crane, while the fourth degree requires a rail-mounted tower-crane.

Concreting work consists of the handling of aggregates and of cement, mixing, transport and pouring. Concrete-mixing is 100 per cent mechanized but transport of mixed concrete is only 20 per cent mechanized. In the industrial sector full mechanization of concrete operations is aimed for by 1975 and the remainder of the industry should be similarly served by the same date.

The handling of bricks in containers was in an advanced state of development in 1955. Of the total number of bricks used in house-construction by building undertakings coming under the Ministry of Construction, 21 per cent was transported in containers. It was found that in addition to a saving of ten man-hours per 1,000 bricks handled there was a saving in breakage of 35 bricks.

The packaging of tiles is also being introduced in Czechoslovakia.

Mortar mixing for bricklaying and plastering was virtually 100 per cent mechanized in 1956 at central mixing plants. Transport of mortar to site was in the process of being mechanized.

A mortar pump, which could be used as a plastering machine, with a capacity of 3 m^3/hour was developed in 1956 and another plastering machine with a capacity of 2 m^3/hour was also developed. About 350 of these machines are at present in operation; their number will increase in the immediate future, although the latest technological developments must eventually make them redundant. A concrete pump with a capacity of 6 m^3/hour was produced.

Pneumatic tools are used for rockbreaking and for other processing screw-cutting machines, pipe-leading machines, terrazzo grinding machines and other equipment are used.

It is planned to increase the mechanization of finishing operations, now rated at 12 per cent, to 50 per cent by 1975.

The growth in the degree of mechanization of all operations, now considered to be at a level of 35 per cent, is planned to rise as follows:-

1960: 46 per cent; 1965: 52 per cent; 1970: 60 per cent; 1975: 65 per cent.

(d) Standardization

Great importance has been attached in Czechoslovakia to standardization and standardized methods of design.(1) The Institute for Studies and Standardization and the Institute for the Industrialization of Building are responsible for all questions of standardization on a national scale.

Within the framework of what appears to be a very coherent technical policy, standardization embraces three essential stages: the design of type plans for a given category of building (not only housing but also schools, hospitals and other public buildings); the working out of type projects, including quantities and quality of labour materials and equipment required, unit prices and overall estimates of costs, etc. (see paragraph on organization of building); the production of standardized building materials and components necessary for the execution of type projects.

Although type plans have national coverage, allowance is made for local conditions. Thus regional design institutes are authorized to adapt foundations and more generally work below ground to local soil conditions; to suggest replacement of materials or building methods taking into account local resources in terms of building materials, transport facilities, availability of skilled labour etc.; or even to vary elevational treatments. In 1956, more than half of the dwellings erected were based on type projects; in 1957, the proportion was nearly 80 per cent.

Type plans show a progressive improvement in the direction of a reduction of non-inhabitable space and improvement in amenities. The trend of these improvements is shown in the following table, which applies to traditional methods of construction. Fully industrialized construction has its own standardized plans.

---

(1) See "Standardization of residential and civil buildings in Czechoslovakia", Prague, May 1958.

Table 4

Development of Standard House Plans

Plan type	T.13	T.01 B	T.16	T.02 B
Floor area (m^2)	78.25	64.70	74.70	64.70
Inhabitable floor area (m^2)	33.15	34.10	31.80	34.10
Volume (m^3)	223.00	194.00	224.00	194.00
Percentage of inhabitable floor area to total floor area	42.4	52.7	42.6	52.7
Material requirement (m^3)	54.2	36.4	43.5	35.6
Labour requirement per dwelling (hrs)	1,340	999	1,150	967
Labour requirements per m^2 of floor area	17	15.5	15.4	15
Price per dwelling Cz.cr.	62.900	54.550	74.800	55.720
Price per m^2 of floor area	800	845	1000	860

Ceiling heights are now fixed at 2.65 to 2.80 metres and the latest industrialized dwellings have a height of 2.55 metres.

Parallel to the development of type projects, a consistent effort has been made to reduce the variety of building materials and to standardize their qualities and their dimensions. National standards exist for most of the basic building materials (cement, steel, timber, bricks, cement blocks, etc.) and for building components (doors, windows, cupboards, sanitary and electrical appliances, etc.).

Methods of using the materials are also extensively codified. Thus national regulations have been issued for the design of structures (concrete, brickwork, timber, steel) as well as "codes of practice" for the execution of work: (reinforced and plain concrete structures, prestressed concrete structures, steel structures, some finishing works, etc.).

(e) New materials

Considerable work is in progress on the development of new materials aimed to reduce the weight of the main structural elements of building. The following in particular are reported:-

- Foamed slag. Two plants are being built at ironworks and a further expansion is envisaged, drawing on slag produced in other industries as well as iron and steel.

- Two plants are being constructed to produce light-weight concrete blocks using pulverized fuel ash for larger power stations. Construction of other such plants is contemplated.

- Production of autoclaved foamed concrete and, for concrete of lower strength, foamed concrete not autoclaved.

- Use of light-weight natural rock such as diatomite and diatomaceous earth.

- Use of waste from mines such as spent shale and clinker from power stations.

- Use of expanded clay for the production of light aggregate (e.g. keramacite).

- The use of plastics is expanding very rapidly: hot and cold water pipes, sanitary equipment, waste water pipes, conduits for electrical rising mains, wear-resistant floor coverings, framed insulation panels, corrugated sheets for roofing, laminates for flat roofs, etc. are being introduced in the industrialized sector with increasing success. Some of the above uses of plastics are closely linked with the prefabrication of complex building units: standardized installation blocks, composite external in-filling panels of "curtain wall" type, movable partition panels, prefabricated elements of central heating installations, etc. In many of these developments, plastics are associated with light alloys (window frames, partitions, curtain walls) or with wood derivatives or other industrial wastes (flooring materials).

(f) Development of traditional materials

The normal process of research and development leads to gradual improvements in traditional materials which enable production costs to be reduced and economies to be effected due to improvements in quality. In Czechoslovakia the following developments have taken place in the last few years:

The expanded use of pre-cast concrete components has prompted the development of quick-setting cement, in addition to the normal line of cements currently used in construction (ordinary, and high-grade Portland cement, blast-furnace cement, iron cement, etc.). Bulk transport of cement has also been introduced.

A new technique for producing lime with a higher thermal efficiency is being studied, while the general trend is towards the production of grinded limes, artificial hydraulic limes and lime hydrates.

The production of bricks has doubled in the last six years, from 912 million in 1951 to 1811 million in 1957.[1] Emphasis has been laid on the production of hollow bricks of 2.5 metric modules, i.e. 25 cm., as well as larger light-weight clay blocks. Special clay blocks used in the construction of pre-stressed floor panels are also extensively used.

---

(1) See "Annual Bulletin of Housing and Building Statistics for Europe", ECE, Geneva, 1957, Table 14.

The production of clay roofing tiles has remained fairly constant; the alternative use of single-layer cement tiles is being developed.

(g) Economy in use of materials

As a result of research and development the disparity between actual loads and stresses and the assumptions which have to be made in the design of structures becomes less. As the "factor of ignorance" diminishes considerable economies can be effected. In addition new techniques are developed which themselves contribute to economy in materials. Recent Czechoslovak standards have prescribed ultimate stress design for reinforced concrete and masonry structures. Safety factors vary between 2.5 and 4.5 in compression; columns, pillars and vaults are designed with a factor of 20. Solid and hollow brickwork is designed with a factor of 2.5 and 3.0 respectively. For steel structures admissible stresses are laid down, from 1,250 Kg/cm^2 to 2,258 Kg/cm^2 according to the quality of steel.

A uniform superimposed load of 150 Kg/m^2 is assumed in the design of dwellings.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.(e)
17 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

FINLAND

1. Relative importance of traditional and non-traditional methods of house construction

The bulk of house construction in Finland has remained traditional during the post-war period. Three main types of dwellings are currently built:

- one family timber houses prevalent in rural districts and in the suburbs;
- masonry semi-detached owner occupied houses, in towns;
- apartment buildings in the large towns

The proportion of non-traditional to traditional construction varies considerably with each type of dwelling. As regards timber houses, the prefabrication of component parts has gained some ground although not as much as might have been expected and certainly little if compared to the considerable volume of Finnish exports of timber prefabs to European and non-European countries. In the last few years prefabricated timber houses have represented 5-10 per cent of those erected in urban districts. Although prefabricated houses can compete in price with traditional houses while providing an adequate standard of quality and durability, a greater expansion of their use has been hindered by the fact that it is usual in Finland to build one's own house for which voluntary labour is not accounted. Masonry houses are built almost 100 per cent according to traditional methods. Several experiments have been made recently to introduce new building techniques well known in other European countries; however, most of them have been abandoned as they did not show appreciable financial gains. On the contrary, the use of light prefabricated concrete elements is becoming more and more frequent. Since 1952, for instance, prefabricated stair flights account for 40-50 per cent of the demand; prefabricated window-sills are also in current use. Over 1,500 dwellings have been built since 1953 with load bearing external walls and partitions cast <u>in situ</u> with sliding shuttering, and structural floors made of <u>in situ</u> reinforced concrete or alternatively of prefabricated beams.

On the whole none of these experiments has proved absolutely convincing. The reason might be traced to the fact that the traditional building industry has undergone a considerable process of rationalization and that dwelling construction is scattered in a considerable number of small sites. A further explanation can be found in the fiscal policy which imposes a 25 per cent turnover tax on all building materials, whereas site wages and overheads are exempted from tax. This means that prefabricated components purchased from the factory have a greater share of taxation than raw materials; although part of the turnover tax is refunded after the building is completed on the basis of a fixed rate per m^2, the difference is still in favour of building methods using a greater share of site labour.

The continued reduction in the total man hours for house building is typical of the development since 1950. To some extent this is due to the increasing use of building machines, improved designs, a more detailed preparation of projects, but the main cause is no doubt the better organization of building firms and keener competition. The following figures provide an idea of this development:

In 1950, an average of 10-11 man hours were required for one m^3 of building; in 1955, the figure was 7-8, in 1958 it had come to 5-6. During the same time the average ratio of total built up volume to habitable floor space had decreased from 5.5 to 4.5. The combined effect of higher productivity and greater efficiency of design has counterbalanced the rise in building costs, which is typical of all west European countries(1).

2. <u>Progress towards rationalization of building industry</u>

(a) <u>Technical qualifications of personnel</u>

Much attention has been paid in Finland to the problem of the technical qualifications of all those engaged in building activity.

Architects and "diploma" engineers are trained at the State Institute of Technology. The number of graduates in selected years since the war is given

---

(1) See "Financing of housing in Europe", ECE, Geneva, 1958, on Table 2, p.2.

in Table 1. Professional practice is not protected by any law stipulating that only graduates can prepare architectural and structural design; architects are nevertheless fully occupied and regularly take part in the numerous competitions held every year for the design of most public and private buildings of some importance. A new category of lower grade "building designers", trained at engineering colleges, will emerge with the first graduates in 1960. "Diploma" engineers are specially involved in the design of multi-storey residential buildings and, naturally, in the design and supervision of major public works. A great number of them are also employed by building contractors.

Supervisory personnel is given special training. Constructional engineers, who received four years' technical training after nine years of primary and secondary education, are mainly responsible for the organization and supervision of work on site (see Table 1). The training of supervisors or "master builders" is done in special technical schools with a three year curriculum, following eight years of primary education. Although many of the trainees attending these courses have had previous practical experience, it is felt that the curriculum is far too technical and that questions of building economy and problems of practical supervision are not adequately covered. Several courses have been organized recently by different organizations or research institutes to fill this gap.

Building workers are trained in two-year courses at technical schools. Table 2 shows the number of building workers employed in 1957, the annual further labour needs, the number of workers actually trained; the difference between the latter two columns shows the requirements for further training. Considerable efforts have been made by the contractors themselves in order to train their operatives; at the same time the State has been erecting new technical schools and arranging courses in connexion with relief work projects.

(b) <u>Organization of house building</u>

Preliminary designs are prepared by the architects and their consultants; detailed bills of quantities however are worked out by the contractors themselves at the moment of submitting tenders. In some cases dwellings are built on a "speculative builder" basis, i.e. the contractor builds his own dwellings for rental or sale; in this case he is obviously closely associated with the design stage.

Work on site is normally organized once the contract has been awarded, although very often insufficient time is available for a proper preparation of building operations. Considerable progress has been achieved in this field thanks to the activity of an organization called "Oy RASTOR Ab" (Rationalization, Standardization, Organization) which has developed out of the "Union of Work Efficiency of Industry" and incorporates since 1952 a building department. The purpose of the organization is to help building contractors in such matters as the planning of site work, drawing up of work schedules, the improvement of methods of control, etc. The largest building firm are shareholders of "Oy RASTOR Ab" although the effect of its work has reached a much wider audience.

During the erection proper of the building, it is rather unusual that accurate cost checks be kept by the average contractor, although even in this field considerable progress is noticeable in the last few years thanks mainly to the interest taken by the State and different research organizations in raising productivity. Thus it is now comparatively frequent to find detailed plans of the building site, careful arrangements of stocks of material, improved design of shuttering in order to save timber, etc.

Most building operations are remunerated on the basis of piece-work rates agreed between the contractor and the representative of the workers; it can be estimated that 30-40 per cent of the total of man hours worked on site are covered by unit rates of this kind. The actual proportion varies between 55 per cent for skilled workers and 10-20 per cent for unskilled workers; it can be as high as 100 per cent in the case of work subcontracted such as electrical and sanitary installations. It has been observed that higher piece-work rates bring about a reduction in overall building time and also in total real cost. The average building time for a multi-storey building is comparatively short and has been estimated at 9-10 months.

(c) Mechanization

Until the war the only machines available on site were concrete mixers and simple winches. Since then the degree of mechanization had increased considerably. Vertical transport is now mechanized almost 100 per cent through the introduction of elevators and tower cranes of which 150 were in operation in 1958. The horizontal transport of bricks and concrete is done by trolleys when tower cranes are not available; the capacity of the typical trolley is 250 litres of concrete or mortar. The delivery of bricks in packages containing 60 units is almost universally adopted; bulk transport is only used for small building sites.

Several types of concrete mixing plants have been developed, complete with hoppers, weighting batches, etc. The most frequently used is the so-called "dragging-rake" plant, operated by one man, with an output of about 10 m^3 of concrete per hour; this plant costs approximately 1,500,000 Fin. Marks. In larger towns ready mixed mortar and concretes of different compositions are also available.

Winter building has required special measures and the development of heating devices. It is estimated that its effect on cost represents between 2 and 6 per cent according to the building time, the weather conditions, the size of the operation, etc.

(d) Standardization

In Finland the word "standardization" applies indiscriminately to product standards and to standard specifications. Strength, durability and classification of building standards have been issued, together with fire-, water-, and sound-proofing standards, as well as rules for the design of reinforced concrete, pre-stressed concrete and steel structures. Materials standards cover cement, steel, timber, etc.; other products in current use such as concrete blocks, cement pipes, woodwool slabs, etc. are also standardized.

The main responsibility for standardization in the building industry lies with the Standards Institute of SAFA (Federation of Finnish Architects). Their approach to standardization has gradually evolved from purely dimensional and qualitative product standards, to the study of typical details and recommendations for the correct design of building components and elements, including the elaboration of improved specifications and general contract documents. This can be partly attributed to the fact that the Institute is almost completely self-supporting and must therefore cover fields where the sale of technical documents is comparatively rentable. For the first six years the emphasis of the Institute's work was on timber building and timber products in general, which is quite natural in a country where most traditional houses are made of wood; recently, however, the problems of standardization in connexion with masonry and reinforced concrete buildings have acquired greater importance. The question of dimensional and more particularly modular co-ordination is the subject of very thorough studies.

A special problem has been mentioned in connexion with the export of timber products, which have to follow two sets of unrelated standards, for the foot-inch and for the metric countries.

Table 1

Progress of the number of designers and supervisory personnel in the building industry

Year	Architects		Diploma engineers		Engineers		Master builders	
	Total	Members of Architects' Federation	Total	Members of Building Engineers' Assn.	Total	Members of Union	Total	Members of Union
1945			380	270	150	-	8,900	4,500
1950		273	515	412	320	-	11,900	6,200
1955		475	650	639	470	300	13,600	6,800
1958		530	730	662	600	400	14,100	7,200

Table 2

Total of building industry workers in 1957 according to occupation

Occupation	Number employed in this occupation	Annual further need of labour	Number of trained per annum	Further need of training	Observations
STRUCTURAL WORKS					
Carpenters	40,750	2,040	450	1,590	
Cabinet makers on building sites	4,800	450	-	400	
Bricklayers	7,100	421)	149	777	
Plasterers	8,450	505)			
Concrete workers	10,140	529	30	499	
Reinforcing workers	2,870	202	-	202	
Slab dressers	760	51	-	51	
Cement workers	3,710	253	-	253	
Sheet-metal workers	?	?	?	?	
Painters	7,000	1,000	119	381	
Insulation workers (bitumen)	380	38	-	-	Training courses desirable
Unskilled workers	68,220	3,370	-	-	
	154,180	8,859	748	4,153	
TECHNICAL WORKS					
Plumbers	3,700	370	47	400	The lack is very great
Electricians	6,000	450	815	-	Teaching of measuring should be increased
Lift workers	130	7	9	-	
	9,830	827	871	400	
TOTAL	164,010	9,686	1,619	4,553	

Distr.
RESTRICTED

HOU/Working Paper No.97 Add(f)
19 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

FEDERAL REPUBLIC OF GERMANY

1. Relative importance of traditional and non-traditional methods of house construction

After the war, the technological development of house-building in Western Germany followed a somewhat different trend than in other European countries. Before the monetary reform in 1948, building activity was very limited. House-building on a large scale did not start until 1950, after the creation of the Federal Republic of Germany and the passing of the Housing Act.

In the years before 1950, several new methods of construction were developed; most of them, however, failed to prove more economical than traditional methods and reached only the experimental stage.

In 1950, when a large-scale government programme of house-building was started, there was no actual need for introducing non-traditional methods owing to the following facts:

(i) no labour shortage in the building industry but a considerable rate of unemployment and, in addition, nearly one million refugees coming every year from the eastern zone of Germany;

(ii) no shortage of building materials, but a very great variety of building materials of all kinds and a growing capacity of the building materials manufacturing industry;

(iii) the capacity of the building industry was great enough to be increased from year to year. The number of man-hours worked in house-building increased from 844 million in 1950 to 1,200 million in 1956. Nearly half the average amount of man-hours worked in the whole of the building industry in recent years was spent for house-building; the number of workers employed in the building industry inclusive of ancillary trades augmented from 1.2 million in 1952 to 2.05 million in 1956;

(iv) the mechanization of the building industry increased considerably from year to year. From about 1953 onwards, even the mechanization of smaller Contractors increased.

In the strict sense of the word, no distinction is made between "non-traditional" and "traditional" building methods in Western Germany; it can even be said that both terms are not used in practice since the actual problem has so far not existed. On the other hand it would not be correct to say that house-building in Western Germany is exclusively "traditional" in the strict sense of the word, since house construction has changed considerably after the war, in particular as far as building materials, building methods, and carcassing are concerned.

The gradual technological development in the field of house-building was considerable. The improvement of usual methods resulted in fundamental changes of construction i.e., in the use of lighter, large-sized, standardized materials and components. Substantial savings in materials and man-hours were obtained, especially as far as wall construction is concerned, through the development and improvement of lighter building materials which resulted in a weight reduction of exterior walls, inclusive of finishing, from 700 kg/m^2 for a solid brick wall (1½ bricks in thickness) used before the war, to less than 300 kg/m^2 for a 24 cm wall of hollow blocks which is nowadays most commonly used. It should be mentioned that both kinds of walls have equal heat insulating qualities. At the same time, the labour productivity per square metre of exterior wall increased by 200 to 300 per cent. In this connexion the compulsory application of standards and modular coordination for houses built with government subsidies was certainly of great importance. Prefabricated houses have played only a minor role. An emergency programme of temporary low-cost housing (so-called "Schlicht-bauten") which was envisaged in the early post war years was not carried out. In 1950, a special research and comparative housing programme was launched by the Federal Ministry of Housing; it comprised also several housing projects where different traditional building methods were to be compared with non-traditional ones; the latter, however, failed to prove economical.

The usual house construction methods have so far been improved in such a degree that new methods hardly show any significant advantage in cost over traditional construction. Moreover, there remains always a certain prejudice against new methods on the part of the housing authorities who build houses and have also to maintain them. This applies even more to mortgage banks which grant loans for house-building.

However one can notice that due to labour difficulties arising in some parts of the country where the building capacity is still very great, the interest in new construction methods and in heavy prefabrication on the type used in Denmark and France is increasing. On the other hand partial prefabrication of components such as steps and staircases, chimney blocks, installation units, roof elements and many others, which can also be used for traditional building, is gaining ground.

From the point of view of government policy, the situation can be summarized as follows:

- non-traditional methods of construction have not been directly promoted by government, although local authorities have encouraged the very successful use of no-fines concrete cast in situ with rationalized methods and special shuttering, using the rabble of war-destroyed buildings;
- new building methods as well as new building materials have to be approved by the "Länder-Sachverständigen-Ausschuß für Zulassung neuer Baustoffe und Bauarten" (State Committee for the approval of new building materials and building methods);
- the research and comparative building programme of the Federal Government was mainly devoted to the improvement and rationalization of traditional methods although non-traditional methods were also employed for testing their economical and technical value;
- the compulsory application of standardization and modular coordination in social housing has been an important factor in the improvement of traditional construction.

2. Progress of rationalization in the building industry

(a) Technical qualification of personnel

The very high level of production in the building industry (about 12 per cent of the gross national product), on the one hand, and the considerable development and improvement in building techniques and new building materials, on the other, require a very efficient professional education of the technical staff of all grades.

(i) Professional and managerial grades

- Architects: Only three out of ten Länder of the Federal Republic have a special law requiring a recognized qualification for architects. A great number of architects have in fact in sufficient qualifications for their profession. Architects graduated from a technical university who enter public administration take additional courses for which they get a special State diploma. One can therefore distinguish three ranks of architects:
  - architects with diploma of a technical university;
  - architects with diploma of a technical school;
  - architects for public administration.
- Engineers: The insufficient co-operation of architects and engineers is often deplored; however in recent times there has been a growing tendency towards team-work of architects and structural engineers. The different grades of education of engineers are similar to those of architects. Contractors employ a great number of qualified engineers: as a consequence of the adoption of new forms of construction and the emphasis laid on economical materials, the importance of having good engineers who have studied at technical universities and technical schools is increasing. The Federal Housing Ministry has sponsored several coursesfor architects and engineers in order to disseminate technical information on rationalization and new building techniques.
- Management: There are two main groups of contractors:
  - "Bauhandwerk", i.e. small contractors with a more handicraft set up and mainly concerned with house-building;
  - "Bauindustrie", i.e. larger firms of contractors with a more industrial set up.

The first group of contractors must be builders of recognized qualification ("Baumeister"); the second group is in most cases headed by a team of businessmen and structural engineers.

The builders federations as well as some building research institutes organize special training courses for contractors and the technical staff of builders.

(ii) Supervisory grades:

There is a great need for well trained general foremen. The function of the general foreman is of great importance in the traditional industry with its increasing level of mechanization and productivity, the use of new building materials, the application of sound and heat insulation, etc. During the last decade, the decreasing quality of building performance has often been criticised. The builders federations, the building research institutes, and the national productivity agency (RKW) promote study courses for foremen. Special training courses are arranged for supervisory and operative grades on the experimental sites of the Housing Ministry before actual construction begins.

(iii) Operative grades:

Craft training in the building industry has in the past been achieved by apprenticeship and education in technical schools. Evening-courses in technical schools play an important part in the instruction in new techniques, new materials, application of standards, etc. The good results obtained in special training courses held on experimental or pilot sites also may be mentioned in this connexion.

(b) Organization of house-building

(i) Preliminary stage: The drawings for public house-building have to be prepared under the rules of the compulsory standards and modular co-ordination, with particular emphasis on heat and sound insulation standards as well as equipment standards. However, the drawings do not always comply with the standards and therefore have to be revised. Drawings are also often incomplete and insufficiently detailed; revision during the erection of the building is frequent and inevitably introduces increase in man-hours and also in cost. A more comprehensive co-operation of architects and engineers should also be achieved. In general, considerable time is spent in arranging the finance of the project and in the purchase of the building lot; insufficient time is therefore left for careful and detailed design. In this respect there is still a wide field for improvement to which the government-sponsored experimental projects have definitely contributed.

(ii) Preparatory stage: Although it is considered essential to have an effective and detailed preparation before the actual erection is started, very often little time was left for this stage due to the short building time available in recent years. Several comparisons were made between experimental sites, with and without preparation and the former proved more economical. On all the above-mentioned experimental programmes (more than 250 such projects were completed in the course of 9 years), special emphasis was laid on a very careful preparation including time table, physical lay-out of site, schemes for the storage of materials, labour schedules, etc. The most successful means of government encouragement in this field were in fact the above-mentioned examples of the experimental building sites.

(iii) Erection stage: The government sponsored experimental sites played an equally important part in the gradual improvement of the erection process. The results of the analysis of man-hours worked, of materials used, and of cost involved have shown where savings are possible. Comparisons between building sites with and without application of detailed methods of rationalization revealed considerable differences. Among the methods introduced one can quote the special training courses before the beginning of the work, the principle of labour organized in teams increased mechanization of the building site and the use of prefabricated single components.

(c) Mechanization

The total stock of building machinery of all kinds, which amount to 900,000 tons in 1940, had decreased to 540,000 tons in 1945. The earliest statistical figures in this field after the war were available only in 1950. Table 1 shows the extremely rapid development of mechanization. A comparison between 1950 and 1957 shows, for example, that the number of tower cranes increased by 880 per cent, dredging machines by 310 per cent, conveyor belts by 214 per cent.

Table 1

Stock and changes in selected groups of machinery between 1950 and 1956-1957

Equipment	Unit	total number			changes in per cent of 1950	
		1950	1956	1957	1956	1957
Concrete mixers	pieces	42,700	92,900	98,900	+ 118	+ 130
Tower cranes	"	644	5,600	6,300	+ 770	+ 880
Hoists	"	21,355	42,200	43,700	+ 98	+ 105
Conveyor belts	"	5,340	15,900	16,800	+ 198	+ 214
Locomotives, 60 and 90 gauge	"	6,090	4,900	4,500	- 20	- 26
Dump trucks	"	112,933	86,000	77,800	- 24	- 31
Dredging machines	"	2,176	7,500	8,600	+ 245	+ 210
Trucks	"	11,595	28,200	31,100	+ 143	+ 169
Tractors	"	2,036	2,900	2,800	+ 45	+ 40
Steam Rollers	"	2,902	6,300	7,000	+ 117	+ 141
Compressors	"	6,219	12,700	13,700	+ 104	+ 120
Pumps	"	16,937	25,700	—	+ 52	—
Rams	"	4,547	8,500	—	+ 87	—
Steel casing	m^2	219,797	687,000	—	+ 212	—
Tubular Steel Scaffolding	tons	1,377	7,100	9,500	+ 416	+ 590
Bulldozers	pieces	—	4,374	5,188	—	—
Scrapers	"	—	389	344	—	—

In 1950, the almost sudden start of large-scale house-building caused also a considerable change in the conditions prevailing on traditional building sites; although there was no serious shortage in labour, a steep increase in the whole building industry favoured the rapid expansion of mechanization. Indirect government measures such as tax concessions for investment in machinery (degressive depreciation) encouraged this development.

Some of the reasons for the rapid development of mechanization are:

- greater productivity of machines as compared to manual work, especially for earth-moving and handling of building materials;
- strong competition between rival firms;
- considerably shorter building times;
- changes in building techniques during the last few years;
- transport and handling of large size building components;
- use of no-fines concrete and reinforced concrete requiring specialized mechanical equipment. Tables 2 and 3 provide further details of the development of mechanization:

Table 2

Equipment used per 10,000 building workers (proprietors of firms and salaried employees not included) in the Federal Republic of Germany, at the end of July of the year in question.

Equipment	Unit	1950	1951	1952	1953	1954	1955	1956	Changes in percent of 1950
Concrete mixers	pieces	387	454	495	525	559	572	650	+ 62
Tower cranes	"	6	7	10	17	27	35	43	+ 616
Hoists	"	182	204	213	227	240	250	275	+ 50
Conveyor belts	"	38	47	59	75	85	93	105	+ 175
Locomotives	"	24	23	20	17	15	15	13	- 50
Dump trucks	"	517	532	464	388	323	295	234	- 45
Dredging machines	"	25	25	27	31	36	44	57	+ 130
Trucks	"	113	143	157	180	185	192	233	+ 105
Tractors	"	19	20	21	21	19	19	21	+ 10
Steam Rollers	"	26	32	34	35	37	41	45	+ 70
Compressors	"	45	53	58	60	65	72	83	+ 84
Pumps	"	72	87	83	90	95	111	116	+ 60
Rams	"	22	27	30	33	38	42	49	+ 120
Steel casing	m^2	1588	2062	2825	3213	3187	3760	4320	+ 172
Tubular Steel Scaffolding	tons	10	13	15	15	23	37	51	+ 410

Table 3

horse-power employed per worker in the building trade proper
1950 - 1956

h.p. employed per worker in the building trade proper	1950	1951	1952	1953	1954	1955	1956
	1.9	2.3	2.7	3.0	3.3	3.6	4.3

In addition to the heavy equipment for the transport of materials and concrete mixing, the development of powered tools (plastering machines, small electrical wall drills, concrete shut guns, electrical handsaws etc.) is worth noting although on a much smaller scale.

Ready-mixed concrete has been used for some years, but so far only in a small number of towns. Bulk delivery of cement is usual not only on large sites but also on small ones. Bulk handling of bricks is a new method. The latest trials on experimental sites show interesting results with packaged bricks.

(d) Standardization

The German Standards Commission was set up in 1917. Some general building standards were established as early as 1870 for bricks and 1877 for Portland cement. At present there are about 8,000 standard specifications, out of which some 800 apply to the building industry. The technical committee for building standards, comprising about 1,500 honorary members, developed some 350 building standards, most of them applying exclusively or partly to house-building. Other technical standard committees concerned with timber, steel, plastics, etc. prepare standards which are also used in house-building. On the whole, there are at present about 650 standards applying to house-building.

Some of these standards apply to important aspects of design, such as the floor space required for furniture and household equipment in dwellings, in particular in the kitchen and bathroom; other standards specify uniform basis for stability, heat and sound insulation requirements. Standards for common building materials and products prescribe their dimensions, qualities, and methods of testing. The so-called "Regulations for Letting Works and Supplies" (Verdingungs-Ordnung für Bauleistungen" - VOB) include uniform technical rules for contract practices. The VOB regulations are issued in the form of standards for dimensions, qualities, and tests of building materials; they also incorporate many performance standards to be included in the contract. The application of standards is enforced through a series of administrative measures some of which are recalled here. Thus for example the government has declared some 120 building standards applying to safety requirements compulsory as "rules for supervising building authorities" (Richtlinien für die Bauaufsichtsbehörden). Another 50 building standards are used as "directions for supervising building authorities" (Hinweise für die Bauaufsichtsbehörden), to facilitate the official checking of building projects.

The Federal Government has also declared some 15 building standards "compulsory standards" (Pflichtnormen), for dwelling houses built with public financial assistance, the most important of them being DIN 4172 "Modular co-ordination in building" which is based on a 12.5 cm module (1/8 of a meter). Public financial assistance is given on condition that the rules established in those standards be observed; in cases of non-observance the state loan may be withdrawn.

Generally, it can be said that building standards are increasingly used in practice. The principal aims of standardization are a reduction in variety and a stabilization of technical requirements. Virtually all common building materials, products, building designs, methods of performance, methods of planning and calculation, as well as contracts concerning works and supplies are standardized. In general, difficulties have not been encountered in the practical application of standards but rather in the quality control as the quality requirements established in the standards are not always met. The industries have set up, in co-operation with public authorities, ad-hoc quality control societies, such as for cement and bricks. For a great number of building products the supervising authorities require that only building materials of controlled quality be used.

Standardization has proved successful in every respect and seems to have become indispensable in the German building industry. There is a natural trend towards more widespread standardization, since there are always newly developed building materials, building methods and techniques for which standards are proposed, and established, by the bodies concerned.

(e) New Materials

The outstanding recent development of new materials used in the building industry is mainly the result of the industry's own research organization, which is of a high standard and adequately supported. Only in a few exceptional cases in the early post war years, government loans were given for the development of new materials and for the erection of new factories, e.g. for light-weight concrete.

Independent building research institutes are in charge of testing new materials. On the other hand the Government committee for new materials has to give its approval for the application of new materials; this approval is first valid for a limited period and for a limited region; later on, after sufficient experience has been gained, the approval is given for the whole Federal Republic.

(i) Plastics: The production of plastics has increased considerably during the last few years to the extent that the Federal Republic of Germany is now the second producing country after USA. Their applications in building are manifold and cover a wide variety of products: appliances (sanitary fittings), services (wire for electrical installations, pipes for cold water supply and sewage disposal), finishes (flooring materials, internal linings, working surfaces), thermal insulation in sheets or blankets, or even finished building components (roofing sheets, translucent domes for roof lighting, windows and doors, hardware, etc.). Plastics enter also in the manufacture of many other composite products: sandwich partition panels, curtain walls, protecting coating to plywood formwork for concrete, etc.

(ii) Thermal insulation: In recent years, great emphasis has been laid on the problems of thermal insulation. It is estimated that the cost of heating over a period of 40 to 50 years an average dwelling by means of a central heating system amounts to the initial cost of the dwelling. The development of new building materials and methods, especially in connexion with flat roof construction, have raised new problems of thermal insulation, for which new lightweight insulating materials had to be developed. The use of lightweight concretes has also increased considerably.

(iii) Sound insulation: Systematic research on sound insulation has been undertaken during the last few years. New building materials and new types of wall construction are much lighter than the former ones, thus raising problems of sound insulation: as a matter of fact one of the principal criticisms of recent house-building relates to insufficient protection against noise. An important campaign of technical information on better sound insulation was launched recently.

(f) Development of traditional materials

Parallel to the introduction of new materials, the development and improvement of traditional building materials has continued after the war. There is a general trend towards lighter and larger building components. The traditional solid brick wall, one-and-a-half brick thick has disappeared almost entirely. Hollow bricks with equal compressive strength but far better thermal insulation than solid bricks, weigh only 1.2 kg/dm^3 as compared with 1.8 kg/dm^3 for the solid ones. Their dimensions are:

11.5 x 11.3 x 24 cm and 17.5 x 11.3 x 24 cm, instead of 11.5 x 5.2 x 24 cm for the solid brick.

But the building material most currently used for house-building in Western Germany is the pumice hollow block ("bims") measuring 23.8 x 49 cm (25 x 50 modular size), the thickness varying between 17.5 cm, 24 cm, and 30 cm. The weight per block varies between 16.5 kg and 26.3 kg. Production of pumice blocks has increased from 784.000 m^3 in 1948 to about 8.600.000 m^3 in 1955 and 1956; the production of clinker blocks has followed a similar trend, doubling between 1950 and 1955.

Solid concrete floors, which have gradually replaced timber joist floors after the war, are now used for nearly all multi-family dwellings. The overall thickness of concrete floors has been gradually reduced with the introduction of flooring materials (parquet or linoleum) laid directly on the concrete slab or on the sound insulating material. Flooring materials have also undergone considerable changes. Wooden floors are used very seldom owing to the high cost; they are replaced by plastic tiles or linoleum. The production of the latter has doubled between 1952 and 1955 and it is reasonable to assume that a great part of this increase was absorbed by house building.

The adoption of higher grade steel for reinforcement has also become evident during the last decade. Similar to this development is the trend towards quick-hardening cement and higher ultimate strength. The latter resulted in higher working stresses so that smaller concrete sections can be used, while shorter setting time enables formwork and shuttering to be removed earlier and to be used more often.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add. (g)
17 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

ITALY

1. Relative importance of traditional and non-traditional house construction

The output of the building industry has increased steadily since the second world war. In 1957 it represented 5.71 per cent of the gross national income, a proportion never reached before, the previous maximum having never exceeded 3 per cent.(1) The relative annual rate of increase, expressed in lire, which was estimated at 45 per cent in 1952, fell to 10 per cent in 1957.(2) Nevertheless, the fact remains that since the war the Italian building industry has expanded considerably and has met increasing demand with a remarkable degree of flexibility.

Immediately after the war, the great shortages of basic building materials and skilled labour were among the leading factors accounting for an enquiry into the use of non-traditional methods of construction. In the early stages of the reconstruction programme around the years 1946-1947, numerous although isolated attempts were made to develop building techniques involving materials currently in better supply than those used in traditional construction. Light prefabrication in reinforced concrete and burnt clay elements was developed at this time; but these efforts were limited mainly to the superstructure and did not affect either the finishes or the equipment. Only a few of these methods remained in practice after the economic situation was stabilized around the years 1950-1951. The absence of an important and continuous collective demand in the field of housing may also account for the markedly traditional outlook of the Italian building industry today. Other material considerations should be recalled: the plentiful supply and good geographical distribution of good quality clay which could be used for the manufacture of traditional or semi-traditional structural wall and floor components; the comparatively reduced stock of medium and heavyweight building equipment which discouraged the use of heavy components; the ever-present problem of unemployment, especially of unskilled labour, which is a deterrent to the adoption of mechanized operations, etc.

---

(1) "Relazione della Giunta Esecutiva e del Consiglio Direttivo alla Assemblea Ordinaria", A.N.C.E., Rome, 1958, pages 54 - 55.

(2) "Rilevamenti su particolori aspetti dell'industria delle costruzioni nei paesi membri della Comunità Economica Europea", A.N.C.E., Rome, December 1957.

It should also be mentioned that, like most other western European countries, Italy is characterized by a building industry made of a large number of small firms. Out of 31,063 firms employing 502,905 people, over 70 per cent of the firms employed ten people or less (representing 14 per cent of the total labour force of the industry), and only 2 per cent of the firms employed more than 100 people (35 per cent of the total).(1) The energy installed per worker is also relatively low: according to official sources, it amounts to 0.6 HP/worker on a national average.

In addition, the structure of the house-building market is not conducive to the co-ordinated efforts of fundamental and applied research in the field of building and housing which underlie technological development as it has occurred in many western European countries in the post-war period. It has already been pointed out that 80 per cent of all house-building in Italy is on a private basis and most of it on a speculative builder approach. The lack of distinction in this field between the building owner ("maître d'ouvrage") and the building contractor is unlikely to encourage the proper definition of purely functional and qualitative characteristics of building components or elements to which economic competition could apply. In effect the man who builds for himself, or who intends to sell the building to a private owner, is little concerned with compliance with technical specifications if the market value of the finished product is in practice assessed by his client who, as a rule, is a layman. The intervention of public authorities in this connexion is limited to granting a building licence, after ensuring that the building projected complies with the basic requirements of safety, health and planning regulations.

On the other hand, the subsidized housing sector is ruled by very strict regulations connected with the employment of public funds; these include detailed specifications which allow no leeway for alternative methods of construction, and make no exception to competitive tender practice (see paragraph (b) below).

Finally, it should be noted that the small average size of building contracts obtaining in both the public and the private sector has prevented the proper organization of building activities on the basis of continuity required to implement the development of new techniques.

---

(1) III Censimento Generale dell'Industria e del Commercio, 1951.

It is evident, therefore, that for different reasons neither the private nor the public sector have created the conditions of incentive necessary for the creation of a non-traditional sector in the building industry. On the whole the main factors of evolution have been the market value of the product, the rate of investment and the shift from building for sale, which has prevailed during the last five years, to building for rental, which is becoming increasingly popular, this last factor certainly has a bearing on the relative importance of first instalment costs, compared with maintenance costs. The effects of this change are not discernible yet, but are likely to become more apparent in the years to come, if the trend is continued.

2. Progress towards rationalization of building construction

(a) Technical qualifications of personnel

The planning, design and supervision of the greater part of building activities is in the hands of professionally qualified engineers or architects, graduated from one of the 28 national universities. The curricula for the civil and building engineering courses, as well as for the architectural courses, are virtually the same for all universities, with slight variations conforming to local practice. Engineers and architects are closely associated in major building operations, although this is by no means a statutory obligation. Most commissions for subsidized housing are given to teams of qualified architects or engineers, entered in a special selected list on the basis of a preliminary competition. Private building on a lesser scale is handled by building firms, the larger of which employ their own engineers and architects; the majority invite practising professionals to design to their requirements. A great part of the small private building market is virtually in the hands of a special class of intermediate professional men known as "Geometri" who are authorized to design and supervise building construction up to a certain value. "Geometri" are also frequently employed by building firms or closely associated with engineers and architects, particularly for surveying and supervising on site building operations in general.

In the field of business management a university course on scientific management of sites is held at the Faculty of Engineering of the Polytechnic School of Milan. This course covers the following subjects: standardization and modular co-ordination, industrial design of components, design methodology for industrialized building, scientific management and work organization, quality control, operational research in housing.

Training courses for foremen, subsidized in accordance with the Italian National Work Contract, are held in Milan at the Carlo Bazzi School and in Naples at the Training Centre for Building Operations. The Ministry of Works, with the co-operation of the ILO, has also organized special courses for building instructors in Naples. Finally, numerous conferences, meetings and lectures to engineers, architects and contractors on the subject of training have been held in the last few years in many Italian towns.

(b) Organization of house-building

The organization of house-building is fairly traditional in Italy. Architects or engineers prepare preliminary drawings for consideration by the clients; estimates or target costs are usually prepared at this stage in terms of approximate costs per unit of volume (Lire/m^3 of built-up space or the like) based on average market prices for the type of construction envisaged. Specifications are in the main derived from standard forms of a descriptive and detailed character. Open competitive tender based on a priced bill of quantities or on a lump sum basis is the rule for all public buildings. Alternative methods have been used for reducing the risk of awarding the contract to the lowest bidder, who might prove unsuitable. Sometimes averages are calculated on all the offers, and bids outside a certain range are automatically excluded; more frequently tenders are invited from a selected number of contractors. The establishment of a national register of suitably qualified contractors is warmly favoured by the contractors' association. Normally contractors are invited to propose a discount or rebate on the total, it being assumed that final payment will be made after measurement, according to the unit prices laid out in the bill of quantity and applying the uniform discount to all items. The fact that specifications refer almost exclusively to traditional methods and materials does not, of course, encourage contractors to propose alternative methods of construction.

The speculative building market is covered by building organizations building for their own account and mostly for sale or, alternatively, for housing societies with whom they are closely associated. In practice there is no competition and prices are agreed upon on the basis of current market values.

Only major building firms prepare accurate programmes or pre-planning of building operations. The supply of traditional materials being plentiful, no detailed programme of deliveries is normally prepared in advance. On the other side, the complex administrative procedure necessary to obtain building licences, to ensure clearance of site, connexion to mains, etc., does put real difficulties in the way of a carefully planned operation. No systematic attempt has yet been made to streamline this procedure, which would imply revising the whole structure of public administration in Italy, at present shared by municipal bodies, provincial or regional delegations of national authorities, nationalized enterprises and services, etc.

It should also be noted in this connexion that until recently, only 50 per cent of residential construction was carried out in municipal councils of more than 20,000 inhabitants; this proportion is slowly but steadily increasing and reached 65 per cent in 1957.

Although precise figures are not available and scientific studies do not appear to have been made on this subject, it would be reasonable to assume that the efficiency of building firms varies widely, from the simplest artisanal set-up to the more elaborate structure of the large house-building contractors. There are no recognized costing systems, although the main housing agencies, some of the larger municipal councils and most of the technical ministries have standard sets of specifications, schedules of typical prices and special rules for measurements and certifying work done.

(c) <u>Mechanization</u>

A brief analysis of the conditions prevailing in the Italian building industry shows that three main factors have until now impeded a greater mechanization of building operations:

- the great dispersal of building firms;
- a very high rate of under-employment and unemployment;
- the high interest rate of loans in the private market.

Leaving aside the first point, which is adequately covered in a separate chapter of the main report, it is obvious that the problem of unemployment has had a negative effect on the efforts to promote a greater mechanization of building operations. In this connexion it is interesting to recall that the original title of the first INA-Casa seven-year programme of dwelling construction was: "Piano incremento occupazione operaia" (Plan for the development of employment). Finally, the high interest rate makes the use of machines requiring heavy capital investment unprofitable, especially when compared with the low salaries prevailing in the labour market. The National Association of Building Contractors (A.N.C.E.) has promoted the setting-up of a special building finance institute (FINANCE) with the purpose of assisting its members in obtaining short-term loans from ordinary credit institutions, in particular for the acquisition of new equipment and tools. The hire or loan of equipment among building enterprises is also frequent. Another way of improving the profitability of machines is through greater specialization of building firms, which can partly offset the drawbacks of the dispersal of building initiative already noted.

On the whole, although the Italian mechanical industry produces a wide variety of building equipment, some of which is exported, the emphasis seems to have been laid in the main on comparatively heavy machines required for civil engineering works or on the most current types of concrete mixers and small size hoists. No efforts have apparently been made to create and produce new types of building equipment particularly suitable for the small contractor.

Very approximate figures have been supplied on the stock of existing machines, which read as follows:

tower cranes (various types)	3,000	units
excavators (various types)	2,800	"
belt conveyors	500	"
tractors	2,300	"
scrapers	400	"
locomotives	750	"
lorries	15,000	"
concrete mixers	40,000	"
elevators	42,000	"

Little heavy equipment is normally used on most house-building sites; horizontal transport is mainly by hand or wheelbarrow and vertical transport by small hoists. The fact that most low-cost housing is limited to 4 - 5 storeys, for several reasons including economic ones, may account for the extensive use of small hoists attached to the main reinforced concrete structure which is always cast <u>in situ</u>. Tall apartment buildings in the major towns are built by the same method, although the use of tower cranes of different capacities is becoming increasingly frequent. In general, for a number of reasons such as private ownership of land on small building plots in urban areas, or consideration of planning amenity which tends to limit the use of very high buildings to "point blocks", the use of travelling cranes such as those frequently employed in France is comparatively rare.

Apart from materials handling and especially lifting operations, the only operations which seem to be mechanized are the manufacture of concrete and mortars and the production of burnt clay components (in factory) and of concrete blocks (on site). Powered hand tools are practically non-existent.

(d) Standardization

Until recently standardization of building products has been almost exclusively carried out by the Italian National Standards Organization (UNI). It covers several hundred standards, most of them unrelated to each other and of very limited practical application.

A new effort towards standardization co-ordinated at the highest level has now been undertaken, thanks mainly to the studies undertaken by the Committee on Building Productivity set up by the Ministry of Works and following the establishment of a special course at the Polytechnic School in Milan devoted to the theoretical and practical aspects of standardization. A basic standard of dimensional co-ordination is being developed by the UNI, while new national regulations are being prepared under the aegis of the Ministry of Works with the purpose of simplifying building operations. Similar efforts are undertaken by major house-building organizations in the public sector (INA-Casa, Low-cost Housing Institutes, etc.) who work out design recommendations intended for architects, manufacturers of building components and building contractors, and aiming at a reduction of cost coupled with improved quality. This action is in particular exerted in the direction of reducing the variety of types of materials and components, as well as stabilizing the different stages of the building process considered as a whole. This includes the phases of design, both functional and dimensional, of production (qualitative factors) and of actual use of the products, from stocking, packing and transport to site operations.

This comprehensive approach to standardization is expected to provide the best means of achieving a real simplification of design activities and a truly industrial organization of building operations, at the factory as well as on site.

(e) New materials

Initiative for the introduction of new materials in the building industry comes entirely from the industry itself and can only be justified on grounds of economy and profit. This appears clearly from the structure of demand and the organization of industry which has been shown in the previous chapters of the report. In this connexion the activities of the "Association for the Study and Development of Materials and Prefabricated Systems" in Milan are worth recording. On the whole, the Italian building industry has followed the general trends in most western European countries by gradually adopting the use of plastics in the finishings and fittings of houses, the use of aluminium for windows and facing panels, light steel sections for windows and door-frames and parts of the sanitary equipment, etc. The scarcity of cheap structural timber has also encouraged the expansion of wood derivatives, such as Novopan, etc. The availability of many natural facing stones and the plentiful supply of natural volcanic aggregate have afforded little incentive to the introduction of alternative facing materials or to the development work involved in the production of artificial light-weight aggregates or aerated concretes.

(f) Development of traditional materials

The development of traditional materials has in the main followed two lines. The first relates to the improvement of the quality of extruded clay elements with very thin wall thicknesses, used for wall construction (hollow bricks of special sizes and shapes for external walls, partition blocks, infilling blocks for ceilings, etc.) and for semi-prefabricated floor construction (hollow clay blocks with grooves designed to receive light reinforcement bars assembled on the ground into pre-cast joists and erected by small crews to build up horizontal slabs). The second concerns the improved techniques of pre-casting light concrete elements (steps, lintels, window-surrounds, etc.) with extremely good surface finishes, mostly designed to replace natural stone elements of similar shapes. The fact that there is great continuity in the use of these components may account for the high standard of quality of the average product.

Parallel developments have taken place in other building material industries. Manufacturers of ceramic tiles, roof tiles, facing stones, etc. have gradually improved their quality, increased their range of finishes and colours and met the somewhat exacting requirements of private speculative demand. Manufacturers' associations for the development of use of special materials are rare; one example has been quoted concerning the aluminium industry.

(g) Economy in use of materials

Building codes and regulations in Italy are mostly of a local character. All major towns, and sometimes towns of not more than 10,000 inhabitants, have their own codes, mainly concerned with safety and health requirements. These codes relate in part to planning matters and to that extent are affected by town planning proposals and revised accordingly. No attempt has up till now been made to unify these regulations, although a survey is at present under way. No functional codes or general codes of practice exist as yet, although consideration is being given to setting them up. In specific cases the introduction of new building techniques, such as pre-stressed concrete, has been followed a few years later by the adoption of adequate regulations.

The fact should not be overlooked that a considerable part of the country is volcanic and exposed to serious earthquake risks. Building codes applicable to these regions are extremely conservative and entail a fairly expensive use of materials.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add. (h)
17 March 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

NETHERLANDS

1. Relative importance of traditional and non-traditional methods of house construction

Up to January 1959, approximately 70,000 dwellings had been constructed by non-traditional systems of construction, amounting to 10 per cent of total post-war production. The proportion of non-traditional to traditional houses has remained fairly constant during the last few years.

Forty non-traditional systems had been the subject of experiments.

It was found that the non-traditional dwellings were not cheaper than those built by traditional methods, but had the advantage that less scarce materials could be used in their construction and that unskilled workers could be employed for certain operations.

An important new development was initiated in 1956, with the object of promoting a higher degree of mechanization and larger-scale prefabrication, whereby the supplying industries could be ensured of a large turnover for a long period of time.

This development was to the effect that contracts might be concluded between principals and builders so that the principal instructs the builder to build for a period of five years a certain number of dwellings per year. In conformity with this development a certain number of municipalities have undertaken to allow a builder to build a total of approximately 1,000 dwellings per annum at such a speed that the erection of the separate projects continues without interruption of any of them. For each of the individual projects a separate contract is concluded at the appropriate time. The individual projects include types of dwellings of the same construction, but these may vary in layout and size.

For fixing the price of each subsequent project, a special procedure has been developed which guarantees that the execution of each new project need not be delayed until the price has been agreed upon.

Clearly a system such as this should be instrumental in enabling mass production on a national scale, this in turn enabling capital outlay to be written off over a reasonable period and thus, ultimately, a reduction in cost. Over twenty contracts of this type have so far been negotiated between municipal councils and builders, mostly for a period of five years; these contracts cover the construction of some 28,000 non-traditional houses and 4,500 traditional houses. No new contracts are envisaged for the time being. As regards costs, it is not possible at the time of drafting this report to draw any firm conclusion, the actual results being known only at the completion of the entire work. Nevertheless it can be noted that the prices agreed upon for the first sections of work were comparable to those normally accepted, although definitely not lower. The main advantages so far claimed for the system are related to better over-all organization of production, greater security of employment and better labour relations.

The trend in new methods of construction is towards concrete elements of larger size than bricks and the prefabrication of as many components as possible, either in factories or in workshops on the building site. One system exists whereby all the walls and floors are made in the factory, but the finishing work and fixing of fittings is done on site. The logical development whereby all finishings and fixing are carried out in the factory is expected to occur in the near future.

For partition walls prefabricated elements story-height in widths of 50 cm or 100 cm are increasingly used.

2. Progress towards rationalisation of building construction

(a) Technical qualifications of personnel

Difficulties have been reported in introducing modern methods of organization of building work owing to lack of trained personnel. As a result of this, up-to-date organization is mainly in the hands of a few efficiency bureaux of limited capacity. Courses are organized by the "Bouwcentrum" in co-operation with the building industry, for executives of contracting firms at professional or managerial level on matters related to the organization of the building industry. Attendance of these courses has slowly but steadily increased in the last ten years; in the years 1957 to 1958 it amounted to over 200 persons. Courses are also given at the Advanced Technical School and Lower Technical College to train foremen, draughtsmen and skilled craftsmen respectively.

There are two courses for architects: the academic or building engineer's course taken at the Delft Technological University, and the course for "Advanced Education in Architecture" (V.B.O. & H.B.O.) under the auspices of the Federation of Netherlands Architects. Nearly 100 architects graduate every year from either of these courses. Civil and building engineers with either academic or technical college training graduate at a rate of over 300 a year; many of them are employed by contractors, although the exact percentages are not known.

The results of the limited activities in the field of organization and rate-fixing have been so favourable that increasing numbers of architects and contractors are making use of them.

(b) Organization of house-building

(i) Preliminary stage

The normal procedure is for the architect (assisted if necessary by consultant engineers on specialized work, such as complex structural design, heating installations, lifts, etc.) to prepare general plans and specifications, on which tenders are invited; bills of quantities are prepared only on special work. Both open and private tenders are currently used; in a few cases the contractor is consulted during the planning stage, but this is still an exceptional practice. As a rule work drawings are prepared while the work is in progress. Where non-traditional methods of construction are used, the contract specifies that the architect's design shall be adjusted to the technical requirements of the particular system adopted. The contractor can therefore play an important part in the preparation of the design; some contractors even employ their own architect.

The importance of complete pre-planning of housing projects is realized, though not yet generally adopted. Vigorous propaganda is being conducted in favour of it.

(ii) Preparation stage and erection stage.

Time schedules are usually prepared by the contractor, but have no compulsory value and are used mainly as a forecast of the progress of work. On large contracts, however, detailed time schedules are prepared, on which recruitment of labour, advance ordering of materials and planning of site operations are based. A small number of consultants are engaged in the preparation of model time schedules and their services are available to contractors, although complete systems of work organization, with details prepared in advance, are used on relatively few projects owing to the limited trained personnel available.

Payments are made in instalments according to the progress of the work, subject to a 5 per cent deduction as guarantee. Bonuses are normally paid by the contractor on piece work on the basis of a recognized award system in the building trade.

(c) Mechanization

No special measures have been taken to promote mechanization in the building industry owing to the fact that it is taking place rapidly without outside intervention.

Earth moving: rapid progress is taking place in mechanization of earth moving.

Transport on building sites: rapid progress is taking place in mechanization of site transport. Cranes, hoists, mechanical wheelbarrows, monorail and fork lift trucks are commonly used on many sites.

Concreting etc.: cement is being delivered in bulk to an increasing extent to the large housing sites. Concrete mixing is entirely mechanical; mechanical mixing of mortar is general only on large projects. Steel scaffolding and metal shuttering are seldom used in house-building. Electrical hand tools working at 42 volts are being increasingly used; this is a development which is relatively uncommon in Europe.

(d) Standardization

(i) House plans

There is no compulsory standardization. Practical house plans are published in order to encourage the use of functionally satisfactory house types. The Ministry of Housing and Building has also issued regulations concerning the minimum requirements (dimension of rooms, total floor area, storage area, etc.) for subsidized housing, which represents 95 per cent of the dwellings built every year; these requirements are generally exceeded by about 10 per cent on the average. The minimum height of rooms is prescribed by local authorities, generally at about 2.60 m for living rooms and kitchen and 2.40 m for bedrooms; but no general rule is applicable on a national scale.

(ii) Materials and components

The need for standardization is increasingly realized. In practice a considerable degree of standardization by general consent has arisen for a limited range of components. Most doors are manufactured in a series of sizes comprising four variations in width and two in height, and wooden and steel door frames are supplied to suit.

There is hesitation in changing over to standard designs for windows. Kitchen and sanitary fittings are supplied on a large scale as standard products.

Standardization is encouraged by the fact that several large users consult each other as to products to be used.

On a very limited scale efforts are being made to produce standard houses, to a complete and fixed design, which can be purchased from a "catalogue". It is thought that the production of houses on these lines may increase.

(e) New materials

Lightweight concretes are extensively used for roofing and partition walls; plastics are increasingly used for sanitary pipes and fittings, electrical fittings, facing materials and thermal insulation.

(f) Development of traditional materials

The normal process of development of traditional materials can be observed to cover improvement in quality, simplification of handling and placing and reduction in cost.

(g) Economy in use of materials

Research and development have as their main object the more economical use of materials, together with improvements in amenities. In order to achieve the economies, however, it is necessary that building laws and regulations should be revised from time to time to keep pace with the results of research.

In 1956 the Minister of Housing and Building Industry issued regulations with the object of bringing uniformity into the municipal building regulations. These reforms are confined to the following points:-

(i) the regulations applicable to calculations for strength and stability;
(ii) staircases for more than one dwelling;
(iii) ventilation shafts and chimney stacks;
(iv) construction width of foundations;
(v) thickness of solid walls;
(vi) thickness of cavity walls;
(vii) use of sand-lime bricks;
(viii) thickness of wooden floors and of roof boards;
(ix) combinations of waste pipes for houses.

The possibility was being considered in 1957 of adding to these regulations provisions applicable to floor-to-floor height, daylight requirements, number and size of stairs per story, etc.

Although all municipal councils are obliged by law to lay down building regulations, considerable flexibility is allowed in their application to non-traditional methods of house construction. In particular, the Reconstruction Law provides for a probationary period of ten years after which houses not conforming to existing regulations are either to be altered to comply with them or are definitely accepted provided they have proved their soundness.

Distr.
RESTRICTED

HOU/Working Paper No.97/Add.(i)
26 March 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda for the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National monographs

POLAND

1. Relative importance of traditional and non-traditional building methods

Before the last war, houses built in Poland were mainly small and single-family houses of a semi-rural type or, at the best a type suitable for small towns. In this kind of building, traditional methods were used almost exclusively and the proportion of timber used was very high. In the residential quarters of large towns, more advanced building methods were used, but these also remained largely traditional. It should be mentioned that in Poland, more especially in country districts, the parties directly concerned used to build the houses themselves, with the assistance of their relatives and neighbours, and frequently without the help of a professional builder. The rural population was, as a general rule, able to carry out building operations, more particularly timber work, and in certain regions, even masonry.

This general situation had an undoubted influence on house-building methods in the larger towns. The urban housing centres built between 1920 and 1939 on relatively modern lines were, in general, the work of medium-sized undertakings, whose labour force varied with the amount of work in hand. Extra workers could easily be obtained by recruiting practically unlimited numbers of labourers from the countryside, who had a reasonable degree of skill in basic building operations. The ease with which the number of labourers employed could be varied according to the orders on hand, together with the risk of a possible slackening of activity as a result of changes in the economic situation, explains the reluctance of building firms to develop modern methods of construction that would have reduced the size of the labour force - very inexpensive in any case - and to invest capital in buying equipment and new machinery which could only be used on public works contracts.

This situation changed radically after 1945. During the early post-war years, the first task was to repair and recondition speedily those buildings which had not been totally destroyed. But from 1946-1947 onwards, and particularly in 1949, when the building programme for new housing estates got under way, the results of the new economic and social situation began to be felt.

There can be no doubt that demographic changes had a very considerable effect: on the one hand, a large part of the population had been either exterminated or deported - particularly very large numbers of engineers, technicians and highly skilled labourers - and on the other hand, the labour surplus in rural districts had been greatly reduced. Where such surpluses still existed, new prospects had opened up for the labourers: they were able to take over abandoned farms in the depopulated territories, or to work in towns, where the expanding industries were competing effectively for labour with the building trade which traditionally offered only seasonal employment.

In order to overcome these difficulties, the Government adopted a series of measures intended, inter alia, to speed up the training of qualified workers, to develop the mechanization of building operations, to standardize products, to evolve uniform building components etc. The bulk of these efforts (which are examined in detail in the following paragraphs) was directed initially towards developing rationalized processes of work and increasing productivity in traditional building. As early as 1946 and 1947, certain medium-weight prefabricated components were introduced. These were, principally, lintels, window sills, floor joists, and filling for floors (the "D.M.S." floor still in general use in traditional building) and since 1948 steps for staircases also. Since none of these components weighed more than 200 kg., they could easily be hoisted by the apparatus in general use on small building sites and, failing that, by hand. After this first drive towards rationalization, the development of traditional building went ahead much more slowly and technical experts concentrated more especially on the non-traditional methods described below.

At the same time, every effort was made to increase productivity in traditional building, which had fallen off noticeably in the first years of the post-war period. The number of man-hours required on building sites per m^3 of housing space actually rose during the first post-war years, although mechanization of operations had considerably increased. (See in this connexion Chapter IV of the report). This was obviously due primarily to the fact that the gangs of building labourers were less well qualified professionally. From 1948 to 1950 every effort was therefore made to raise productivity of the work done on the main structure, particularly the masonry, by rationalizing elementary operations and by increasing specialization among the labourers. Although the overall effect of these measures has still not been to bring absolute figures of productivity up to pre-war level in traditional building, it must, nevertheless, be pointed out that present-day buildings contain far more fittings and that, because they are smaller in size, they entail higher labour costs per unit.

In view of the tasks set by a building programme which has been constantly expanding (122,000 houses in 1957 as against 65,000 houses completed in 1952), it became obvious, from 1951 onwards, that the measures aimed at raising the productivity of traditional building would have to be supplemented by more thorough efforts to reduce the man-hours spent on the site and shorten the total time of building. Accordingly, from 1951 onwards, the use of larger prefabricated concrete components was explored as a solution to this problem. Largely because of the technical difficulties encountered in the first phases of reconstruction, the tests carried out during previous years had not yielded satisfactory economic results. Nevertheless, certain general circumstances favoured the introduction of new building methods, in particular:

- the existence of State building schemes, State building enterprises, and State design offices, which were able to co-operate in introducing methods which had been recommended for test purposes by senior authorities;
- the number and size of building enterprises and building sites, which made it both justifiable and feasible to undertake large-scale capital investment projects, calling for the adoption of new methods;
- the elaboration of long-term plans for housing construction on a national or regional scale.

In fact, as a result of these favourable conditions, the new methods were sometimes introduced too rapidly and on too ambitious a scale, that is to say, without tests being made on a limited scale and without carrying out pilot projects.

The first major experiment dates from 1954, when large prefabricated slabs weighing from 2 to 3 tons were used on building sites in the town of Nowa Huta. The first stage was the prefabrication of horizontal building parts - flagstones for floors, balconies, etc., - and of staircases and roofing components, whereas supporting and inside walls were still made of brick, on traditional lines. This system was called "first-degree industrialization". It enabled the cycle of building operations and the number of workers required on the site to be reduced very considerably. However, it also led to a considerable rise in building costs, owing both to inadequate skills in applying the new method and to certain organizational and technical mistakes. This rise varied from 20 to 40 per cent of the traditional building cost, and was attributable, inter alia, to:

- the need to instal heavy hoisting equipment which could handle the heaviest component, but which, because of the varying sizes of components hoisted, was used for only a fraction of its theoretical capacity;
- the concentration of the production of heavy components in large central factories, whose remoteness from the site further raised the cost of transport;
- deficiencies of organization in applying the new method on site, and particularly in applying traditional methods to finishing and installation operations, which partly cancelled out the time saved on the main structure.

Moreover, once these difficulties had been overcome, production costs often rose because the prefabrication factories had been over-capitalised.

From an analysis of these difficulties there emerged two essential conclusions regarding the development of non-traditional methods:

- the need to find building techniques based on the use of heavy components of a uniform average weight, so that full use can always be made of costly hoisting equipment;
- the need to arrange for the prefabricated components to be as completely finished as possible, so as to reduce to a minimum the amount of finishing and installation required on site.

The second stage was called "second-degree industrialization", that is, the use of heavy concrete components as vertical supporting members, thus completely eliminating wet processes in the construction of walls. The use of blocks containing plumbing pipes reduced the work actually carried out on site to the mere assembly of plumbing installations. However, it was not found possible to mechanize finishing jobs like external plastering and floors, since the inside walls of each room were made up of several floor and wall components weighing on an average between 2 and 3 tons. The next development would thus seem to be to arrange for the prefabrication of large inside wall and ceiling slabs big enough to cover the whole inside wall or ceiling surface of an average sized room. Experimental work on this type of construction is going on at present.

The "second-degree industrialization" method has now been completely perfected from the technical point of view, and on certain sites from an organizational angle too. In 1958, over 10 per cent of all the dwellings built were built by this method, and the proportion will very likely increase still further. Industrialized building costs 7 to 15 per cent more than building by traditional methods. This difference was partly due to the previous price policy applying to building materials, and is less serious on sites where components are produced on mobile installations. By 1960 the cost of this method of building will presumably be the same as that of traditional building methods.

The present state and future prospects of non-traditional building methods may be seen from Table 1 below:

Table 1

Relative importance of non-traditional building methods expressed as % of the total

	1956	1957	1958	1959	1965
1. Building with heavy components	3	5	5.3	6.8	15.0
2. Building with large slabs	-	-	0.04	0.4	10.0
3. Building with heavy components (complete concrete walls)	-	0.06	0.5	1.4	5.5
4. "First-degree industrialization"	10	9.5	9.4	7.0	8.0
Total	13.0	14.56	15.24	15.6	38.5

In the case of undertakings coming under the Building Ministry, the figures shown in Table 1 will be exceeded, and will probably reach 67 per cent by 1965.

Present opinion on the use of heavy concrete components in building can be summarized by stating that this system can, subject to rational organization and maximum factory finishing, enable the cost to be brought down to the level of traditional building. Apart from this, it is essential that the use of large prefabricated slabs should be greatly expanded, particularly since housing construction schemes will increase in volume in the immediate future. Calculations show that it will be impossible to increase the labour force engaged on housing in proportion to the larger number of schemes, so that the number of gangs on sites must be radically reduced and their productivity increased by means of the methods described above.

Presumably, therefore, the tendency to transfer a complete series of operations from site to factory will continue in the coming years. Nevertheless, the principle of having centralized factories will be at least partially replaced by the method of producing larger prefabricated components in temporary factories set up in close proximity to the building site. Finally, despite the remarkable expansion in "industrialized" building, great efforts will still have to be devoted to improving productivity in traditional building, which will continue for many years to come to play an important part in the overall building effort.

2. Progress in the rationalization of building

(a) Technical qualifications of personnel

Mention has already been made of the serious shortage of skilled personnel in Poland immediately after the war. This shortage was felt at all stages of building operations, in the professions (architects, engineers), in the intermediate categories (foremen, supervisors), and at the level of specialized or simply skilled workers. One of the measures taken by the Government to relieve this shortage was to organize professional courses for all the specialized trades. Persons who, because of the war, had to interrupt their secondary or higher professional studies were enabled to obtain diplomas after following special short technical courses. Large numbers of technical building schools were set up for the training of technicians, foremen and workmen at day and evening courses. Higher technical institutes similarly organized short courses for engineers, under which a preliminary diploma was granted after three years of study; two years of further study made it possible to obtain the full degree of engineer. These short courses were recently terminated, as the shortage of engineers and architects had finally been made up. On the other hand, the problem of augmenting the number of qualified foremen and highly skilled workmen is still a very burning one. The lowering of the standards required in foremen and skilled craftsmen in the building trade, necessitated by the urgency of the immediate housing problem, has seriously affected the quality of building work in Poland.

(b) Organization of building operations

In 1957, 58 per cent of all the housing built in Poland was undertaken for State account, the remaining 42 per cent being for account of private individuals or co-operative societies; the latter proportion has risen steadily during the last five years, as it represented only 24 per cent of the total in 1954. Actually, the part played by the State is of decisive importance in housing policy. If house-building is considered not so much a technological as a financial problem, it will be seen that in 1956 public investment made up nearly 75 per cent of the funds devoted to housing, and that in 1957 18 per cent of privately-built housing was supported by State loans. Nor must it be overlooked that more than three-quarters of privately or co-operatively built housing went up in the rural districts (1956), whereas the five-year plan 1956-1960 originally provided for the building of 1,200,000 rooms in urban districts, of which only a quarter was to be built by private or co-operative undertakings.(1)

The preponderance of State building in towns has thus been the determining factor in the technological development of the building industry in recent years. The following statement will therefore merely consider how this influence has been exerted in the nationalized economic sector; however, if the private sector, particularly in rural zones expands, it might in time lead to interesting modifications in this development.

(i) Preliminary phase

Under the regulations in force, the principal part in co-ordinating house-building is played by the building promoter, whose job it is to work out the detailed investment programme on the basis of which schemes are prepared. All work on housing is subject to the directives laid down in the National Economic Development Plan, no matter what the sector concerned, but the important administrative reforms adopted in 1956 and 1957 made considerable changes in the

(1) See "Financing of Housing in Europe", Geneva 1958.

structure of demand as regards housing. Some of the functions of the three technical ministries abolished[1] were transferred to the new Building Ministry; but at the same time the People's Councils of the Voyevody (provinces), and subsequently the District Councils, were given greater freedom of action with regard to investment. In the case of building investment, they come under the control of the Ministry of Communal Economy, and the regional and local housing programmes are worked out by the relevant administrative and technical services within the framework of the National Economic Plan and of the long-term plans. Some of the big building promoters specializing in industrialized building have their own design offices; others transmit the directives of the programmes they have drawn up to the State Planning Offices, which work out the detailed design. The State Planning Offices, which draw up designs for house-building, are generally under the control of the People's Councils. They are organized in the form of undertakings employing from 100 to 1,000 people: architects, engineers, draughtsmen, surveyors etc., the average size being from 200 to 250. Most Planning Offices have their own technical department; in addition, there are a few study offices specializing in urban and industrial building which can, if required, undertake special studies on a larger scale at the request of other Planning Offices. The preliminary design drawn up by the Planning Office is first checked by a commission of experts called in by the building promoter; in the light of the findings of this commission the Planning Offices then work out the final plan, which has to be approved by the building promoter and by the technical control services.

The system used to determine the total cost of building, both at the time of the estimate and at the stage of actual building, is extremely important for the introduction of new building methods. It is the Planning Offices actually which most often help to introduce non-traditional methods, the part played by the building promoter and the contractors being far less important in this respect. In the case of traditional building, estimates are based on official uniform standards defining the price of basic materials, the labour costs per unit and the final cost per unit. Obviously, a system of this kind is not

(1) Ministries of Industrial Building, Urban Building and Building Materials.

very conducive to the introduction of non-traditional methods, the technical and economic features of which are not known beforehand.

Since there is no system of putting contracts out to tender in Poland, apart from exceptional cases, work in the nationalized sector is, in principle, given to a contracting enterprise which operates in a specific area. The nature of contractual relations is defined by the State.

(ii) Preparatory phase

As a result of studies made between 1950 and 1953 in order to form a basis for drawing up detailed organizational programmes, such programmes have now been declared compulsory on all building sites. In addition, sections specially responsible for framing plans have been set up in all the Planning Offices. Experience gained since then has shown that the detailed organizational programmes could only be applied profitably on large sites, particularly on sites where building was scheduled to last several years. The very principle of these operational programmes as established by the Planning Offices has been questioned; so that, nowadays, most major contracting enterprises have their own organizational offices which can work out more realistic programmes conforming more exactly to the special conditions of the site and the contracting enterprise. From a more general point of view, the Scientific Institute for the Organization and Mechanization of Work has been set up and courses on building organization are now a regular part of the study programmes of Polish polytechnic institutes.

(iii) Operational phase

Building operations are undertaken by the contracting enterprises, most of which belong to the nationalized sectors; early in 1957, there were 590 such contracting enterprises. About a half of these was engaged on new building and the other half, consisting largely of communal enterprises, was working on repair and maintenance jobs and on smaller sites. Thirty-nine nationalized contracting enterprises in the sector of the Building Ministry specialize in urban housing. These enterprises employ from 800 to 3,000 workers, and their annual turnover is between 100 and 200 million zlotys. In house-building it was the normal practice to conclude a contract with a general enterprise which would undertake the main structure. On the other hand, finishing work and technical installations, and work requiring the use of very specialized machinery (large-scale earth-shifting operations etc.), were in general given to specialized undertakings acting as sub-contractors. In some cases, the specialization of small sub-contracting enterprises was carried too far, and nowadays there is a reverse tendency towards re-grouping different branches within a single enterprise engaged exclusively in house-building. The sector of private and co-operative enterprises is eminently artisanal in character and despite certain tendencies to develop, it is still rather limited in scope. The Social Building Enterprise, on the other hand, which works on a nation-wide scale, is making great strides. It works on co-operative lines and its special task is to exceed the plans of building co-operatives.

Payment in respect of building operations is made on the basis of monthly statements which take the place of interim delivery notes and deductions are made as guarantees at large sites. A system of payment on account also exists under which a contractor can be credited for all work done during the first half of the month. In general, contracts do not allow for payment of bonus where work is finished before the target date. However, special awards are made where the building promoter stipulates completion dates earlier than what is considered normal, in order to allow for overtime costs and additional posts, etc. Penalties are imposed for any delay incurred and are calculated at the rate of 0.01 per cent of the amount of the estimate for each day of delay up to thirty days; beyond that, these penalties are heavily increased. Changes in the official prices of building materials or in labour costs during building are integrated in the over-all cost. The principle of economic incentives, introduced and developed as a result of the reorganization mentioned above, leaves the contractor a comparatively wide degree of latitude in technical matters. He is, for instance, entitled to the prices laid down in the contract, whatever methods are actually used on the job, provided always that the final quality is maintained. Consequently, it will be well worth while for a firm to use any methods (mechanization of operations, use of replacement materials, adoption of rationalized methods, etc.) which enables it to reduce the length of a job, to increase productivity and to cut costs. Most of the profit derived from such measures is kept by the contractor and used at his discretion.

A case in point was the introduction of bricklaying by gangs, where bricklaying operations were split up into jobs calling for professional skill and auxiliary jobs. Subsequently, gangs were composed of labourers specialized in a particular operation. This system gave very satisfactory results, for in certain cases it proved possible to double the output of bricklaying. Mention should further be made of the "continuous work" method which has been widely followed in traditional building since 1950, that is, since large housing blocks began to predominate. This method consists of organizing specialist labour gangs on sites where standard or repetitive types of buildings are being built. These labourers go from one building to the next, performing certain specific jobs. Under this system a considerable increase in output can be achieved, since the same operations are repeated at a large number of points.

Efforts have also been made to reduce the drawbacks caused by weather conditions. By using different technical methods of organization, conditions have been successfully created under which work can be continued almost uninterruptedly even at temperatures of - 10°C. Any resultant increase in cost (say, from 2 to 4 per cent) is covered by the promoter, who can make up for some of this extra cost by recruiting rural labour seasonally unemployed.

While work is in course, the site is supervised both by the planning offices and by the building promoter. The planning offices are bound by contract and their supervision is obligatory in the case of large blocks or other projects where new techniques are used. Technical and financial control, strictly so-called, is the job of an inspector who represents the promoter acting in close contact with the planning office. Finally, the general contractor has his own system of supervising, chiefly the co-ordination and execution of the work done by the sub-contractors, for whom he has drawn up a plan of operations.

(c) Mechanization

Mention was made above of the principal reasons why the building industry in Poland was very backward in mechanization in the period between the two wars. The horsepower of mechanized equipment available in 1939 has been calculated at approximately 0.15 HP per building worker; the figure nowadays is nearly 2.2 HP. in the Building Ministry's sector.

Efforts made since 1945 to popularize mechanization have been greatly helped by the new structure of building enterprises as compared with conditions before the war. This is particularly true of State enterprises, the average size of which is many times greater than the size of the biggest enterprises in pre-war days. Moreover, the prospect of a permanent and growing volume of work in these enterprises has made it possible to undertake long-term investments without fear that the capital invested might remain unused. In the early stages, mechanization was necessarily concentrated primarily on rubble clearing operations in devastated towns, and it was only later that it could be directed to work on new housing. Thus, immediately after the war, army surplus material was brought in large quantities, including bulldozers, tractors and lorries which needed frequent repairs and were very inefficient.

During the following years, cement and concrete mixers and simple hoisting machines were introduced on a very large scale, even on small building sites. By the end of the 1950-1955 six-year plan the preparation of mortar was 71 per cent and of concrete 89 per cent mechanized. From 1954 onwards, mamy major sites were 100 per cent mechanized for these two operations.

At present, mechanization is still concentrated primarily on vertical and horizontal transport. Poland nowadays produces a large number of mobile elevators, conveyor belts, hoists of varying capacity, jib-cranes on rails or wheels, mortar pumps, etc. At the larger sites, earth levelling is entirely mechanized, and in view of the development of prefabrication of heavy building components, tower cranes are already a part of the normal equipment of large building sites. The major effort of mechanization has naturally been devoted to the main structure; however, interesting tendencies can be noted in the mechanization of finishing operations, such as the polishing of floors and painting. But in this connexion requirements are by no means completely met, particularly as regards traditional building.

The financial effort of contracting enterprises with regard to equipment can be calculated as a percentage of the wage bill or of the turnover. For enterprises coming directly under the Building Ministry, these percentages were, in 1958, 5.47 per cent and 1.67 per cent respectively. However, it should be noted that these figures have varied considerably in the course of the past five years, rising occasionally to as much as double the previous sum, for reasons which it would take too long to analyse here.

(d) Standardization

The standardization of building materials, products and components is a continuous action, directed by specialized standardization services of the ministries concerned and co-ordinated by the Polish Standardization Committee. The following traditional basic materials have been standardized: cement, lime, reinforcing steel, bituminous lining for roofs, and the following products: bricks, tiles, flooring blocks, steel lintels, items of joinery and of equipment. Several prefabricated building components have also been standardized, such as reinforced concrete joists, flagstones for floors, and components of staircases and of roofs. The standards for the first group of products are compulsory; they are simply recommended in the case of the second.

For dimensional standardization, a module of 10 centimetres was adopted in 1949 and has been used in establishing all other standards of products subsequently introduced. Multiples of this module (40 centimetres for house-building, 300 centimetres for industrial building) were taken as a basis for the principal horizontal dimensions for building plans; for vertical dimensions the unit of increment is, for the moment, the module itself. Finally, sub-multiples of the module have been recognized for the thickness of supporting components of the structure (floors, landings, partition walls and exterior walls).

Regulations governing the surface area of and the fittings used in, housing, schools and in other buildings of a public character come under a different category of standards. They are the basis for establishing prototypes for buildings intended for mass production. Special planning offices design the standard components and sections covering the whole of the building.

The use of standards and, as far as possible, of standardized plans is compulsory in the nationalized sector. At present, approximately 36 per cent of housing is built according to standardized plans, which indicates that their quantity and quality are still insufficient.

The remaining part of housing construction is based on individual plans; nevertheless, the standards for the surface area and fittings mentioned previously are absolutely compulsory. These help to ensure a wide degree of unification in the establishment of plans even where the plans are not absolutely standardized in the exact sense of the term.

In the case of private building of single-family houses, the State, represented by the authorities concerned with architecture and building, is making every effort to popularize the use of standardized plans. The choice of such a plan speeds up, inter alia the issue of building permits or the granting of loans.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add. (j)
17 March 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Country monographs

PORTUGAL

1. Relative importance of traditional and non-traditional building methods

A noteworthy feature of building activities in Portugal is that a constantly increasing proportion of dwellings is being built without any State aid whatsoever (67 per cent in 1949, 95 per cent in 1957); State intervention, whether direct or through corporations and municipal authorities, is limited to questions of safety, health, and town-planning. The total number of dwellings completed *per annum* rose from 15,200 in 1952 to 29,900 in 1957[1]; it will be noted that this quite large increase was not accompanied by a rise in the building cost index, which index remained at 90 per cent of the level noted for the first quarter of 1949.[1] The great majority of the dwellings built are in buildings of one or two storeys (nearly 90 per cent of the total[2]); in the large towns, however, multiple-storey buildings are under construction, some of them for dwelling purposes. It would seem that, on the whole, only strictly traditional methods are used; however, in the two large urban centres (Lisbon and Oporto) there is a trend towards the manufacture of certain building components away from the building site (conglomerates, pugging, woodwork, etc.).

---

(1) Quarterly Bulletin of Housing and Building Statistics for Europe, Vol. VI, No. 2.

(2) *Estatistica Industrial*, 1957, Instituto Nacional de Estatistica, Lisbon.

In general, the production of basic building materials (cement, timber, bricks, tiles etc.) keeps pace with the rise in housing construction, and there seems to be no serious supply problem. The same observation applies, moreover, to building labour, of which there is a supply adequate to satisfy the immediate demand. In these circumstances, and in the light of the type of construction usual in Portugal, it is not surprising that construction should have continued to follow traditional lines in the main, while taking advantage of the general development trend in building techniques (reinforced-concrete skeletons, ribbed floors with concrete or ceramic pugging, partition walls built of solid or hollow bricks or concrete blocks, etc.).

2. Progress in rationalization

(a) Technical qualifications of personnel

Under Legislative Decree No. 40,623 of 30 May 1956, a building concern wishing to perform work for the public authorities is required to satisfy certain technical conditions and, more particularly, to employ the technical staff necessary for its operations, according to the category in which the concern wishes to be placed and to the volume of the work it is authorized to perform. As a general rule, a medium-sized building concern is under the technical management of an engineer, an architect or some other graduate of a technical college. The engineers' professional association has about 2,500 members (civil engineers or electrical engineers); the national architects' association has about 500 members. The members of these two professional groups hold diplomas from colleges; other schools (of intermediate or elementary level) train technicians, builders and building foremen. Building workers (bricklayers, stonecutters and the like) receive their training in vocational schools supervised by the technical services of the national or municipal authorities or even of private bodies.

(b) Organization of building operations

All specifications relating to the performance of large-scale contracts - whether the contract is placed by the State, by a municipal council or by a private person - contain a clause under which the builder is required to submit, as soon as the contract has been awarded to him, a detailed plan of operations which is placed before the competent authority for approval. Any breach of the obligations laid down is penalized by a fine. Each plan must specify full particulars of the operations: performance of the work, time-sequence of orders and deliveries, etc.

In the field of town planning and in cases where capital projects are carriod out in common, some co-ordinating functions are also exercised by the technical services of the municipal authorities of the large urban centres.

(c) Mechanization

There are practically no Portuguese-built items of machinery or similar equipment and imports are limited, a fact which doubtless explains to some extent the backwardness of building undertakings in the matter of mechanization. However, the larger building firms regularly use modern quality-improving equipment (concrete-mixers, vibrators, elevators, polishing machines and the like) and plant which reduces cost (hoisting and earth-moving machinery). In some cases the regulations prescribe the use of machinery for particular operations (concrete-mixing, hoisting to a height exceeding 4 m, etc.).

(d) Standardization

Standard plans have been prepared under the low-cost building programmes; in addition, the grant of subsidies by the State is conditional on the observance of certain standards with respect to equipment and area. The number of dwelling units built under these financing arrangements, however, is only a negligible proportion of the total for the country.

With respect, in particular, to the standardization of building materials, the use of standardized materials is not compulsory except where such materials are specified in the contract, which is the case in most of the specifications governing contracts placed by the State or by public authorities. The National Bureau of Standards, working in close co-operation with the National Civil Engineering Laboratory, has laid down a number of standards relating to building materials (slates, ceramic and mosaic tiles, prefabricated and reinforced-concrete floors, panes of glass, bricks, paints and varnishes, solid cellular-concrete blocks, fibrous-concrete piping, etc.). The scope of application of these standards varies a great deal according to the sector of activity concerned; in some cases (e.g. in the ceramic industry) almost the entire production range seems to be standardized.

(e) Introduction of new materials

The introduction of non-traditional materials or processes is governed by article 17 of the General Urban Building Regulations, under which the use of such materials is authorized only if they are first approved by the National Civil Engineering Laboratory. Accordingly, this Laboratory is responsible for appraising the characteristics and behaviour of new processes or materials, and for issuing a certificate authorizing their use. In any case, non-traditional techniques do not seem to have been introduced to any significant extent in house-building; noteworthy advances have been achieved, however, in large-scale civil-engineering projects (bridges, dams, light-weight arches, etc.).

(f) Development of traditional materials

It has already been stated that traditional materials and methods are generally developing in the direction of an improvement of quality, a reduction of dead weight, and greater efficiency. This is particularly true of concrete-mixing, the manufacture of ceramic products, the development of new systems for the partial prefabrication of floors (reinforced concrete, pre-stressed ceramics, etc.), the manufacture of solid or hollow light-weight concrete blocks, the use of insulating panels, etc. Most of the research work which has led to these advances has been carried out by the National Civil Engineering Laboratory, which is one of Western Europe's ablest and best-equipped organizations specializing in this field.

(g) More rational use of materials

The General Urban Building Regulations and the Reinforced-Concrete Regulations, at present being revised, embody rules enabling materials to be used more rationally through such measures as an increase in the stress tolerance of concrete and steel and a reduction in wall thicknesses. The municipal regulations, which locally complement the national regulations, reflect the improvements introduced by the latter in both safety and health matters.

Distr.
RESTRICTED

HOU/Working Paper No.97/Add.(k)
17 March 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(item 6 of the provisional agenda of the eighteenth session)

EFFECT OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Country monographs

SPAIN

1. Relative importance of traditional and non-traditional methods of house construction

It seems that until recently little effort was made to develop non-traditional building methods in Spain. As in most Mediterranean countries, the basic materials for the construction of dwellings are cement, bricks, plaster, and, in some regions, stone. These relatively heavy materials are in general not very suitable for experiments with prefabrication which do not involve a relatively advanced degree of mechanization.

Late in 1955, a nation-wide competition for the selection of new construction methods was organized under the auspices of the National Housing Institute. The purposes of this competition, which are summarized below, illustrate the desire of the authorities to encourage technical advances in the industry:

"(a) Spanish and foreign building undertakings may take part in this competition by building a specified number of dwellings in conformity with a minimum programme and as part of a project which should be capable of adjustment (except that the area and number of rooms constructed should be invariable).

(b) Each undertaking may use whatever methods of construction it chooses, provided that the building fulfils certain minimum conditions of stability and durability.

(c) The only condition laid down is that the methods of construction should be new, i.e. different from the traditional methods; the National Housing Institute will put up a model building constructed by traditional methods which will serve as a basis for purposes of comparing cost and quality.

(d) Participation in the competition will be open in the first place to undertakings proposing to use new materials whose introduction would result in a definite economy in the use of labour..."[1]

The competing undertakings were asked to build either a four-storey apartment building containing twenty-four apartments (type A) or a row of four or five one-family houses having one or two floors (type B), each dwelling to have a total area of 80 m^2 and to comprise four principal rooms plus offices. Thirty-five type A and eighteen type B exhibits were finally left in the competition. In making their award,[2] the judges gave special marks for a number of factors; total building time and the number of working hours spent on the main structure, adjusted by a coefficient depending on the capital value of the heavy machinery used, the architectural quality of the result, the value of the method of construction and the quality of the finished product with special regard to the interior equipment. For the purpose of the final placing of the building firms concerned the marks earned were divided by the cost per square metre of each exhibit, which gave a single weighted index. Except for certain items (aerated concrete, prefabricated reinforced concrete structure, prestressed concrete beams), the building methods used were broadly traditional (brick or concrete block supporting walls, semi-prefabricated floors with ceramic pugging or reinforced concrete beams, etc.), but several examples of simpler constructional elements and of good planning of entrances and interior lay-outs of the dwellings were illustrated in some of the exhibits. In spite of the administrative and technical advantages to be gained from adopting the chosen designs, few dwellings have since been built by means of the prize-winning processes.

Almost all the dwellings are built according to traditional methods, with supporting walls of brick or concrete blocks, or with a reinforced concrete structure poured on the site with outside filling, exposed or faced masonry, dividing walls of hollow brick, light concrete blocks, etc. Owing to the shortage of tensile materials (steel, timber) - a shortage which is observable in most of the less industrialized countries of the Mediterranean region - horizontal structural parts (floors and roofs) are of relatively heavy construction. In

(1) Extracts from the Government's reply.
(2) See "Hogar y Arquitectura", No.12, 1958, pages 89 to 92.

addition, at least in some regions of the country (Catalonia) there is an age-old tradition of building vaults with light bricks which are very quickly assembled and are extremely economic. Accordingly, it is not surprising that building should have remained to a large extent traditional; although changes are certainly taking place in the large towns, unfortunately the available statistics do not show the ratio of urban to rural building.

The cost of building index has increased appreciably (by nearly 70 per cent) in the last five years; from the indices of material and labour costs it appears that these two factors account for about equal shares in the total increase in building cost. The information available does not indicate any real "bottleneck" in traditional home-produced building materials (cement, bricks, ceramic products). On the other hand, the scarcity of such materials as steel and building timber (the latter usually comes from Brazil or Scandinavia) determines the development of new techniques and naturally encourages the building industry to seek methods which will economise in these scarce materials. Incidentally, steel, timber and, up to a point, cement are subject to quotas and their use is controlled by the Ministry of Housing through the issue of building licences.

Any Government policy regarding building techniques is capable (it is stated) of having a bearing on a large proportion of the total number of dwellings built (about 70 per cent in 1956, with indications of a higher percentage in 1957 and 1958); and as, in addition, nearly 20 per cent of the dwellings built by private enterprise are indirectly aided (exemption from real property tax and from profits taxes, etc.), clearly a relatively small volume of building (in fact, luxury building only) is completely "free".

2. Progress towards rationalization of building construction

(a) Technical qualifications of personnel

By virtue of a forty-year old law, plans of dwellings are required to be prepared by an architect; moreover, a Decree of 16 July 1935 defines the functions of a special technician (known as *aparejador*).

According to these legislative provisions, the *aparejedor* is specifically responsible for supervising the proper execution of the work on the site, of checking the mortar and concrete mixes and assisting the contractor with technical advice as necessary. He is appointed by the principal with the architect's concurrence.

The law defines very clearly the function of the architect who is the person effectively in charge of the work. The architects are members of the various provincial associations of architects (total membership nearly 1,500); about 100 architects graduate annually from the two leading colleges of architecture at Madrid and Barcelona.

A great many architects are employed by public bodies. In addition, large building firms often employ architects on their technical staffs, which, however, are mainly composed of civil engineers trained in the State Universities. The workers and subordinate technical personnel are divided into many different groups, ranging from completely unskilled labourers to craftsmen, master craftsmen, foremen, managers and quantity surveyors. In general, these grades do not possess official qualifications, but the aparejadores and assistant engineers receive their training in technical schools.

(b) Organization of house-building

The National Housing Institute began in 1956 to ask all builders of rent-controlled dwellings to submit plans for the purpose of:

"... 1. estimating future demands for building materials;

2. encouraging contractors to make a prior study of building projects and to study the organization of the work at each of the different stages;

3. establishing the precise administrative responsibilities for the observance of the time limits..."

The Work Rationalization Institute and the National Industrial Productivity Committee, in concert with the Ministry of Housing, are making a sustained effort to train instructors specializing in the efficient organization of work and these (it is stated) are made available to undertakings on request.

In the national plan, it is possible to discern a more or less systematic tendency, tempered by the effect of competition acting through open tenders, to place large orders with the largest and best equipped undertakings. The preparation of plans by the architects attached to the principal undertaking should also tend to achieve a better integrated phasing of building operations. The results seem to be interesting, and in any case it is worth noting the trend towards lessening the influence of "official" architects (or of architects designated by the authorities) and enhancing that of architects more directly connected with the industry.

With a view to ensuring better co-ordination of the various phases of the building activities, the Ministry of Housing and the principal bodies responsible for public works (in particular the "Obra Sindical del Hogar y Arquitectura"), in concert with the professional associations of architects, have laid down very detailed regulations governing the presentation of plans[1] for State-aided dwellings. These plans must contain detailed descriptive specifications, a prescribed number of drawings to a specified scale and giving certain specific particulars, an itemized memorandum of costs and a summarized estimate based on a detailed quantity survey. Specimen plans may be consulted by the architects responsible for the preparation of such projects.

(c) Mechanization

The "experimental house" competition referred to above gave prominence to the more general use of machinery for handling factory-made components (large blocks for external walls, facing panels, structural units, steps and hand-rails for stairs, etc.). In fact, up to ten years ago, comparatively little use was made of mechanical equipment for handling and transporting materials. Since then, some large and medium-sized undertakings have been equipped with simple machines used on sites (concrete mixers, hoists, small cranes, etc.), mostly of Spanish manufacture. The heavier machines required for earth-moving (excavators, bulldozers, etc.) are usually hired from specialized firms at an hourly rate. The scarcity of raw materials (steel, iron) and import restrictions (Spanish industry only produces a very small range of building machinery) are further factors restricting the expansion of mechanization. Unfortunately, there are no particulars of the numbers and types of machines in use, but it seems that the trend towards the mechanization of certain elementary building operations is one of the most striking characteristics of the evolution of the Spanish building industry in the last few years.

---

(1) "Normas e instrucciones para la adquisición de terrenes y redacción de proyectos", October 1956.

(d) Standardization

The effects of standardization have made themselves felt only in the case of dwellings which are subsidized by the State or public financing bodies. The legislation containing low-cost dwellings lays down, first, the minimum and maximum areas in respect of each category of dwelling qualifying for the assistance of the authorities. At a later stage, the National Housing Institute prepared model plans for individual dwellings[1], the adoption of which would have simplified the administrative formalities connected with the grant of State aid. More than 10,000 dwellings designed according to these model plans were scheduled to be built in 1957; from more recent information it appears that very few dwellings were actually built to these plans, one of the reasons being that the model plans were designed almost exclusively for rural areas and do not meet the requirements of the users, most of whom live in urban areas. There are no model plans for apartment buildings, although the plans chosen during the experimental housing competition might perhaps be considered as such.

The National Housing Institute has also pursued a policy of standardizing building components. The sizes of wall-openings, windows and doors, sanitary and kitchen fittings have been standardized, and these are mandatory in the case of building projects financially aided by the Institute.

At the same time, the National Housing Institute carries out a qualitative standardization by awarding the right to use the mark "INV" on standardized components of equipment (furniture, kitchen components, door frames, etc), chosen by nation-wide competitions. This has produced results not only in improving quality but also in lowering prices; a notable example is that of metal door frames selling at 175-215 pesetas, as against the price of 350-400 pesetas on the ordinary market.

By contrast, the building industry does not appear to have made any systematic effort at standardization.

---

(1) "Viviendas unifamiliares", Plan Nacional de la Vivienda, Instituto Nacional de la Vivienda, 1956.

(e) New materials

As already stated, the Spanish building industry remains generally true to traditional methods. This observation is true above all of the main structural parts of buildings in which such new processes as the use of aerated ("no-fines") concrete or cellular concretes of the "Ytong" type are only just being introduced. Light alloys and plastics are still little used, although some interesting applications of aluminium were displayed at an international competition promoted by a large aluminium-fabricating firm. Waterproofing and heat-insulating materials, mostly of foreign origin, are also beginning to make their appearance.

(f) Development of traditional materials

On the other hand, very interesting developments have occurred in the use of traditional materials, especially ceramic products (bricks for ventilation courses, pugging for self-supporting beams, prestressed ceramic products, etc) and materials with a cement base (hollow blocks of "fines" or light aggregate concretes, prefabricated ceiling components, prestressed concrete beams, etc). Fibro-cement in the form of flat or corrugated sheets (for facing or roofing) or pipes (rainwater pipes) and ceramic facing materials (tiles, etc), the quality of which is improving steadily, are also widely used.

(g) Economy in use of materials

The Madrid Building and Cement Technical Institute conducts fundamental research into the strength of materials and into the properties of structural elements; the results of this research are reflected in better methods and in the greater economy of materials in building.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.(1)
8 April 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Country Monographs

SWEDEN

1. Relative importance of traditional and non-traditional methods of house construction

The analysis of the evolution of house building techniques in Sweden over the last few years cannot be easily reduced to a single comparison of "traditional" to "non-traditional" construction. In order to give a comprehensive appraisal of the trend of changes which have taken place, it will be necessary to examine successively several aspects of the problem, such as the relative importance of single and multi-family dwellings, of private and public-owned houses, of the different materials used in construction, etc.

In the early 30's, out of 32,000 dwellings built every year, nearly 55 per cent were one - or two-family houses, while multi-family dwellings of more than 10 units represented less than 35 per cent of the total. The relative proportion had changed to 18 per cent and 74 per cent, in 1953, and 27 per cent and 69 per cent in 1957 (out of a total of 64,000 dwellings completed that year). The change in the type of building was paralleled by a change in the type of organization who built it; whereas in the years before the war multi-story dwellings were built by private builders on a speculative basis, the same type of building is now undertaken mostly on behalf of non-profit-making housing societies and cooperatives. (See Table 1). Similarly, individual houses which used to be erected by the prospective owner himself or by small local firms, tend to be concentrated in larger groups, usually entrusted to medium- and large-size contractors. The tendency to concentration is also apparent in multi-family dwellings: the percentage of units of more than 50 dwellings has grown from 36 per cent in 1946, to 51 per cent in 1952 and 62 per cent in 1958. It should however be noted that the relative number of dwellings comprised in units of 200 and more has slightly declined, as large housing operations are now frequently broken down in smaller units for purely financial and administrative reasons.

The general trend can also be appreciated from the changes which have taken place in the relative proportion of materials used in the construction of the different parts of the building. For instance, the traditional construction for external walls which consisted of one-and-half bricks for masonry houses or a double 2" planks in timber houses, has been gradually but steadily replaced by other types of construction. Table 2 shows the proportion of "traditional construction", as defined above, between 1938 and 1958 both for individual and multi-family houses.

In multi-family dwellings masonry construction has replaced almost completely timber construction. External brick walls which represented 47 per cent of the total in 1946 represent only 17 per cent in 1957; the most remarkable increase over the same period can be observed in the use of solid concrete walls (1 per cent in 1946 to 26 per cent in 1957) and light-weight concrete walling (33 and 55 per cent respectively, with a peak of 63 per cent in 1954 - 1955, the later decrease being due to a relative increase of solid concrete walling). The trend in the use of materials for load bearing internal walls in multi-family houses is given in Table 3. It should also be noted that during the last few years there has been a tendency to avoid plastering on concrete walls, which are usually precast or cast in situ in smooth shuttering.

With regard to one and two-family-dwellings, external walls in timber used in 90 per cent of the houses in 1946, covered only 54 per cent of them in 1952 and 68 in 1957. Although the relative proportion of brick walls has remained fairly constant, a considerable development has been observed in the use of light-weight concrete which accounted for 4 per cent of the total in 1946, 32 per cent in 1952 and 24 per cent in 1957.

A more detailed discussion of the changes introduced in the use of traditional building materials is provided in paragraph (f) below. Another important aspect of the development of building techniques in Sweden is the gradual transfer of operations from site to factory. Many factors account for this trend. Severe climatic conditions are certainly a strong incentive to perform the greatest possible number of operations under controlled environment (especially wet construction naturally exposed to the danger of frost) and preferably in a specialized plant. Differences in wages between industrial workers and building workers have also been reported as important in this connection; thus whereas general labourers are paid 6.25 Kr/hour, bricklayers are paid 7.60 Kr/hour and painters 7.70 Kr/hour (1956 figures), workers in prefabricated wooden houses factories receive only 4.50 Kr/hour and male industrial workers between 4.35 and 5.15 Kr/hour. Lastly, one should mention the considerable development of site mechanization and especially of lifting equipment which has made possible the handling of rather heavy units on site. Prefabricated stair flights, roof trusses, bathroom and balcony floors or even complete bathroom units have become increasingly frequent. The tendency to use thinner and lighter materials is no doubt intimately connected with the development of prefabrication. It is estimated, for instance, that approximately 10 per cent of the total of multi-family dwellings built today use precast concrete elements for external walls.

At the same time, the prefabrication of wooden houses, which was started in the early thirties, has developed considerably. In 1944, 40-45 per cent of all individual timber houses were made out of prefabricated components; this proportion has increased in recent years to 50-60 per cent.

Lastly, one should mention the considerable rise in the productivity of building operations which has been observed over the last 10-15 years.(1) The overall increase was of the order of 30-40 per cent, according to the time and the operations concerned, and has more than offset the corresponding increase in building costs, which is common to most European countries over the same period.

2. <u>Progress towards rationalisation of building construction</u>

(a) <u>Technical qualifications of personnel</u>

There has been in Sweden a progressive increase in the proportion of technical staff in relation to manual workers. Thus in a survey of five organizations employing 7000 building workers between them, the ratio of "Engineers" per manual worker rose from 0.14 in 1947 to 0.25 in 1954. During this period the turnover per worker rose from Kr. 39.000 to Kr. 48.000.

(i) <u>Professional and managerial grades</u>

- Architects

There were about 1100 architects practising in Sweden in 1958 of whom 600 were in private employment.

The annual intake to the industry, of architects qualified in Technical Schools, rose progressively from 35 in the five year period 1945-49 to 60 in 1958.

---

(1) See Chapter IV of the main report.

- Engineers

The total force of graduate civil engineers rose from 1,595 in 1944 to 2,160 in 1954. The annual intake rose from 95 in 1945-49 to 135 in 1958. The shortage of men in this category was estimated at 250-300 in 1955.

Engineers at sub-graduate level, trained in technical colleges were about equal in numbers to the graduate engineers in 1954, and the rate of training in this category has been stepped up so that by 1970 it is estimated that the proportion will be: graduates 4,000 and technical college trained personnel 5,500.

It is estimated that the total number of engineers trained at sub-graduate levels from all sources was of the order of 500 a year over the period 1950-1954.

Management

It must be assumed that the higher management functions will, in the main, be performed by men from the graduate and sub-graduate engineers. Thus around 16% of the total force of graduate engineers are in the employment of contractors and building firms.

There is no information as to specific courses of training in the functions of building management as such.

(ii) Supervisory grades

Foremen and supervisors are trained at a series of courses organised by the Foremen's and Supervisors Institute. These take the form of a four weeks' course, followed by 1-2 years practical work, and then a two weeks continuation course on modern production techniques.

Various lectures and courses are also provided by a number of organisations concerned with building technology.

(iii) Operative grades

Craft training is given by apprenticeship in the industry or in vocational training schools. It is considered that a combination of training in a vocational school supplemented by practical instruction on a site is particularly effective.

(c) Mechanization

As in most other west European countries, the use of machines and equipment was first introduced in civil engineering work, and has only recently been extensively adopted on house building sites.

Although since the early 30's concrete mixers and excavators were common on all big sites, lifts were used only for transporting concrete in connexion with high buildings. The first vibrators were used in the construction of a bridge in Stockholm as early as 1932; at the same time production of precast concrete units was started. Sliding forms were introduced in the early 40's, specially for the construction of silos and industrial buildings; around 1948, cement silos and movable concrete plants were also introduced on house building sites. A very special development has also taken place in blasting and drilling techniques required for preparing foundations on the very rough ground existing around most Swedish towns (in 1953, 35 per cent of multi-storey houses were founded on rock).

But the pace of mechanization did not step up until the early 1950 when simple lifts with reversible winches came into use for the transport of materials as well as persons; in 1953 these lifts were replaced by more elaborate equipment with steel structures, button-operated. At about the same time tower cranes became frequent on most multi-storey building sites. Although the first tower crane was introduced in Sweden in 1928, Table 4 shows that in 1950 only 20 of them were in operation. Apart from the lifting equipment listed in this Table one should mention portal cranes, 10 of which were in operation in 1958, and a considerable number of batching and concrete mixing plants (225), concrete hoists with tubular steel structures (300), pneumatic concrete conveyors (70) and other types of simpler hoists 2,000 of which were introduced between 1950 and 1953.

Considerable progress has also been achieved in scaffolding and in form work for in-situ concrete walls and floors. Simple boards were gradually replaced by planks assembled into panels and, later on, by plywood shuttering which provide very smooth finished surfaces requiring no further plastering. A similar development has been observed in the construction of props, originally made out of timber on site, but gradually replaced by standard adjustable timber or steel elements. In the last few years the use of large formwork assemblies which can be transported from floor to floor with the help of a crane has become more frequent. At the same time, large concrete elements have been cast on the ground in batteries of vertical moulds, with the purpose of facilitating stacking and further transport operations.

Auxiliary equipment for horizontal transport has been improved by the development of a special brick truck as well as specially designed barrows for transporting light-weight concrete blocks, mortar, etc. Oil-operated steam generators and drying stoves are currently used in winter construction. A great variety of power tools such as circular saws, drilling tools, bolt pistols, grinding machines, etc., have also been introduced.

The introduction of equipment on house building sites was, as in many other countries, hindered by the lack of capital necessary for their acquisition. A Government loans fund for the acquisition of building machinery was therefore established in July 1952, and placed under the managing authority of the Royal Housing Board. The loans cannot exceed 80 per cent of the purchase cost at an interest rate of 4 per cent (this rate has been increased to 5 per cent as from 1 January 1959), and are amortized over 4 years. They are granted to building contractors and contractors' associations, but not to manufacturers of building materials or firms specialized in hiring of mechanical plant. Since its creation, the Fund has granted nearly 25 million Kr of loans for the acquisition of nearly a thousand machines, including half of the tower cranes and 15 per cent of the lifts bought in the country. Loans have also been granted for all kinds of equipment, including the complete installation of factories for prefabricated concrete units.

Another factor which accounts for the late introduction of mechanization was the piece-rate system currently adopted in building operations, the fear that mechanization might increase unemployment and the ignorance on the benefits to be derived from a rationalized use of equipment on site. Most of these obstacles have now been removed thanks to the experience acquired over the last few years.

(d) Standardization

The central authority for standardization is the Swedish Standards Association, which includes a building department. Quality and test standards for most basic building materials (cement, lime, concrete and structural steel) have been issued and are extensively applied. Considerable success has been achieved by the standardization introduced on the initiative of manufacturers associations in the field of timber doors and windows, kitchen fittings, built-in furniture, ordinary and facing bricks, concrete blocks, wallboards, etc. These standards, currently accepted by the majority of firms manufacturing, concern the quality, the dimensions and the methods of testing as the case may be. The main non-profit making housing societies have also adopted a systematic policy of reduction of variety and enforcement of strict quality requirements which has led to the typification of many building components or even assembly details currently used in their building programmes.

(e) Introduction of new materials

– Light-weight concrete

The large-scale use of light-weight concrete had its origin in Sweden and has been further developed there than in any other country.

Production increased from 0.09 million m^3 per annum in 1936 to 0.77 million m^3 in 1956. Of this production, around 15-20 per cent is supplied in the form of reinforced building products. There are three principal producers operating different processes. As development proceeded the density of the materials has been reduced and the compressive strength improved.

The main developments have been in the form of building blocks and large slabs. In small house construction the slabs are frequently jointed by adhesives.

A recent development is the production of storey-high walling slabs with a density of 0.5 kgs/dm^3 in a standard width of 50 cm and in thicknesses of 7-25 cm.

A "sandwich" slab is being used for external wall construction consisting of storey-height light-weight concrete slabs with foamed rubber or plastic between them.

(f) Development of traditional materials

The most important changes observed in the use of building materials have already been illustrated, as far as the walls are concerned, in a previous paragraph. A general idea of the overall trend can be obtained from Table 5 which shows the national consumption of some basic building materials, expressed in quantities required for 100 square metres of floor space.

These figures should be further qualified to underline the technical developments which have occurred. For instance, external timber walls made out of planks supporting external and internal panels have been practically replaced by lighter framework with inside and outside panels (69 per cent of the total in 1957). In the case of multi-family dwellings, one-and-half brick walls, which in 1938 represented 90 per cent of the total of dwellings with brick walls had completely disappeared by 1957; instead, the one brick wall insulated with 5 to 7 cm wood wool or mineral wool slabs has become predominant.

Parallel with the increased use of brickwork the bricks themselves have shown a progressive trend towards lightness. In the 1920's the usual heavy brick had a weight in the region of 1.7-1.9 kgs/dm^3 and this gave way to a lighter product obtained by adding combustible materials to the clay giving a density of 1.4-1.6 kgs/dm^3. In 1940 the production of hollow clay blocks commenced whereby the compressive strength of heavy brick was maintained with the density of the lighter weight material. The percentage of heavy bricks declined from 54 to 15 during the period 1936-1956 and the light-weight bricks and blocks increased from 32-44 per cent during the same period.

During the 1950's 75 per cent of facing brickwork has been in hollow block and 20 per cent of the backing brickwork.

The principal dimensions of hollow blocks since their introduction in the 1930's have been 25 x 12 x 6.5 cm and 25 x 12 x 7.5 cm. During the 1950's modular building blocks of 25.4 x 12 x 8.5 cm and 25.4 x 12 x 8.5 cm have been introduced, the latter being much used for 14 or 20 cm thick load-bearing walls.

Plastered internal walls and ceilings, which were used in most multi-family dwellings until 1953, have now almost completely disappeared; cardboard, which was currently used in 1930 as internal lining has very often been replaced by laminated boards and recently by plasterboard which accounted for 15 per cent of cladding of all wooden houses in 1957.

The use of glass wool or mineral wool for thermal insulation purposes in external walls has become increasingly frequent and in 1957 has been adopted in nearly two-thirds of the external walls.

It is also interesting to note the evolution in the use of facing materials. Timber individual houses, which were mainly painted or plastered until 1950, are now often finished with facing bricks (36 per cent) or painted (48 per cent). A similar trend can be observed in masonry houses, where external plastering (which represented 74 per cent in 1950 and 46 per cent in 1957) has given way to facing bricks (21 to 46 per cent). Asbestos-cement sheets have also become common as an external facing material.

Floor structures have been following a similar development. Solid concrete floors, which have gradually replaced timber or steel joist floors since 1930, are used for almost all multi-family dwellings now.

The overall thickness of concrete floors, which was normally 30 cm until 1953 (to include 10 cm concrete screed or timber subfloor), has gradually been reduced, with the introduction of flooring materials (parquet or linoleum) laid directly on the concrete slab or on elastic cardboard. At the same time, the thickness of structural slabs was increased from 13 to 17 cm, mainly for reducing steel consumption. Flooring materials have also changed. Deal floors which represented 35 per cent of floors in 1945 have practically disappeared and been replaced by parquet and linoleum, which account for 35 to 45 per cent of the total in 1956. Timber has also been replaced by concrete in individual houses. In 1957 concrete floors were used in 50 to 90 per cent of wooden and masonry houses respectively.

The adoption of higher grade steel for reinforcement has also been apparent over the last ten years. St44 steel, with a permissible stress of 1,500 kg/cm^2, was used in 85 per cent of the houses in 1948 but only in 5 per cent of them in 1958, whereas the use of St52 and Ks40 steels, with a permissible stress of 2,000-2,200 kg/cm^2, has grown from 15 to 95 per cent over the same period.

The use of roofing materials has changed too. Burnt clay tiles, which were used in less than half the multi-family dwellings in the early thirties, have practically replaced other roofing materials (metal sheets, bitumen felt); a similar trend has been observed in individual houses, 80 per cent of which were covered with burnt clay tiles in 1957. Asbestos cement is also increasingly used in this connexion.

(g) <u>Economy in the use of materials</u>

The efforts to rationalize house construction have affected the layout of plans, the utilization of floor space and the actual building methods. Some of these efforts have in particular been devoted to a rationalization of building regulations. Until 1940 most of these were of a local character and varied considerably from place to place; as a rule the local bodies responsible for their enforcement were also reticent in the introduction of new methods of construction or non-traditional materials. The policy of granting loans through the State Building Loan Office (now Royal Housing Board) subject to compliance with some technical conditions has considerably facilitated the introduction of a more economical use of building materials. Thus, for instance, the adoption of new technical requirements for prefabricated timber houses affected the construction of almost 50 per cent of all individual houses. National building regulations were issued for the first time in 1945/46, and revised in subsequent years by the Public Buildings Administration. The Building Act and the Public Health Act have also been revised recently. Considerable efforts were also devoted to applied research in the field of building materials, domestic science, community development and planning, building documentation techniques, etc.

With improvements in technique, and in strength and uniformity of cements, permissible working stresses in concrete have risen by stages from 40 kg/cm^2 in 1910 to 125 kg/cm^2 in 1949.

Similarly with the use of higher grades of steel, working stresses in reinforcing steel have risen from 1,000 kgs/cm^2 in 1910 to 4,000 kgs/cm^2 in 1958.

Table 1

Relative Proportion of Multi-Family Dwellings according to Building Owner, in percentages

Year	Dwellings in multi-family houses			
	Non-profit societies	Co-operatives	Private builders	Total
1935	8	8	84	100
1938	7	5	88	100
1941	15	10	75	100
1944	10	30	60	100
1947	16	21	63	100
1950	43	21	36	100
1953	46	25	28	100
1956	40	34	26	100
1957	39	35	26	100

Table 2

Proportion of Houses of "Traditional Construction" in percentages

Year	Individual houses	Multi-family houses	All houses
1938	90	90	90
1944	55	75	69
1946	30	35	34
1948	5	15	12
1950	3	11	9
1952	2	8	7
1954	1	4	3
1956	-	1	1
1958	-	-	-

Table 3

Relative Proportion of Load-Bearing Internal Walls in Multi-Family Houses, According to Building Materials

(in percentages)

Year	Brick	Light-weight concrete	Concrete blocks	Concrete in-situ	Total
1936-40	95	-	-	5	100
1946	90	5	-	5	100
1949	80	5	5	10	100
1953	70	-	20	10	100
1956	40	-	40	20	100
1958	35	-	10	55	100

Table 4

Number and type of lifting equipment in operation at the end of the year

Type of equipment	Year								
	1950	1951	1952	1953	1954	1955	1956	1957	1958
Tower cranes, track-bound	20	45	80	100	150	225	275	305	340
Tower cranes, stationary	-	-	10	20	40	55	85	140	265
Lifts of steel with reversible winches	-	-	-	85	345	590	925	1290	1810

Table 5

Trends in the Consumption of Building Materials

(in tons and cubic metres)

	Units	Consumption per 100 m^2 floor-space						
		1938	1943	1948	1951	1953	1955	1957
Cement[a]	t							
One- and two-family houses		9	11	11	13	13	14	
Multi-family houses		13	17	18	20	22	24	
All houses		10	14	15	17	19	20	
Light-Weight Concrete	m^3							
One- and two-family houses		-	1	4	11	13	11	
Multi-family houses		1	6	10	13	15	16	
All houses		1	3	7	12	14	14	
Structural and facing Bricks	m^3							
One- and two-family houses		9	8	7	9	10	10	
Multi-family houses		28	27	19	19	18	14	
All houses		17	18	14	15	15	12	
Timber[b]	m^3							
One- and two-family houses		60	55	48	39	36	34	30
Multi-family houses		41	32	28	21	20	20	19
All houses		52	43	37	29	25	25	22
Steel	t							
One- and two-family houses		0.50	0.50	0.60	0.70	0.70	0.70	
Multi-family houses		1.90	2.00	1.70	1.70	1.60	1.50	
All houses		1.30	1.50	1.35	1.45	1.45	1.30	

Note: (a) including cement for concrete products.
(b) including joinery and mouldings, scaffolding and formwork.

Distr.
RESTREINTE

HOU/Document de travail No 97/Add.(m) Rev.1
6 mai 1959

Original: FRANCAIS

COMMISSION ECONOMIQUE POUR L'EUROPE

COMITE DE L'HABITAT

(Point 6 de l'ordre du jour provisoire
de la dix-huitième session)

INCIDENCE DES MESURES PRISES PAR LES GOUVERNEMENTS EN VUE DE FAVORISER LES PROGRES TECHNIQUES DE L'INDUSTRIE DU BATIMENT ET DE REDUIRE LE COUT DE LA CONSTRUCTION

Monographies nationales

URSS

1. Importance relative des méthodes traditionnelles et non traditionnelles de la construction

Le volume de la construction de logements en URSS s'accroît sans cesse. C'est ainsi que 1.245.000 logements (appartements et maisons unifamiliales) ont été construits en 1953, 1.351.000 en 1954, 1.512.000 en 1955, 1.636.000 en 1956, 2.172.000 en 1957 et 2.664.000 en 1958. Dans le cadre du plan septennal 1959-1965, il est prévu de construire, grâce à des investissements publics et aux ressources de la population aidée par des prêts de l'Etat, près de 15 millions de logements (totalisant environ 650 millions de mètres carrés de surface habitable) dans les villes, les cités ouvrières et celles des "sovkhozes", des stations de réparation des tracteurs et des exploitations forestières; d'autre part 7 millions de logements seront construits par les kolkhoziens et les cadres ruraux.

Ce programme de construction, caractérisé par un rythme de croissance particulièrement rapide doit être effectué sans qu'augmente d'une manière appréciable l'effectif des ouvriers du bâtiment et en réduisant au strict minimum les dépenses en matériaux. C'est pour cela que la tendance fondamentale de la politique technique de l'URSS en matière de construction de logements consiste à industrialiser celle-ci dans toute la mesure du possible.

Les principales conditions nécessaires pour pouvoir industrialiser avec succès la construction de logements sont les suivantes:

1. Un programme de construction de logements non seulement vaste mais d'une ampleur sans cesse croissante, de manière à assurer une activité ininterrompue dans la construction et des commandes ininterrompues pour les entreprises qui travaillent pour l'industrie du bâtiment.

2. L'existence de puissantes entreprises mécanisées pour fabriquer les éléments structuraux.

3. La typification des maisons d'habitation et la normalisation des éléments utilisés pour la construction de logements, de manière à bénéficier de la rentabilité qui s'attache à la production massive en usines des pièces et éléments structureux.

4. L'existence de puissants organismes de construction, disposant des moyens mécaniques nécessaires pour assembler les éléments préfabriqués.

En fait, la gamme de solutions techniques utilisées dans la construction de logements en URSS est extrêmement variée et va depuis les procédés les plus traditionnels et presque artisanaux jusqu'aux méthodes de montage en chaîne d'éléments entièrement fabriqués à l'usine. Il est donc particulièrement difficile de dresser un bilan satisfaisant d'une réalité qui, en plus d'être très fortement diversifiée, poursuit une évolution constante et extrêmement rapide, ce qui constitue peut-être sa principale caractéristique. Sur un total de plus de 2 millions de logements construits en URSS au cours de l'année 1957, 878.000 à peine, soit 42% environ, pouvaient être considérés comme des logements d'Etat. Le reste, représentant donc plus de 1.200.000 logements, était construit directement par des individus ou des coopératives, dont une grande partie, il est vrai, avec une aide financière ou matérielle de l'Etat sous forme de prêts, d'exemption d'impôts, de fourniture de matériaux, etc. La part de logements construits par les individus et les coopératives est d'ailleurs allée en augmentant au cours de deux dernières années; enfin, près de deux tiers de cette dernière catégorie de logements, soit près de 40% du total, se trouve dans des régions rurales.

Il faut également tenir compte de la part importante de constructions effectuées directement par la main-d'oeuvre volontaire et avec l'aide des employeurs ou des coopératives dans les régions rurales du pays. Ce type de réalisations se base sur l'emploi presque exclusif de matériaux de gros-oeuvre locaux qui comprennent non seulement la brique, mais, suivant les régions, la pierre de taille, le bois, ou une ossature en bois avec remplissage non porteur.

La rapide évolution qui est en cours dans l'industrie de la construction tout entière n'épargne certes pas ce secteur traditionnel. D'une part l'emploi toujours croissant de petits éléments préfabriqués en béton remplace de plus en plus les éléments traditionnels en bois, en acier ou en pierre. La préfabrication d'éléments légers de plancher, d'appuis de fenêtres ou même d'entourages de baie complets, de corniches, de marches d'escalier, etc., se généralise à tous les échelons de la construction. Dans certains cas, 80% de la valeur des matériaux incorporés dans un bâtiment est préfabriqué. D'autre part, les opérations de maçonnerie elles-mêmes, à cause entre autres du manque de maçons en nombre suffisant, tendent à être remplacées par des opérations de montage d'éléments de plus grandes dimensions que la brique ou le bloc traditionnel. On emploie ainsi des panneaux ou dalles composés de briques pleines (ou dans les cas les plus récents de briques à perforations horizontales) fabriqués à l'usine ou à pied d'oeuvre et montés sur place avec joints apparents; ces éléments composites de briques sont souvent remplacés par des dalles de dimensions analogues (entre 3 et 4 m^2 de surface de mur) réalisées en béton de mâchefer et de laitier et montées par des procédés semblables. Certains de ces panneaux comportent des éléments de chaînage préfabriqués en béton armé ordinaire ou en béton de laitier, destinés à être solidarisés en place par le coulage de béton monolithique. La transition des opérations de maçonnage par briques individuelles à celle de montage de panneaux préfabriqués ou blocs est graduelle et correspond à une tendance généralisée de l'industrie de la construction de l'URSS.

Une évolution analogue peut être observée dans la préfabrication de dalles pour planchers ayant la longueur des pièces et une largeur allant de 1 à 2 mètres. Certaines de ces dalles sont nervurées, et doivent être complétées sur leur face inférieure par des panneaux de plafond préfabriqués en béton ou en plâtre; d'autres comportent une surface inférieure lisse qui est peinte par la suite et des évidements intérieurs de forme circulaire ou ovale. Le poids de ces éléments, ainsi que de ceux déjà décrits utilisés pour la construction des murs extérieurs, est relativement limité et permet leur montage par des engins de levage de faible capacité.

Mais le développement le plus intéressant qu'il est donné d'observer en URSS est celui de l'emploi toujours croissant des éléments préfabriqués de grandes dimensions en béton armé. Une réslution spéciale du Comité central du Parti et du Conseil des ministres de l'URSS, en date du 19 août 1954, était consacrée au "développement de la production d'éléments en béton armé préfabriqué destinés à l'industrie du bâtiment". Ayant constaté que la production de ces éléments était nettement insuffisante, la résolution faisait ressortir l'intérêt qu'il y avait à développer leur emploi qui permettrait d'économiser l'acier et le bois, d'augmenter la productivité du travail et de réduire le prix de revient. Les réunions ultérieures du Comité central, et notamment celle de juillet 1955, ont confirmé ces directives en les développant sur le plan technique et en donnant des instructions précises pour l'organisation de ce qui était à l'époque une nouvelle branche de l'industrie du bâtiment.

L'importance de cet effort peut être mesurée par le fait qu'en 1958 plus de 17 millions de m^3 de béton armé préfabriqué ont été produits, ce qui représente une augmentation de sept fois par rapport à 1953. Les plans prévoient que la production de ces éléments ira en augmentant et qu'elle atteindra 42-45 millions de m^3 en 1965, dont un quart environ d'éléments en béton précontraint.

Le coût des maisons à grands panneaux n'a pas encore pu être ramené au-dessous de celui des maisons en briques du fait que, jusqu'à présent, leur production en série n'a pas été mise au point. Toutefois, l'expérience acquise par le consortium Tchérépovetzmetallourgostroï du Conseil économique régional de Vologda, par le Glavmosstroï dans le XIème arrondissement de Moscou et par quelques autres organismes de construction qui ont édifié des groupes de maisons en 1958 montre que lorsque les maisons d'habitation à grands panneaux sont préfabriquées en usine par grandes séries, leur coût est sensiblement inférieur à celui des maisons en briques. On estime que si la construction par grands panneaux est pratiquée sur une vaste échelle, son coût doit être d'au moins 10% inférieur à celui de la construction mixte en briques avec utilisation d'éléments préfabriqués. D'autres calculs montrent que les investissements nécessaires pour créer des entreprises produisant des maisons préfabriquées sont sensiblement inférieurs à ceux qu'exige la création des entreprises indispensables à la production des matériaux et des éléments qui servent à construire les maisons en briques.

Déjà au cours des deux dernières années, le prix des grands éléments en béton préfabriqué produits dans les meilleures usines ont baissé de 25% environ. S'il est naturellement difficile de distinguer dans cette baisse la part de la typification et de la standardisation proprement dites de celle de la production en série dans son ensemble, on peut cependant l'attribuer à la fois à la spécialisation des usines de production, à la limitation de la variété d'éléments produits et à la mécanisation très poussée des opérations de fabrication en chaîne.

Il existe, à l'heure actuelle, près de 600 usines consacrées exclusivement à la production d'éléments en béton préfabriqué: certaines de ces usines sont extrêmement modernes et ont adopté des méthodes de fabrication industrielles qui permettent d'obtenir des produits de bonne qualité avec un emploi minimum de main-d'oeuvre.

Une autre mesure, quoique très approximative, de l'importance de l'effort consacré à la préfabrication d'éléments en béton est donné par le fait que si l'on estime à 10% la valeur des éléments préfabriqués incorporés dans un bâtiment de construction traditionnelle, ce pourcentage atteint 70 ou même 15% dans certains procédés de construction à préfabrication lourde actuellement employés en URSS.

Au début du processus d'industrialisation par préfabrication lourde, la presque totalité des éléments porteurs du gros oeuvre était constituée par des panneaux très épais (40 à 50 cm) en béton armé ordinaire dont les armatures étaient soudées en oeuvre à celle des panneaux voisins. Les éléments de plancher étaient également constitués par des dalles pleines de forte épaisseur avec couche isolante supérieure et un revêtement de sol monolithique.

Des considérations diverses, et notamment les inconvénients entraînés par le grand poids de ces éléments et le fait qu'on ne pouvait pas éviter une proportion importante de déchets sur chantier et des opérations de finition assez coûteuses, ont amené les techniciens à rechercher des solutions plus évoluées et en général plus légères. C'est ainsi, par exemple, que des logements expérimentaux construits en 1957 à Moscou pesaient 1,15 tonne par m^2 de surface habitable, soit un tiers du poids d'une maison traditionnelle en briques; la réduction de consommation d'acier était à peu près du même ordre de grandeur. L'emploi d'éléments de plancher en béton précontraint comportant souvent des évidements à l'intérieur de la dalle est églement en voie de généralisation. De nombreuses expériences sont actuellement effectuées pour la fabrication de panneaux extérieurs porteurs et non porteurs incorporant des bétons légers ou des solutions mixtes avec isolation en mousse plastique, des revêtements extérieurs céramiques ou en amiante-ciment, différents degrés de finition intérieurs en plâtre, etc.

Parallèlement à la production à l'usine de grands éléments destinés à la construction d'immeubles d'habitation, on a développé la production d'éléments préfabriqués légers destinés à la construction de maisons de un ou deux niveaux. En 1957, la production de ces usines représentait déjà l'équivalent de 4,3 millions de m^2 de surface habitable. Les mêmes usines produisaient des éléments préfabriqués d'ossature en bois destinés à être employés avec des murs construits avec des matériaux locaux pour l'équivalent de 3 millions de m^2 de surface habitable. La production de ces usines est en augmentation constante et le plan prévoit qu'elles atteindront 20 millions et 10 millions de m^2 respectivement en 1961. Chaque année la porportion de maisons préfabriquées constituées par des éléments types assemblés sur chantier par des particuliers augmente. En 1961, il est prévu que 90% de la production totale de maisons préfabriquées sera ainsi vendue à des particuliers.

Des expériences sont actuellement en cours sur des procédés de construction d'une conception tout à fait différente et basés sur l'emploi d'une "boîte" rigide contenant le bloc sanitaire entièrement fini et d'un ensemble de panneaux de murs porteurs et de planchers de la largeur d'une pièce.

Le degré de finition des éléments préfabriqués varie également beaucoup Certaines solutions, surtout dans les toutes dernières réalisations à caractère expérimental, comportent une finition presque complète des éléments de murs dans lesquels sont incorporés, aussi bien les canalisations d'eau et de gaz et les installations électriques ou de chauffage que les revêtements muraux définitifs.

Ainsi donc la construction résidentielle d'Etat en URSS peut être considérée comme appartenant au secteur industrialisé, bien que le degré d'industrialisation soit variable suivant les maisons. La préfabrication totale des maisons à grands panneaux ou à grands blocs n'existe, en général, que dans les grandes villes et les centres industriels importants; le type d'immeuble qui est le plus répandu partout est la maison du type industriel dans laquelle les planchers, les escaliers et certaines autres parties de structure sont représentés par des éléments en béton armé, préfabriqués en usine, alors que les murs sont construits en blocs, en briques ou en pierres naturelles. La construction résidentielle de faible hauteur effectuée pour le compte des pouvoirs publics est généralement représentée soit par des maisons légères entièrement préfabriquées en usine, soit par des maisons qui ont des murs en matériaux d'origine locale mais qui comportent aussi des éléments de production industrielle.

Les quelques données disponibles sur la productivité de la main-d'oeuvre, exprimées en heures-ouvrier par m^3 de construction, semblent indiquer que celle-ci est en progrès constant surtout au sein des grandes organisations de construction (voir paragraphe b) ci-dessous). Des chiffres relevés sur des chantiers de la région de Moscou et qui peuvent être considérés comme représentatifs de la tendance générale montrent que le nombre d'heures nécessaires sur chantier pour la construction d'un mètre cube de bâtiment hors-tout varie entre 6 - 7 pour les procédés traditionnels et 4 - 5 pour les méthodes de préfabrication partielle ou totale; sur des chantiers expérimentaux on a obtenu des résultats encore meilleurs.

b) <u>Organisation des opérations de construction</u>

Les activités du bâtiment en général sont de la compétence d'organes administratifs centraux, régionaux ou municipaux. Le Comité d'Etat de la Construction du Conseil des Ministres ("Gosstroi SSSR") est l'organisme supérieur de contrôle et de coordination de toutes les activités relatives au bâtiment et, notamment, la construction de logements.

A partir de juillet 1957, la profonde réforme de la structure industrielle de l'Union soviétique a également affecté l'organisation de l'industrie du bâtiment. En effet, la responsabilité exécutive pour la presque totalité de l'activité industrielle a été transférée aux 104 conseils économiques régionaux ("Sovnarkhozy"), le reste étant confié aux conseils de l'industrie et de la construction locale ("Sovmestpromy") qui dépendent des conseils provinciaux ("Oblast"). Presque tous les ministères techniques centraux de l'ancienne organisation ont disparu; au niveau des républiques et en matière de bâtiment, restent seulement le ministère du bâtiment de la République russe et celui du bâtiment et des matériaux de la construction de la République d'Ukraine, qui n'ont cependant qu'un rôle de coordination, toute fonction exécutive étant confiée aux sovnarkhozy. Ceux-ci sont responsables de la moitié environ du volume total de la production, de l'industrie du bâtiment du pays, y compris les industries locales de production des matériaux; un quart du total est encore effectué directement par les ministères centraux qui ont survécu à la réforme, et notamment le ministère des constructions pour les transports; un quart, enfin, par les administrations locales municipales.

La plupart des travaux de construction proprement dits sont effectués par des organismes de construction ou entreprises, placés le plus souvent sous l'autorité d'un sovnarkhoz et travaillant sous contrat pour un maître d'ouvrage déterminé. Les statistiques de 1957 montrent qu'en cette année 85% du volume total des travaux de construction avait été réalisé par ces organismes de construction.

En général, les entreprises de construction sont donc établies sur des bases territoriales définies et peuvent effectuer des constructions pour différents maîtres d'ouvrage dans une région donnée.

Enfin, quand les réalisations ont une certaine importance, on constitue des organismes de construction spéciaux consacrés exclusivement à la réalisation du chantier en question. Les organismes de construction sont classés d'après le caractère de leur activité principale en "entreprises générales" et "entreprises spécialisées". Ces dernières, qui se consacrent surtout aux installations techniques (équipement sanitaire, électrique, etc.), ont des fonctions analogues à celles des entreprises spécialisées des pays d'Europe occidentale et, le plus souvent, exécutent des travaux en tant que sous-traitants des entreprises générales. La tendance vers la spécialisation des entreprises est relativement récente et sera amenée à être développée à l'avenir, car elle permet une meilleure utilisation des machines, des capacités techniques des cadres et de l'expérience acquise par la main-d'oeuvre grâce à la répétition d'opérations semblables. Une tendance analogue s'observe parmi les entreprises générales qui se spécialisent souvent en fonction du type de bâtiment: résidentiel, public, industriel. Ces dernières se spécialisent à leur tour d'après le genre de branche industrielle: bâtiment pour les industries de l'acier, des métaux non ferreux, des viandes, etc. Les possibilités de spécialisation sont naturellement limitées par l'importance des programmes lancés dans une région donnée; parfois il s'agit simplement de branches spécialisées créées à l'intérieur d'une entreprise générale. Enfin, des entreprises spécialisées dans la construction de logements ont parfois établi des départements séparés chargés des travaux préparatoires du gros-oeuvre, de la menuiserie en général, des charpentes et des travaux de finition. Cette subdivision ultérieure est susceptible d'apporter des résultats intéressants sur le plan économique.

La coexistence, à l'intérieur de la même ville, d'activités de construction relevant de l'autorité d'administrations différentes avait toujours posé de sérieux problèmes de coordination et d'efficacité. Bien avant la réforme administrative de juillet 1957 et dès 1954, les plus grandes villes du pays (Moscou, Leningrad, Kiev, Bakou, Tashkent, etc.) avaient établi des organisations spéciales appelées, d'après le nom de la ville: Glavmosstroï, Glavkievstroï, responsables de la plus grande partie des activités du bâtiment dans la ville en question.

L'organisme de construction le plus puissant de Moscou, le Glavmosstroï, qui est placé sous l'autorité du Soviet de la ville de Moscou, et les autres grands organismes de construction qui exercent leurs activités dans cette ville, englobent non seulement des consortiums d'entreprise générale qui jouent le rôle de maîtres d'oeuvre, mais également des consortiums spécialisés dans certaines catégories de travaux tels que la construction des fondations et des caves, l'installation de communications et de réseaux souterrains, les travaux de finition, les installations sanitaires et techniques, les installations électriques, les travaux de voirie et autres travaux de caractère spécial. A Moscou, les usines qui produisent les éléments structuraux et les matériaux de construction relèvent de l'autorité d'une autre direction du Soviet de la ville de Moscou - le Glavmospromstroï-matérialy. En 1957, le Glavmosstroï a mis en service plus de

1 million de m^2 de surface habitable, soit environ la moitié de toute la surface habitable construite cette année-là à Moscou. En outre, cet organisme a exécuté à Moscou un important programme de constructions portant sur des immeubles destinés à abriter des services publics ou édilitaires.

L'efficacité de l'agrandissement et de la spécialisation des organismes de construction peut être illustrée par l'exemple de Glavmosstroï qui, en l'espace de trois ans, a presque doublé le volume de la construction d'immeubles résidentiels ou à usage d'écoles, d'hôpitaux ou d'autres services d'utilité publique. En outre, le coût des travaux de construction et de montage a diminué d'environ 15%, cependant que la productivité de la main-d'oeuvre a augmenté de plus de 50%. De son côté, en l'espace de quatre ans, le Glavleningradstroï a augmenté de 65% le volume de ses constructions, tout en employant le même nombre d'ouvriers.

Les objectifs du volume total de construction de logements, compris dans les plans généraux d'investissements non productifs, sont établis en fonction des capacités réelles de l'industrie, aussi bien à l'échelon de la production des matériaux ou des machines que des travaux de construction et de montage sur chantiers. Les dispositions prises en août 1957 pour encourager à long terme la construction de logements n'ont pas été modifiées; cependant, à partir de 1959, le plan de construction de logements doit être basé sur un prix moyen local par mètre carré. L'appel à la concurrence n'existe pratiquement pas en URSS. En dehors des travaux effectués directement par les entreprises industrielles ou de ceux entrepris par les particuliers avec l'aide de l'Etat, de la collectivité locale ou de l'employeur, les travaux de constructions font l'objet de marchés passés entre le maître d'ouvrage et les entreprises de construction.

La part des travaux effectués par ces entreprises de bâtiment, par opposition à ceux exécutés directement par les entreprises industrielles elles-mêmes, est allée en augmentant au cours des dix dernières années, ainsi qu'il ressort du Tableau 1 ci-après.

Tableau 1

Part du Programme de construction effectuée par les entreprises du bâtiment

(en milliards de roubles, prix 1955)

Total pour la période	Travaux de construction en général en milliards de roubles	Travaux effectués par les entreprises de bâtiment	
		en milliards de roubles	en %
1946-50	220,4	164,9	73 %
1951-55	420,3	354,6	82 %
1956-57	241,2	207,8	85 %

Les prix unitaires des éléments constitutifs des ouvrages sont déterminés en partant de listes officielles de prix des matériaux de base et des tarifs unifiés des transports, avec toutefois des coefficients d'adaptation régionaux. Presque tous les travailleurs du bâtiment sont rémunérés à la tâche, sur la base de normes établies pour l'ensemble du pays et d'un système de primes de rendement croissantes assorties d'autres compensations en argent ou en nature (congés payés, séjours dans des stations de repos, etc.).

La plus grande partie des travaux de construction à caractère non industriel est projetée par des "instituts de projets" placés sous l'autorité des architectes en chef des villes principales; ces instituts s'appellent d'après le nom de la ville, "Mosproekt","Kievproekt", etc. Certains de ces instituts emploient plusieurs milliers de personnes et sont organisés en départements responsables d'une zone déterminée de la ville. Toute entreprise de construction qui exerce une activité dans les limites de la ville doit se conformer aux plans d'aménagement urbain et aux directives de l'institut de projet compétent. Des départements du bureau de l'architecte en chef dressent les plans d'aménagement, les relevés topographiques, déterminent les alignements, les niveaux, etc. En plus des instituts de projets, il existe un certain nombre d'instituts d'Etat chargés d'établir des projets types, qui ont leur contrepartie dans des instituts placés auprès de chacune des républiques de l'Union. Ces instituts produisent non pas des plans types mais des "projets types" (comprenant les détails d'exécution, le mode d'organisation du chantier, les moyens de mise en oeuvre, etc.) qui peuvent être construits dans le pays tout entier. A cet effet, l'Union est divisée en différentes zones climatiques et les projets types peuvent être modifiés dans chacune des zones afin de tenir compte des conditions locales (hauteur sous plafond, isolation thermique, etc.) aussi bien que des méthodes de construction adaptées aux possibilités des organismes ou entreprises locales de construction. Très souvent, l'activité des instituts de projets urbains se limite à l'adaptation ou à l'assemblage de projets types élaborés par les instituts d'Etat dans le cadre d'un plan général établi d'année en année. Les bureaux d'étude dépendant de certains ministères ou organisations élaborent également des projets types pour les bâtiments spéciaux dont ils ont la charge: écoles, hôpitaux, magasins et bâtiments industriels.

Pendant la construction des représentants des maîtres d'ouvrage d'une part et des organes locaux de contrôle en matière d'architecture et de construction, d'autre part, veillent à la réalisation correcte des projets et participent aux travaux des commissions chargées de la réception des bâtiments. Le représentant du maître d'ouvrage est d'habitude un collaborateur de l'institut de projets qui a, comme nous l'avons vu ci-dessus, procédé à l'adaptation des projets types aux conditions locales.

c) <u>Mécanisation</u>

On accorde une attention particulière à la mécanisation des opérations de construction de logements en URSS, aussi bien pour des raisons d'ordre technique qu'afin d'atteindre le rythme de production fixé par les plans nationaux de développement. L'effort de mécanisation a pour l'instant porté principalement sur les travaux qui exigent des efforts pénibles ou qui demandent beaucoup de main-d'oeuvre non spécialisée. Ceci est mis en évidence par les chiffres concernant le parc de machines de construction existant à la fin de chaque année et donnés au Tableau 2 ci-dessous:

Tableau 2

Parc de machines de construction

	1940	1950	1953	1955	1956	1957
Pelles excavatrices	2086	5870	12457	17471	20800	24600
Scrapers	1100	3000	7449	9290	9750	10100
Bulldozers	750	3000	10407	16100	20588	32717
Grues mobiles	1135	5642	18018	28900	32717	35800

Les engins de montage principalement utilisés dans la construction de logements sont les tours à pilône d'une puissance variant de 0,5 à 5,0 tonnes.

L'abrègement considérable de la durée de construction dans le cas des immeubles à grands panneaux ou à grands blocs nécessite de fréquents déplacements des grues de montage, ce qui a incité à entreprendre des travaux, à peu près achevés à l'heure actuelle, en vue de créer toute une gamme de grues à pylône mobiles d'une puissance allant jusqu'à 5 tonnes et ayant des couples de levage variant de 30-100 tonnes-mètres, qui peuvent être déplacées tout d'une pièce et dont le montage et le démontage n'exigent que quelques heures. Ces grues possèdent toutes les caractéristiques nécessaires pour pouvoir monter des immeubles des types à grands blocs ou à grands panneaux.

Pour faciliter l'exécution des travaux, on a même créé des groupes mobiles de machines de construction qui permettent d'assurer une mécanisation plus complète de la construction et d'organiser celle-ci suivant des méthodes industrielles. La mécanisation de la construction en général est planifiée dans le cadre d'un plus national qui détermine le volume des travaux à exécuter et, par conséquent, les besoins en matériel des organismes constructeurs.

En URSS, comme dans presque tous les pays d'Europe, on peut remarquer le manque de mécanisation dans le domaine des travaux secondaires du gros-oeuvre (finition des fouilles et des tranchées, petits chargements et manutention, confection de mortier, etc.) et du second oeuvre. Des efforts ont récemment été entrepris pour remédier à cet inconvénient.

Le processus de mécanisation des principales opérations de construction est actuellement en cours. C'est ainsi que sur des chantiers même importants coexistent souvent des formes très développées de mécanisation comportant des engins de transport ou de levage ultra-modernes et des opérations analogues effectuées par des méthodes perpétuées par la tradition artisanale ou rurale.

d) Standardisation

L'effort de standardisation poursuivi en URSS aussi bien dans le domaine qualitatif que dans le domaine dimensionnel s'encadre dans la politique technique du gouvernement qui tend vers la rationalisation et l'industrialisation du bâtiment.

Cet effort était d'ailleurs indispensable afin d'atteindre les cadences accélérées d'augmentation des programmes de construction de logements qui caractérisent l'évolution de l'industrie du bâtiment en URSS au cours des cinq dernières années.

Le fait que, en URSS, les principaux maîtres d'ouvrage sont des organisations publiques permet d'appliquer les mesures de typification et de normalisation à l'échelle du pays et d'élaborer des normes et des catalogues d'éléments standard de production industrielle qui présentent un caractère obligatoire pour les établisseurs de projets, les organismes de construction et les usines qui les approvisionnent. Ce système assure, de la part des organismes de construction, la continuité de la demande pour les articles standard produits par les usines qui travaillent pour l'industrie du bâtiment.

Les travaux en matière de typification et de normalisation de la construction de logement ont pris une extension particulière après la guerre, époque à laquelle on est passé de l'établissement de projets types individuels à celui des séries de projets types, dans lesquels les projets afférents à des maisons de différents volumes et structure se rattachent les uns aux autres par des identités de solution sur le plan de l'architecture et de la technique et par l'emploi d'éléments standard de production industrielle, époque à laquelle l'élaboration de petits éléments types normalisés destinés au petit oeuvre des constructions traditionnelles a fait place à la typification et à la normalisation des grands éléments de production industrielle. En URSS, la typification et la normalisation reposent sur un système modulaire caractérisé par un module de base de 10 centimètres.

Les travaux de typification et de normalisation s'exécutent conformément à des plans d'ensemble de typification et de normalisation en vertu desquels les divers instituts d'Etat chargés de l'établissement de projets qui se trouvent dans les différentes parties du pays élaborent des projets types et des normes qui correspondent à la nomenclature approuvée. Une fois approuvés, les projets types et les normes sont imprimés à grand tirage. Les projets types de maisons sont établis en tenant compte de l'obligation d'utiliser pour la construction des éléments types de production industrielle et des objets standard qui figurent dans les catalogues d'articles. Ces catalogues contiennent la nomenclature et donnent les principales caractéristiques techniques de tous les articles fabriqués dans les usines qui produisent des matériaux de construction et des éléments structuraux.

A l'heure actuelle, on a fixé des grandeurs uniformes pour les paramètres dimensionnels des maisons d'habitation: hauteurs d'étages, portées de planchers, travées longitudinales, largeurs de cages d'escaliers, etc. Il existe également plusieurs dimensions standard pour les portes et fenêtres destinées aux maisons d'habitation.

Le pourcentage de travaux de construction effectués d'après des plans types est en augmentation constante depuis 1955, ainsi que le montre le Tableau 3 ci-dessous:

Tableau 3

Volume de bâtiments réalisés d'après des plans types, en pourcentage

	1955	1956	1957	Projets lancés en 1957
Industrie 1)	20	25	27	42
Transports 1)	54	59	61	69
Agriculture 1)	67	71	81	81
Logements	59	62	70	83

1) L'expression "plan type", dans le cas des bâtiments industriels ou agricoles, peut signifier la répétition d'unités ou sections de base, assemblées de façon différente selon le besoin du programme particulier en question.

D'après les donnéos do la Banque industriolle do l'URSS concernant cinq des régions de l'Union, en 1955, le coût de la construction de logements exécutés conformément à des projets types a été en moyenne de 20% inférieur au coût moyen des constructions effectuées suivant des projets individuels.

e) Développement de matériaux nouveaux

f) Evolution des matériaux traditionnels

L'accroissement accéléré du volume de la construction a été rendu possible par la création d'une puissante industrie de matériaux de construction grâce à la mise en application d'un certain nombre de mesures gouvernementales découlant de la décision du Comité central du parti et du Conseil des ministres de l'URSS "Le développement de la construction du logement en URSS" du mois d'août 1957.

Dans la plupart des régions économico-administratives de l'Union, il existe aujourd'hui encore une pénurie de liants, de matériaux de maçonnerie et de matériaux d'étanchéité. En effet, immédiatement après la guerre, les matériaux de construction de base ont été dirigés en priorité sur les constructions industrielles lourdes, ce qui n'a laissé au secteur de la construction de logements que des ressources comparativement limitées. Comme conséquence de cette politique, on a été amené à développer l'emploi des matériaux locaux dans la construction de logements.

Les difficultés d'ordre technique (mauvaise résistance au gel) ou économique (manque de main-d'oeuvre spécialisée) rencontrées dans l'application des enduits aux murs extérieurs ont favorisé la production de plaques ou éléments céramiques de revêtement des murs dont l'emploi se répand surtout dans les grandes villes. La technique de production de ces plaques qui comporte une double cuisson avec mélange d'argile crue et d'argile cuite concassée, est parfaitement au point; cependant, leur prix de revient final est souvent trop élevé à cause notamment des frais de transport des matières premières et des produits finis sur plusieurs centaines de kilomètres.

L'emploi de la pierre naturelle, surtout calcaire, dans des blocs de moyennes et de grandes dimensions pouvant aller jusqu'à 1 m^3 est pour l'instant limité. La production de pierres prétaillées, qui a représenté seulement 8% en volume du total des produits pour maçonnerie en 1955, sera augmentée de 2,6 fois d'ici 1960.

Un développement analogue peut être observé dans la mécanisation des opérations de taille de pierre décorative utilisée pour les revêtements muraux (marbre, syénite, granit, etc.). L'emploi rationnel des différents types de pierre, et non pas seulement des plus appréciés, est favorisé dans des conditions qui les rendent souvent compétitives avec les revêtements en plaques céramiques déjà cités.

L'emploi de produits silico-calcaires est en expansion également sous la forme de briques ou blocs utilisés dans la construction de murs porteurs avec des résistances allant jusqu'à 200 kg par cm^2, ou comme éléments de remplissage dans les panneaux de murs en béton préfabriqué. L'utilisation du laitier et du mâchefer, sous la forme d'agrégats légers, pour la fabrication de produits en béton n'est pas encore suffisamment développée, malgré les ressources de l'industrie métallurgique et l'intérêt économique évident que présenterait l'utilisation de ce qui est pour l'instant considéré comme un sous-produit de la métallurgie et dont plus de la moitié est perdue.

Le ciment est produit dans 45 des 104 sovmarkhozy de l'Union. Le développement constant du programme de construction a eu comme conséquence une augmentation considérable de la production de ciment qui est passée de 16 millions de tonnes en 1953 à 34 millions en 1958. Le plan septennal a fixé comme objectif une production de 75-81 millions de tonnes, soit une augmentation de 2 à 3 fois environ. On observe par ailleurs une extension de la gamme de qualités de ciment produites par les différentes usines. Dans certains cas, cette diversification paraît cependant avoir été poussée trop loin: c'est ainsi que le ciment du type "500", qui représente seulement 20% du total de la production, est distribué d'une façon très inégale parmi les différentes régions de l'Union, ce qui entraîne des frais de transport très importants. (Une tonne de ciment livrée à Moscou en provenance d'une usine située à 1.200 kilomètres de distance coûte environ 200 roubles). Le transport du ciment en poudre à grande distance peut également entraîner des pertes de l'ordre de 10% à cause des différentes opérations de manutention de transport et de déchargement: si l'on tient compte du fait que le pouvoir de prise du ciment souffre également à cause de ces manipulations, on estime cette perte à 5% pour les transports et 5 et 8% par mois pour le stockage.

On verra que, dans l'ensemble, on peut estimer une perte totale de l'ordre de 20%. Une partie de ces inconvénients peut être réduite grâce au transport du ciment dans des sacs en papier ou dans des containers spéciaux. Les premiers renchérissent le ciment de 25 à 30 roubles par tonne environ; la deuxième solution entraîne des frais d'investissement assez élevés, de l'ordre de 100 roubles par tonne de volume. C'est ainsi que les installations d'ensilage du ciment en vrac ne sont considérées rentables que dans les grandes villes et quand elles peuvent desservir dans un rayon de 25 km environ.

La solution paraît devoir être cherchée dans la séparation des deux opérations, celle de la production dans les cimenteries et celle de la mouture et du dosage des additifs (pierre calcaire, sable, laitier, etc.) dans des installations spécialisées et proches de l'endroit d'utilisation. Le transport du clinker à l'état brut est en effet beaucoup plus facile; d'autre part, les opérations de mouture peuvent être effectuées par voie sèche ou humide dans des installations spéciales avec l'utilisation d'une grande variété de produits locaux. Des calculs préliminaires paraissent montrer que ces installations seraient rentables auprès d'usines consommant environ 30.000 tonnes de ciment par an.

On prend actuellement des mesures pour accroître fortement la production d'éléments en fibro-ciment à la fois légers et durables, articles qui doivent trouver de larges possibilités d'emploi dans la construction de logements, et d'intensifier la production des matériaux de construction et des éléments structuraux fabriqués à partir de résines ou autres matières plastiques.

Pour ce qui est des matériaux thermo-isolants, on s'intéresse tout particulièrement à la production d'articles en laine de verre, de la "fibrolite" (panneaux de copeaux de bois pressés, liés avec du ciment), de la "kamychite" (panneaux de roseaux pressés) et des panneaux en fibres de bois.

La production d'autres matériaux de construction fabriqués à partir de matières premières locales ou de sous-produits de l'industrie prend également de l'extension.

Distr.
RESTRICTED

HOU/Working Paper No. 97/Add.(m) Rev.1*
6 May 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

USSR

1. Relative importance of traditional and non-traditional methods of house construction

The amount of house-building in the USSR is continually increasing, as is shown by the fact that 1,245,000 dwellings (flats and single-family houses) were built in 1953, 1,351,000 in 1954, 1,512,000 in 1955, 1,636,000 in 1956, 2,172,000 in 1957 and 2,664,000 in 1958.

Under the seven-year plan for 1959/1965, it is proposed to build, on the strength of public investments and individual savings, backed up by State loans approximately 15 million dwellings (in all about 650 million m^3 of floor space) in towns, workers and "sovkhoz" communities, tractor repair stations and forestry centres. In addition, 7 million dwellings will be built by "kolkhoz" members and rural elite workers.

This rapidly expanding building programme has to be carried out without any appreciable increase in the labour employed and with expenditure on materials kept down to a strict minimum. Hence technologically the basic trend of USSR house-building policy lies in the maximum degree of industrialization.

The main conditions for the successful industrialization of house-building are as follows:

1. A house-building programme not only vast in scope but continually expanding so that building is going on without interruption and there are constant orders coming in for those undertakings working for the building industry.

---

*The unrevised text of HOU/Working Paper No. 97/Add.(m) has not been issued in English.

2. The existence of large mechanized undertakings for the manufacture of structural components.
3. The typification of dwellings and standardization of components used in house building. This makes it possible to reap the economic advantage of large-scale factory production of structural parts and components.
4. The existence of powerful building organizations with the mechanical equipment at their disposal for the assembling of prefabricated components.

The range of technical processes used in house building in the USSR is extremely varied, from the most traditional and almost home industry methods to the serial erection of entirely factory-produced components. It is therefore very difficult to give a satisfactory account of a situation which is not only extremely varied but is undergoing constant and rapid change - indeed this is perhaps its main feature. Out of a total of more than 2 million dwellings built in the USSR in 1957, only 878,000, or approximately 42 per cent, could be regarded as State dwellings. The remaining 1.2 million dwellings or more were built directly by individuals or co-operatives, though admittedly in the case of a large proportion of them, financial or material assistance was provided by the State in the form of loans, tax reliefs, supply of materials etc. The proportion of dwellings built by individuals and co-operatives has moreover increased in the past two years, and nearly two-thirds of the co-operative-built housing, or approximately 40 per cent of the total, is in rural areas.

Account must also be taken of the large amount of building undertaken by direct voluntary labour and with the assistance of employers or co-operatives in rural areas. This type of building is based almost exclusively on the use of local materials for the main structure, including not only bricks but freestone, timber or timber framework with non-supporting fillings, according to the region.

The rapid changes taking place throughout the whole building industry has certainly not left this traditional type of building untouched. In the first place, the growing use of small precast concrete components is more and more tending to replace the older type of elements - timber, steel or stone. Prefabrication of light flooring components, window sills, or even entire window frames, cornices, staircase steps etc., is becoming widespread at every stage of building. In some cases, 80 per cent of the value of the materials incorporated in the building are prefabricated. Secondly, in part because of the shortage of masons masonry work as such tends to be replaced by the assembly of components of larger size than the traditional brick or stone block. Thus, panels or slabs made of solid bricks (or in very recent practice horizontally perforated bricks) made in the factory or on the site and laid with open joint are used; these composite brick components are often replaced by slabs of similar dimensions (wall area of between 3 m^2 and 4 m^2) made of clinker and slag concrete and erected in the same way. Some of these panels have interlocking precast components in ordinary reinforced or slag concrete, poured concrete then making a solid block. The transition from masonry work using single bricks to the assembling of precast panels or blocks is gradual and is in line with a general trend in the Soviet building industry.

A similar development may be noted in the precasting of room-length floor slabs between one and two metres wide. Some of these floor slabs are ribbed and have to be matched on the underside by ceiling panels precast in concrete or plaster; others have a smooth lower surface, which is afterwards painted, and have circular or oval cavities on the inside. These components and those used for building outside walls, as already described, are comparatively light in weight and can be erected by low-power cranes.

The most interesting development in the USSR, however, is the increasing use of large precast reinforced concrete components. A special resolution adopted by the Central Committee of the Party and the Council of Ministers of the USSR on 19 August 1954 dealt with the development of the production of precast components in reinforced concrete for the building industry. After noting that the production of such components was quite inadequate, the resolution stressed the importance of extending their use, thus economizing steel and timber, increasing productivity and reducing costs. Subsequent meetings of the Central Committee, in particular that of July 1955, amplified those directives on the technical side and gave specific instructions for the organization of what at that time was a new branch of the building industry.

The extent of this effort may be gauged by the fact that in 1958 more than 17 million m^3 of precast reinforced concrete were produced, which represents a seven-fold increase over 1953. The programme provides for steadily increasing production of such components, which by 1965 will amount to between 42 and 45 million m^3, approximately one-quarter of it in prestressed concrete.

The cost of large wall-panel houses has not yet been brought below that of brick houses owing to the fact that mass production has not yet been organized. However, the experience gained by the Cherepovetzmetallourgostroi consortium of the Vologda Regional Economic Council, by the Glavmosstroi in the XIth district of Moscow and by some other building institutions which built groups of dwellings in 1958 shows that when large-panel dwellings are mass-produced in the factory their cost is appreciably lower than that of brick houses. It is estimated that if large-panel building is undertaken on a wide scale the cost will be at least 10 per cent lower than that of mixed building in bricks and precast components. Other calculations show that the capital required to set up undertakings producing prefabricated houses is much less than that needed for the production of materials and components for building brick houses.

Even in the last two years, the price of large components in precast concrete produced by the most efficient factories has fallen by some 25 per cent. Although it is of course difficult to say what part of this reduction is due to typification and standardization proper and what results from the over-all mass production, it can safely be attributed to factory specialization, restriction of variety in regard to the components produced and a very high degree of mechanization in the processes of serial production.

At the present time, nearly 600 factories are engaged exclusively in the production of precast concrete components; some of these factories are extremely up-to-date and have adopted industrial methods by which high-quality products can be manufactured with the minimum amount of labour.

A further indication, although only very approximate, of the extent of the effort concentrated on the precasting of concrete components is the fact that, if the value of prefabricated components in a building constructed by traditional methods is taken to be 10 per cent, the figure rises to 70 or even 85 per cent in certain heavy prefabrication building processes at present used in the Soviet Union.

At the beginning of the process of industrialization by heavy prefabrication, almost all the load-bearing components of the main structure were very thick (40 to 50 cm) slabs of ordinary reinforced concrete which were site-bonded to the neighbouring slabs. The floor elements also consisted of very thick smooth slabs with an upper insulating layer of mortar and a one-piece floor lining.

Various considerations, in particular the disadvantages entailed by the heavy weight of the components and the unavoidably high proportion of waste on site and fairly expensive finishing processes, led the experts to evolve improved methods, in general using lighter elements. For example, experimental dwellings built in 1957 in Moscow weighed 1.15 tons per m^2 of floor space, or one-third the weight of a traditional brick house, and the reduction in steel consumption was approximately the same. The use of prestressed concrete floor components, often employing hollow slabs, is also becoming widespread. Many experiments are now being made in the production of outside wall panels, supporting and non-supporting, using light concrete or mixtures with plastic foamed insulation, asbestos cement tiled or outside facings, different types of inside plaster finishing, etc.

Side by side with factory production of large components for house building, the production of light, precast elements for building one or two-storey houses has been developed. In 1957, the production of such factories already amounted to 4.3 million m^2 of floor space. The same factories produced prefabricated framework components in timber, for use with walls built of local materials, representing 3 million m^2 of floor space. The production at these factories is steadily expanding and under the plan will reach 20 million and 10 million m^2 respectively by 1961. Each year the proportion of prefabricated houses built of standard components assembled on the site by private individuals is increasing. In 1961, 90 per cent of the total production of prefabricated houses will be sold to private persons.

Experiments are now being undertaken in building methods on a completely different principle, based on the use of a rigid "box" containing the finished bathroom unit and a set of supporting-wall panels and room-sized floors.

There is also considerable variety in the degree of finishing of the prefabricated components. Certain methods, particularly in the most recent experimental processes give an almost complete finish to the wall components, which contain not only plumbing, gas pipes and electrical or heating equipment, but the final wall-linings.

Thus, State house-building in the USSR may be regarded as part of the industrialized sector, although the degree of industrialization may vary according to the type of house. Complete prefabrication of houses with large panels or blocks is usually found only in the large towns and industrial centres. The type of building met with everywhere is the industrial dwelling in which floors, staircases and certain other parts of the structure consist of reinforced concrete components precast in the factory, whereas the walls are built of blocks, brick or natural stone. Low dwellings built for public authorities are usually in the form of light houses entirely prefabricated in the factory or houses with walls of local materials, but also containing industrially-produced components.

The few data available on labour productivity expressed in man-hours per m^3 of building would appear to indicate that productivity is steadily rising, especially within the large building organizations (see (b) below). Figures compiled on building sites in the Moscow region and no doubt representative of the general trend indicate that the number of hours required on the site for building construction per m^3 outside measurements vary from six to seven hours using the traditional methods and four to five hours for partial or total prefabrication methods. On experimental sites, still better results have been obtained.

(b) Organization of building operations

Generally speaking, building activities fall within the competence of central, regional or municipal administrative bodies. The State Building Committee of the Council of Ministers ("Gosstroi SSSR") is the supreme supervisory and co-ordinating body for all activities relating to building, and in particular to house-building.

From July 1957, the widespread reform of the Soviet Union industrial structure also affected the organization of the building industry. Executive responsibility for almost the whole of industrial activity was transferred to the 104 regional economic councils ("sovnarkhozy"), the remainder being allotted to the councils of industry and of local building ("sovmestpromy"), which are under the provincial ("oblast") councils. Most of the sovnarkhozy manage their undertakings through administrations ("upravlenie") which have competence in matters of planning, staff and establishment, exchanges with other sovnarkhozy, etc. Almost all the central technical ministries of the older organization have disappeared; the only ones left at republic level in the field of building are the Ministry of Housing of the Republic and the Ministry of Housing and Building Materials of the Ukrainian Soviet Socialist Republic, which have only a co-ordinating role, however, all executive functions being entrusted to the sovnarkhozy. These latter are responsible for approximately half the total production of the country's building industry, including local industries for the production of materials; one quarter of the total is still directly controlled by these central ministries which have survived the reform, in particular, the Transport Building Ministry; and one quarter by the local municipal administrations.

Most building work proper is carried out by building organizations or undertakings usually under the authority of a sovnarkhoz and working under contract for a particular building promoter.

Generally speaking, therefore, building undertakings are established on a specific territorial basis and may undertake building for different building promoters in a given region. The 1957 figures show that in that year 85 per cent of the total volum of building work was carried out by these building organizations.

When work is of a certain scope, special building organizations for the specific task of operating the sites concerned are established. These are classified according to their main activity into "general undertakings" and "specialist undertakings". The latter, which deal particularly with technical installations (sanitary fittings and electrical equipment etc.), have functions similar to those of specialist undertakings in the countries of western Europe and usually work as subsidiaries of the general undertakings. The trend towards specialization of undertakings is comparatively recent and will certainly develop in the future because it gives scope for a fuller utilization of the machinery, the technical capacity of the staff, and the experience gained by the workers through the repetition of similar operations. The same trend is to be noted in the general undertakings, which often specialize in one type of building: dwellings, public buildings, or industrial buildings. The last-named specialize in turn, according to the branch of industry, in buildings for the steel or non-ferrous metals industries, the meat industry, etc. Specialization possibilities are naturally limited by the scope of the programmes under way in a given region; sometimes there are merely specialized branches set up within a general undertaking. Undertakings specializing in housing have sometimes set up separate departments for the preparatory work on the main structure, general joinery, skeletons and finishing work. This last sub-division may well have interesting economic repercussions.

The existence side by side in the same town of building activities coming under different administrations has constantly given rise to serious problems of co-ordination and general efficiency. As early as 1954, long before the administrative reform of July 1957, the largest towns in the country (Moscow, Leningrad, Kiev, Baku, Tashkent and others) set up special organizations called after the town: Glavmosstroi, Glavkievstroi, etc., which were responsible for the greater part of building activities in the city concerned.

The largest building organization in Moscow, Glavmosstroi, which is under the authority of the Soviet of the City of Moscow, and the other large organizations operating in the city, include not only the type of general consortium which acts as a building promoter but also groups specializing in certain types of work such as the construction of foundations and cellars, the installation of communications and underground work, finishing operators, sanitary and technical installations, electrical equipment, road works and other specialized work. In Moscow, the factories producing structural components and building materials are under another department of the Soviet of the City of Moscow, Glavmospromstroi-materialy. In 1957 Glavmosstroi put into service more than 1 million m^2 of floor space, about half the total floor space completed in Moscow in that year. In addition, this body has carried out in Moscow a large programme of building to house public or municipal services.

The efficiency of the development and specialization of the building organizations may be illustrated by the example of Glavmosstroi, which in three years has almost doubled the volume of building of dwellings or schools, hospitals or other public utility services. Moreover, the cost of building and assembly has fallen by about 15 per cent, while labour productivity has increased by over 50 per cent. In the same way, in four years, Glavleningradstroi, employing the same number of workmen, increased the volume of its building achievements by 65 per cent.

The volume targets of the over-all house-building programme included in the general plans for non-productive investment are based on the real capacity of the industry, as regards both production of materials or machinery and building and erection work on the site. The provisions laid down in August 1957 for the long-term encouragement of house-building have not been changed; however, from 1959 the house-building plan must be based on a local average cost per square metre. The competitive element is practically non-existent in the Soviet Union. Apart from work undertaken directly by industrial undertakings or carried out by private individuals with the help of the State, the local community or the employer, building work is carried out under a contract concluded between the building promoter and the building undertaking.

The proportion of work carried out by these building undertakings, as opposed to that done directly by the industrial undertakings, has increased over the last ten years as shown in Table 1 below.

Table 1

Proportion of the building programme carried out by building undertakings

(in thousand million roubles at 1955 prices)

Total for the period	General building work (in thousand million roubles)	Work carried out by building undertakings	
		In thousand million roubles	Per cent
1946-50	220.4	164.9	73
1951-55	420.3	354.6	82
1956-57	241.2	207.8	85

The unit price of the constituent components is determined from official lists of basic materials and unified transport rates adjusted, of course, by regional coefficients. Nearly all building workers are paid piece-rates on the basis of standards established for the whole country and under a system of rising output bonuses together with other benefits in cash or in kind (paid holidays, holidays in recreational resorts, etc.).

Most non-industrial building work is planned by executive architectural offices under the supervision of the chief architect of the main towns and called after the town - Mosproiekt, Kievproiekt, etc. Some of these employ several thousand persons and are organized in departments responsible for a particular sector of the city. Any building undertaking operating within the city limits must follow the development plan and the directives of the competent architectural office. Departments of the chief architect's office prepare the development plans, the topographical surveys and determine alignments, levels, etc. In addition to the architectural office, there are a certain number of State institutes engaged in preparing type projects which have their counterpart in institutes set up in each of the Republics of the Union. These institutes do not produce type plans, but "type projects" (including the operational details, organization of the site, application of the equipment needed, etc.), which may be implemented throughout the whole country. For this purpose, the USSR is divided into different climatic zones and the type projects can be modified in each to allow for local conditions (height of ceilings, heating insulation, etc.) and to ensure that the building methods used are best suited to the capacities of the local building organizations or undertakings. The activities of the town architectural office is frequently confined to the adaptation or assembly of type projects prepared by the State institutes under a general plan prepared every year. The designing departments of certain ministries or organizations also prepare type projects for the special buildings for which they are responsible: schools, hospitals, industrial stores and buildings and the like.

During the building operation, representatives of the building promoters and of the local architectural and building supervisory bodies see that the projects are carried out correctly and sit on committees for taking over the buildings. The representative of the building promoter is usually a collaborator of the architectural office, which, as already mentioned, has been responsible for adapting standard projects to local conditions.

(c) Mechanization.

In the USSR particular attention is given to the mechanization of house-building operations, in the first place for technical reasons and also in order to enable the production rate fixed by the national development plans to be achieved. Attempts at mechanization have so far been concentrated mainly on arduous tasks or operations requiring a great deal of unskilled labour. This is shown by the figures giving the building machinery park existing at the end of each year given in Table 2 below.

Table 2

Building machinery park

	1940	1950	1953	1955	1956	1957
Mechanical navvies	2 086	5 870	12 457	17 471	20 800	24 600
Scrapers	1 100	3 000	7 449	9 290	9 750	10 100
Bulldozers	750	3 000	10 407	16 100	20 588	32 717
Mobile cranes	1 135	5 642	18 018	28 900	32 717	35 800

The main erection machines used in house-building are tower cranes with a lift of between half a ton and five tons.

Since construction time has been considerably reduced for buildings using large slabs or blocks, lifting cranes have to be moved about a great deal. This has led to research - which is now almost completed - on the construction of a whole range of travelling tower cranes with a lift up to five tons and lifting frames ranging from 30 ton/metres to 100 ton/metres which can be moved in one piece and can be mounted and dismounted in a few hours. These cranes are fully equipped to erect buildings of the large block or large panel type.

In order to improve operation, mobile building machinery units have been set up which enable building to be more fully mechanized and organized along industrial lines. The mechanization of building in general is planned as part of a national plan determining the amount of work to be done and thus the materials which the building organizations will need.

It is noteworthy that in the USSR, as in almost all European countries, the subsidiary work of the main structural erection (excavation and foundation work, minor loading and handling operations, mortar-mixing, etc.) and of the secondary structural erection is scarcely mechanized at all. A start has recently been made towards remedying this defect.

The mechanization of the main building operations is now in progress. Thus, even on large sites highly advanced mechanization with ultra-modern transport equipment or lifting machinery is to be found alongside carrying and hoisting methods still based on craft or rural tradition.

(d) Standardization

Standardization activities carried on in the USSR with regard to quality as well as dimensions are part of the Government's technical policy in the direction of rationalization and industrialization of the building industry. These activities were a necessary corollary to the achievement of a higher rate of increase in the housing programmes which has marked the development of the building industry in the USSR over the last few years.

The fact that the main building promoters in the USSR are public authorities means that typification and standardization can be applied on a country-wide scale and that it is possible to establish standards and catalogues of standard industrially-produced units which must be used by all building designers, building organizations and the factories supplying them. This system ensures a steady demand by the building organizations for the standard products made by the factories working for the building industry.

Work on typification and standardization of dwelling construction has made great strides in the post-war period. Individual type projects have given way to series of type projects in which the designs for houses of different size and structure are interrelated by identical architectural and technical planning and by the use of industrially-produced standard components; and the production of small standardized stock components for minor work on traditional buildings has been replaced by the typification and standardization of large industrially-produced components. In the USSR typification and standardization are based on a modular system with a basic module of 10 cm.

Typification and standardization follow specific plans, under which the various State designing institutes in various parts of the country work out type projects and norms corresponding to the approved general classification. When the type projects and standards have been approved, they are printed and published in large editions. The type designs for houses are established with due regard for the compulsory use of the industrially-produced stock components and standard articles in the catalogues. These catalogues contain the general classification and give the main technical specifications of all articles made in the factories manufacturing building materials and structural components.

Uniform measurements have now been fixed for the parametric dimensions of dwelling houses, such as storey height, floor span, main girders, width of staircases etc. There are also several standard dimensions for doors and windows for dwelling houses.

The proportion of building erected according to type plans has been increasing constantly since 1955, as shown in Table 3:

Table 3

Building erected on type plans

(As a percentage)

	1955	1956	1957	Projects under way in 1957
Industry(1)	20	25	27	42
Transport(1)	54	59	61	69
Agriculture(1)	67	71	81	81
Dwellings	59	62	70	83

According to information supplied by the USSR Industrial Bank for five regions of the Soviet Union in 1955, the cost of constructing dwellings erected on the basis of type projects was, on an average, 20 per cent less than the average cost of building carried out according to individual designs.

(e) New materials

(f) Development of traditional materials

The rapid increase in the amount of building was made possible by the establishment of a large building materials industry in implementation of a number of government measures arising out of the "development of housing in the USSR" decision taken by the Central Committee of the Party and the Council of Ministers of the USSR in August 1957.

There is still a shortage of bonding, masonry and insulating materials in most of the economic-administrative regions of the Soviet Union. Immediately after the war building for heavy industry was given priority in the supply of basic building materials, leaving comparatively small supplies for housing. As a result of this policy, the use of local materials for housing had to be developed.

The technical difficulties (poor resistance to frost) and economic difficulties (shortage of skilled labour) encountered in plastering outside walls has led to the production of tile-ware facing slabs or units which are coming increasingly into use, especially in the large towns. The method of producing these slabs - double firing

(1) The expression "type plan" may mean, in the case of industrial or agricultural building, the repeated use of basic units or sections assembled in different ways to meet the requirements of the particular programme in question.

with a mixture of raw clay and crushed earthenware - has been perfected, but the final cost is often too high, mainly owing to the cost of conveying the raw materials and finished products for hundreds of miles.

The use of natural stone, especially limestone, in medium and large-sized blocks of up to 1 m^3 is at present limited. The production of pre-cut stone, which accounted for only 8 per cent of the total output for masonry in 1955, will be increased 2.6 times by 1960.

A similar development is to be seen in the mechanization of the process for cutting decorative stone (marble, syenite, granite, etc.) for wall facings. The rational use of various kinds of stone - not merely the most popular kinds - is being encouraged to such an extent that they can frequently compete with the clay facing slabs mentioned above. The use of sand - lime products in the form of bricks or blocks for making load-carrying walls with resistances of up to 2000 kg per cm^2 or as filling for wall panels of prestressed concrete is also on the increase. The use of slag and clinker in the form of light aggregates for making concrete units has not yet been sufficiently developed, despite the resources of the iron and steel industry and the obvious advantage of making the best of what is at present regarded as a by-product of that industry, more than half of it being wasted.

Cement is produced in 45 of the 104 sovnarkhozy in the Soviet Union. The constant increase in the building programme has led to a considerable rise in cement output, from 16 million tons in 1953 to 34 million tons in 1958. The seven-year plan target is an output of 75-81 million tons, a double or treble increase. The extension in the range of cement grades produced by the various factories is also notable. In some cases, however, this diversification seems to have been carried too far; thus the "500" type cement, which accounts for only 20 per cent of the total output, is distributed very unequally among the various regions in the Soviet Union, entailing very heavy freight costs. (A ton of cement delivered in Moscow from a factory 1,200 kilometres distant costs about 200 roubles.) Transporting pulverized cement for long distances may also entail losses of some 10 per cent in handling and unloading operations. If the reduction in setting capacity entailed by such handling is also taken into account, the loss may be estimated at 5 per cent for carriage and 5-8 per cent per month for storage, so that a total loss of some 20 per cent may be reckoned. Some of these difficulties may be reduced by having the cement carried in paper bags or special containers. The use of paper bags would put the price of cement up by about 25-30 roubles per ton, while the special containers involve a relatively high capital investment, about 100 roubles per ton. Thus, installations for the bulk storage of cement are regarded as worth while only in the large towns and only when they can service a radius of about 25 kilometres.

The answer is probably to separate the two operations, namely the production at the cement works and the grinding and addition of other materials (limestone, sand, slag, etc.) in special installations close to the place where the cement is to be used. Clinker is much more easily transported raw, and the grinding can be done dry or damp in special plants using a large range of local products. Preliminary calculations show that such installations would be profitable at factories consuming about 30,000 tons of cement per year.

Steps are now being taken to press forward with the production of light and durable fibro-cement components which should prove very popular in housing construction and to step up the output of building materials and structural components made from resins and other plastic materials.

For insulating materials special attention has been paid to turning out articles of glass wool, "fibrolite" (compressed chipboard panels bound with cement), "kamychite" (compressed chipboard panels) and fibreboard panels.

The production of other building materials from local raw materials or industrial by-products is also on the increase.

Distr.
RESTRICTED

HOU/Working Paper No. 97 Add.(n)
17 March 1959
Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

UNITED KINGDOM

1. Relative importance of traditional and non-traditional methods of house construction

Shortly after the war, the government placed contracts for 156,667 factory-made houses to relieve the immediate housing shortage, and to supplement the limited production of the seriously depleted building industry and building materials producing industries. This was an emergency measure and was discontinued when the contracts were complete in the first half of the year 1948.

At the same time, the government encouraged the development of non-traditional forms of construction. Proposals brought forward by the industry were examined as to their technical efficiency, and those which were found suitable were recommended by the appropriate housing department for use by local authorities. In order to assist in the development costs of these non-traditional houses, the Exchequer made an additional grant over and above the subsidy in respect of local authority housing using traditional methods.

This special grant was discontinued in 1947, since it was felt that by that time the new methods of construction should be able to compete in cost with traditional construction. Housing administration deals separately with England and Wales, Scotland and Northern Ireland, and the conditions in the three regions vary considerably. Thus in Scotland the shortage of skilled bricklayers and plasterers was more acute than in England and Wales and, consequently, the proportion of non-traditional houses built in Scotland was higher, with an emphasis on dry-built methods of interior construction.

Twenty-eight systems of house construction were approved by the Housing Department for England and Wales, and twenty-nine for use in Scotland. These projects mainly aimed to provide alternatives to brickwork and bricklayers' labour in the walls and partitions. Only in a limited number of cases were floors and roofs an integral part of the project. A varying proportion of the structure of the houses was made up in factories or in workshops attached to the site, with the principal object of decreasing site labour. Certain of the more successful non-traditional houses were, in fact, of concrete cast in situ, but using rationalized methods and special frame-work. In a very small number of projects the object was to obtain a high degree of prefabrication in the interior and finishings of the houses.

The designers and sponsors of the various new systems of house construction were for the most part from the building industry itself, and of the few still operating in England and Wales in 1957, all were the work of well-established organizations in the building industry. Now that labour and material are available for mainly traditional construction, and also because productivity has been raised to its pre-war level by mechanization of traditional building and by better management, it seems unlikely that for the individual house, at any rate, there will be a reversion to any large-scale development of prefabrication.

It is concluded that the basic reason for the decline in the use of new methods of individual house construction in England and Wales is that the majority of the systems used were unable to show any significant advantage in cost over traditional construction. This taken with the fact that there remains a certain prejudice against new methods on the part of the housing authorities who purchase and have to maintain them.

The experiment towards the extension of factory production of house components in the United Kingdom has been on a large scale, government assisted with financial inducements in the early stages; but, in the main, the new methods did not produce sufficient advantage in cost to hold their place. It should be noted, however, that the experiment in the United Kingdom with new methods was carried out within the traditional framework in which the requirements of a considerable number of authorities need to be reconciled. The process is not without frustration for the industrialist and to this extent the experiment, though valuable, is not conclusive.

Reference was made at the commencement of this section to the temporary housing programme in which one house was almost entirely factory-constructed. The conditions during the immediate post-war period were difficult, and the transition from aircraft production to house production was not without its problems. Whilst the large number, 54,000, of these houses was of great value at that time, the cost was not competitive with simpler buildings with a higher proportion of site erection costs. Regarded as an experiment, the results are not conclusive, but they were certainly not such as to justify any large-scale transition to the fully prefabricated dwelling.

The numbers of traditional and non-traditional houses built in England and Wales and in Scotland during the period 1945-1954 are shown in Table 1.

Table 1

Total Number of Houses Built by Local Authorities and Similar Bodies, and Non-traditional Houses as Percentages of Total, 1945 to 1954

Year	England and Wales		Scotland	
	Total, all houses	Non-traditional as percent of total	Total, all houses	Non-traditional as percent of total
1945	508)	12.7	1,428	1.9
1946	21,202)		3,811	19.0
1947	86,567	23.6	10,773	44.3
1948	170,821	30.7	19,547	52.5
1949	141,766	23.6	24,180	55.2
1950	139,356	14.1	23,314	46.9
1951	141,587	13.5	20,997	46.3
1952	165,637	15.3	27,623	51.0
1953	202,891	17.3	35,992	52.1
1954	199,642	19.7	35,331	49.7

Comparative data for the years subsequent to 1954 are not available, but it is stated that the proportion of non-traditional, or "new-traditional" houses, as they have been termed, has declined and that only a few systems are now being exploited.

2. Progress towards rationalization of building construction

(a) Technical qualifications of personnel

It is axiomatic that progress towards higher technical development in any industry must be related to the numbers of technically trained personnel available. This has been realized in the United Kingdom and measures have been taken to increase facilities for technical training. Since the ideal is to have a balance of trained personnel at all levels it is convenient to distinguish between the qualifications desirable for:-

(i) professional and managerial grades;

(ii) supervisory grades;

(iii) operative grades.

(i) Professional and Managerial grades

- Architects

The recognized qualifications for Architects in the United Kingdom is membership of the Royal Institute of British Architects. Candidates are admitted to the institute by examination, but certain parts of the examination, including the main technological subjects are satisfied by the diplomas of students who have qualified at recognized schools of architecture. There has been a progressive tendency for the curriculum of the Royal Institute to require higher standards in technological subjects and this trend continues. The number of architects admitted every year to membership of the Royal Institute has varied between 700 and 1,200 over the last 10 years.

- Engineers

Design and control of the structural element of building is mainly in the hands of engineers who are members of the Institution of Civil Engineers (23,000 members in 1958), and of the Institution of Structural Engineers (8,000 members in 1958). The former Institution comprises men who are qualified for public works of all kinds in addition to buildings as such, whereas the Institute of structural Engineers is mainly in the province of building. The services of civil engineers and structural engineers are not normally very much in demand for traditional housing in small individual units but they are invariably required for multi-story building. With new forms of construction and with emphasis on economy in materials the tendency is for the professional engineer to be consulted even in small house projects to an increasing extent. The approximate numbers of engineers admitted every year to membership of these two Institutions are 800 and 500 respectively. It should be noted that membership of these two Institutions is not confined exclusively to "clients". The contractors employ large numbers of qualified engineers and the tendency is for these numbers to increase.

- Management

Realizing the need for high professional standing in building, apart from the specialized province of the architectural engineer, Chairs of Building have been set up at Universities. Many technical schools and colleges provide full-time courses for a Higher National Diploma and Certificate in Building. In addition there are large numbers of students who take part-time courses. The final criterion for students in this category is membership of the Institute of Builders and the Institute itself organizes Diploma examinations.

By the end of 1957, over 3,000 members had been admitted to the Institute of Builders and the numbers attaining the Diploma every year has varied between 100 and 180 over the last ten years.

A recent innovation, and one which is capable of affecting considerably the efficiency of a traditional industry, is the establishment of an advisory service for builders. This has been organized by the National Federation of Building Trades Employers to advise individual firms on request on such matters as site organization, the operation of incentive schemes, costing and headquarters office organization, and, generally, to assist in any way to raise the standard of technical and administrative competence within the industry.

It will be noted that the subjects enumerated above are strictly within the framework of what might be termed the promotion of efficiency within the limits of the traditional industry. Whilst undoubtedly a means of increasing productivity and decreasing costs, such measures do not of themselves engender any new approach to the technical problems of the industry.

(ii) Supervisory grades

The function of the general foreman is of great importance in a traditional industry and in the past these men have graduated from the ranks of the craftsmen on the building site. A mainly practical background, but often supported by part-time craft courses at technical schools. With the increasing complexity of modern building methods, the need for more specialized training for foremen has been experienced and the National Federation of Building Trades Employers has established a Standing Committee for the Training of General Foremen, which promotes foremanship study courses and issues certificates to students who complete the course satisfactorily. Young entrants are expected to follow a formal course lasting two years followed by an examination by the City and Guilds of London Institute. Short courses are arranged for older men and there are additional courses for men on maintenance and jobbing work and for craft foremen.

(iii) Operative grades

Craft training in the Building Industry has in the past been achieved by apprenticeship, supplemented by part-time instruction in Technical schools. When new processes and new materials have been accepted as proper to the traditional industry, courses have been set up in the technical schools for instruction in the new techniques. The craft school is in fact an essential feature for the assimilation of new materials and modified techniques in a traditional industry.

(b) Organization of house-building

It is desirable to consider the organization of house-building in three stages:

(i) preliminary stage, where drawing quantities and specifications are prepared, tenders obtained and contract let;

(ii) preparation stage, where site organization is set up, materials purchased and labour recruited;

(iii) erection stage.

(i) Preliminary stage. It is almost universal practice in the United Kingdom, with houses built by local authorities, for the authority's architect to prepare drawings and specifications and for the surveyor to draw up bills of quantities. These then form the contract documents. Within the framework of purely traditional construction of the normal two-storied individual house there would rarely be any exception to this procedure.

When, however, a new method of construction is involved there are normally discussions between the architect and the sponsors of the new method at which the house design is brought to conform with the method or vice versa. The sponsor of the new method may ultimately be the contractor, but often this will not be the case and the contractor would not necessarily take part in the discussions.

In multi-story apartment buildings the situation is somewhat different. The architect will prepare drawings and specifications, often in collaboration with an appointed structural engineer, and in certain cases, where specialized forms of construction are involved, the specialists are called in for consultation at the design stage. Normally the contractor will not have been appointed at this stage so that he cannot take part in the discussions.

In the cases of individual houses built for private ownership the situation is mainly similar to that for local authority housing. The prospective owner will employ an architect who will prepare designs and tenders will be obtained from contractors.

When, however, a contractor himself builds houses for sale to the public the architect will often be a member of his staff or, if an independent architect, the design will be prepared in the closest collaboration with the contractor, who will have the power of veto.

(ii) Preparation stage. It has usually been considered desirable, if not essential, for a building project to be programmed. A time schedule is drawn up against which can be set the requirements for materials and labour as the work progresses and a proper balance of labour can be organized. The larger contracting firms have always programmed their work but the smaller housebuilders have done so less frequently.

The government has actively encouraged the wider use of proper systems of programming by lectures and by wide distribution of literature and model charts embodying various methods of programming, and this work continues. There is a growing awareness in the industry of the benefits accruing from detailed programming and with a higher proportion of trained men entering the industry the practice should increase rapidly.

(iii) Erection stage. Parallel with the programming it is normal practice to set up some form of costing system and, preferably, a costing system so devised that target figures can be set for the various operations so that a check can be kept on productivity and costs as the work proceeds. Even the smallest housing contractor may be expected to operate some form of costing system although on the smaller jobs this may be of a very rudimentary kind. Indeed, experience has shown that no useful purpose is served by introducing a costing scheme so elaborate that it is beyond the capabilities of the foremen on site. The larger contracting firms have always maintained good systems of cost recording, the object being to break house-building down in to its constitutent operations, so that the expenditure on every operation can be checked and, where costs are excessive, the cause can be looked for and a remedy applied.

As with programming, the government has actively encouraged the wider use of costing systems. A number of formats have been prepared for costing systems of varying degrees of complexity, suitable for the small builder as well as the large contractor, and these have been widely distributed. This work continues and it is to be expected that the proportion of firms using well devised costing systems will gradually increase. It is appropriate to note here that a reliable costing system is virtually indispensible when new techniques are introduced. Without guidance on detailed cost build-up it would not be possible to find out whether the innovation can hold its own against traditional methods.

Parallel with programming and costing is the problem of providing incentives for productivity. By suitable framing of the programmes and cost records they can be the targets for a system of incentive payments, whether by piece work or by incentive bonus payments. Government has encouraged the use of incentive payments and they have been and are widely used in house-building and have been instrumental in increasing productivity of labour and reducing labour cost. Thus at the end of 1950 a sample survey of individual house-building[1] showed that there was an average reduction in total labour cost between five and ten per cent when operating incentive bonus schemes as compared with sites where no incentives were applied.

Some contractors, and they are a majority, make payments extra to the standard wage rates where they consider that the productivity of labour is satisfactory. This is a form of bonus payment which does not require the establishment of targets or the keeping of accurate records. The sample survey referred to above showed that extra payments, not related to measured productivity, resulted in a small saving in manhours but no saving in the total labour costs.

Time and motion study: There has been no general use of time and motion study in the house-building industry in the United Kingdom. A certain amount of work is now being done to introduce time and motion studies in certain trades by groups of contracting firms. Considerable progress has been made in the organization of concreting work by time and motion study and, in particular, in obtaining the correct balance of the components in a "gang" operation. The introduction of time and motion studies into building work is an innovation and it will be interesting to see how it develops in the course of time.

With the greater mechanization of building sites (discussed later) the physical layout of the building site assumes additional importance. Questions such as the storage of materials and proper access to work in progress can no longer be left to chance. Serious studies are being made of the organizational problems involved, and accurate drawings are being made of the layout of material storage and access on sites. This work is in an embryonic stage at the moment, but shows signs of gaining momentum and contractors are interesting themselves considerably in its progress.

(c) Mechanization

It is generally thought that prior to 1939 there had been little mechanization in building, and indeed this is true of small individual house-building as practised

---

(1) National Building Studies, Special Report No. 21, London.

by small contracting firms. Taking building as a whole, however, there were important developments in the mechanization of building during this period and the more enterprising contractors made considerable use of mechanical aids even in small house-building.

The period 1920-1939 was in fact one of rapid development in mechanization in building in the United Kingdom. Public works became almost entirely mechanized; multi-story building considerably so, especially for all the operations involving concrete or reinforced concrete; and the smaller individual housing sites, which comprised the vast bulk of housing, hardly at all. The capital investment, which was significant, was founded by the industry without difficulty and the criterion was always the economic one. If the new tool or appliance led to a saving in cost it was quickly adopted.

The period following the war brought a considerable change in conditions on traditional building sites. There were serious shortages of labour, both skilled and unskilled, and the problem of material handling on sites became acute. The government instituted an Applied Research Organization, The Field Test Unit, which was set up in the Chief Scientific Adviser's section of the Ministry of Works and was subsequently transferred to the Building Research Station. The object of the Field Test Unit was to provide facilities for quantitative testing of appliances for increasing productivity on building sites, and to develop new appliances in conjunction with the manufacturers of building plant and equipment. Special emphasis was placed on the needs of the small contractor on the individual house site.

With the emphasis on materials handling, small power hoists were developed for the vertical handling of materials and these are to be found on a high proportion of building sites at the present time. Small powered barrows were developed for horizontal handling and these now are extensively used. Their introduction was checked at the outset by the failure of traditionally trained foremen to realize that a site must be organized to use a power appliance, but these difficulties were gradually overcome. For larger sites the specialized tower crane for horizontal and vertical handling was reintroduced and official trials showed this to be a useful development; it is rapidly gaining ground. (The tower crane has been widely used in other Western European countries for a considerable time and the United Kingdom is profiting by continental experience).

In concreting work, developments have continued and excellent devices for handling aggregates and distributing concrete on site are becoming more widely used. Bulk delivery of cement is normal on large sites and is increasing. Ready-mixed concrete is spreading rapidly and there were twenty-five plants operating in 1956 and as many more in the process of being set up. Precast concrete construction had developed considerably before the war with varying degrees of mechanization. Shortage of timber after the war, and the considerable increase in cost of imported timber, favoured the use of precast floor units in the postwar period and the volume of material produced has increased considerably.

Considerable attention has been devoted to the handling of bricks, which remain the most important material to be handled in bulk in sites in the United Kingdom. Recent trials in conjunction with brick manufacturers are showing interesting results with "packaged" bricks. The manufacturer supplies bricks in packs of fifty, strapped with a light steel strip. The packs remain unbroken until they reach their position alongside the bricklayer's working point. The first trials showed that there was a significant reduction in breakage of bricks when supplied and delivered in packs, and it seems that the saving in breakage alone may cover the cost of packaging.

The conclusion is that the progress of mechanization is controlled, to a large extent, by the technical qualification and training of executives on building sites. Progress continues on the larger projects and has already made itself evident on individual house sites. There is no reason to suppose that lack of capital has been a serious handicap in the step-by-step transition towards mechanization in the United Kingdom. Actual quantitative data as to the extent of mechanization are not available.

(d) Standardization

Standardization may relate to house designs, to assemblies of housing components and to the constituent materials for housing. Standards may be prescribed for "quality" aspects of components or materials or for dimensions or both.

(i) House design: Immediately after the war the Minister responsible for Housing at the time set up a Committee to advise on accommodation and services to be provided in post-war housing. The Committee made recommendations as to minimum sizes of rooms and as to the minimum provision for sanitary and other services. These recommendations have, in the main, been accepted and acted upon.

The Housing Ministry has issued, from time to time, a handbook on housing in which type house plans are set out which conform to the recommended standards of accommodation. Whilst there has been no compulsion on local authorities to follow the type plans slavishly, there has been the advantage of a reasonably uniform practice throughout the country which has enabled costs to be compared and a reasonable measure of control to be exercized on costs by central housing departments.

More recently type plans have been revised in the direction of reducing non-useful space in dwellings with the result that appreciable reductions have been made in costs of housing. Here again, it has not been necessary to adopt compulsory measures but, effectively, the number of possible variants has been considerably reduced and it has been possible to concentrate on the most economical treatment of a limited range of house types.

(ii) Standardization of materials and components for house-building: British standards have been prepared and issued for virtually the whole of the materials and components used in house-building. Standards have been observed in the vast majority of the houses erected since the war although their use is not obligatory.

The standards themselves vary considerably in their scope. Briefly a standard may perform the following functions:

- define forms and dimensions;
- define a minimum acceptable quality;
- define methods of use for the material or component standardized.

The third function is less common in the United Kingdom standards, but there are certain cases where quality requirements cannot be dissociated from methods of use.

As examples of the first function, there are British standards for doors and windows of metal and wood. These standards do, in fact, limit the number of types and sizes of doors and windows for housing, components which are almost universally produced on a larger scale in highly specialized factories. The same thing applies to built-in cupboards and certain other fitments. They are almost, although not entirely, universally followed because the price of a non-standard article is almost certain to be higher than the standard.

Similar standards exist for sanitary fittings when the positions of joints with incoming and outgoing pipework are defined.

Electrical fittings including switches and outlets and panel assemblies for meters, main switches, distribution boxes and fuseboards are standardized.

In total the high degree of standardization of components for houses, with the reduction in types of article manufactured, must represent a considerable economy although, in fact, there are no data available as to the magnitude of the saving.

As regards standardization for quality there are British standards for control of quality only for such materials as cement, lime, plaster, aggregates for concrete and mortars. These standards represent an economy in time and work on the part of architects and engineers who have to write specifications. There is no reason, however, to suppose that the use of the standards has any important effect on the economy of house-building, except rather indirectly in the nature of such benefits as can be derived from having a uniform national practice. The faddist is eliminated. Broadly speaking it is thought that quality standards for materials have benefited the traditional building industry quite considerably. Traditional specifications were often vague in important respects, such terms as "best" or "equally good" figuring prominently. The standard gives a precise definition of the properties which matter and the contractor knows where he stands.

The British standards for quality of building materials have, in effect, the force of law since, for many important groups of materials, compliance with the standard is deemed to satisfy the requirements of Building Regulations and the appropriate standards are referred to in the regulations.

The present position as regards standardization for housing can be seen from the handbook on British Standards for Housing issued by B.S.I.[1] in which several hundred standards are summarized.

(iii) Codes of practice: In addition to standards for materials and components for house-building there is also a series of British Standard Codes of Practice. This series of codes brings together accepted good practice in the use of materials for building and, in the case of major structural materials as, for example, structural steel or reinforced concrete, the relevant codes lay down rules for design and supervision which are acceptable in terms of compliance with Building Regulations. The codes have the advantage that they give uniform national practice.

---

(1) B.S.I. Handbook of British Standards for Housing.

They go one step further, however, in that the series known as the "functional" codes lays down uniform basic design requirements in precise terms, so that anyone introducing a new method of building can find definite guidance as to the conditions which must be fulfilled. This may well be one of the most important steps in making possible the evolution of a new form of construction. The large element of uncertainty is removed.

(e) New materials

In the United Kingdom the majority of the important innovations are the direct outcome of scientific research and, where a major producing industry is concerned, it is normal to find that the industry's own research organization is of a high standing and very little further investigation is needed. Where, however, an independent and authoritative opinion is needed, the research organizations of the Department of Scientific and Industrial Research are available to provide them. The building industry is well served in this way.

There are many important new materials in the process of assimilation by the building industry at the present time, of which the following may be cited as examples:

(i) Plastics: The range of materials in this category is very wide and developments follow each other very rapidly. Some of the more obvious uses are as insulating coverings for electrical wiring, when the essential characteristics of toughness and adequate electrical insulation can be combined very well. Plastic piping for domestic water services has positive advantages where waters may be corrosive to metals. Plastics are used extensively as a base for paints and certain modern paints have valuable properties, especially for application over building materials which are destructive to traditionally based paints. Transparent plastic sheeting is used extensively for roof lighting and, with its capacity for being moulded and cast, it is possible to foresee the development of lights and frames combined in a single piece.

As structural materials, plastics have not figured to any considerable extent as yet in building, but in analogous industries of boatbuilding and vehicle body-building, fibreglass reinforced plastics have developed very rapidly. It is to be expected that they will find many applications in the house in the near future.

Plastics have been extensively developed as glues for many industries and can be formulated to meet a wide range of requirements. Plywoods bonded with plastics are now available and provide a weather-resistant material of great strength for which many uses have already been found. There has been an important development in the production of plastic floor tiles for housing, and the ground floors of a high proportion of all houses built in recent years have been covered with tiles of this kind.

Plastic pipes are rapidly coming to the fore for water supply and sanitation. They are cheap, completely resistant to the effects of frost and to any corrosive action likely to occur with any water supply normally used.

(ii) Thermal insulation: Prior to the war, thermal insulation for houses was rarely considered in the United Kingdom. Fuel was relatively cheap and the climate does not yield extremes of temperature. Since the war, the price of fuel has increased considerably and conservation of heat has become an important item in government policy. Consequently, a considerable demand has arisen for insulating materials and a number of new materials have been produced. It is possible to equate cost of fuel saving with cost of insulation, and this is frequently done and is likely to be more common in the future. Fibreglass in various forms has been used considerably and slag wool also. Expanded mineral aggregates, such as vermiculite, have been developed on a considerable scale and the tendency at the present time is to develop concretes made with lightweight aggregates having sufficient strength to be used as major structural materials. The saving in structural weight will produce useful economies in building costs and the enhanced insulation of buildings will be important in the national economy. On both counts these developments may be expected to be pursued with energy.

(iii) Metals: There have been important developments in the use of corrosion-resistant light metal sheeting in various forms. Thin copper sheet roof and light alloys have been used extensively. The fact has on occasion been overlooked that the very light weight of roofs of this kind implies a tendency for the roof to be displaced by wind pressures. Roofs have, in fact, been blown off bodily in certain cases where fixings were insufficient. This perhaps is a striking example of what can happen when an unfamiliar material is introduced into a traditionally based industry.

Sheet metal facings have been used also for composite wall panels and this is a trend which is likely to continue. The savings in weight are considerable and this can be an important factor in reducing cost.

This very brief review of a limited range of the many new materials which are coming into general use in the United Kingdom will serve to show that considerable changes are in grogress, and the important point to note is that the innovations are justifying themselves on grounds of cost. It is not a question of a passing phase of innovation.

(f) Development of traditional materials

To take the range of normal binding materials, the evolutionary changes are easy to see.

(i) Cement: The trend with cement has been a continuous one in the direction of higher uniformity, more rapid strength development and higher ultimate strength. The result has been that working stresses have been reduced and thus smaller concrete sections can be used; the increase in rate of strength development enables formwork and shuttering to be struck at earlier ages and to be used more often.

Special cements have been developed for special circumstances of use; methods of packaging have been improved; the jute bag gave place to the multi-ply paper bag and now bulk delivery is the rule for the larger contracts.

All these are factors which contribute materially to reductions in housing costs and it should be noted that the evolution is a continuing process. It is almost certainly true, however, that the highly qualified engineers on a public works contract are in a better position to take advantage of the economies offered as a result of evolution of the material, than are the technically unqualified personnel on the average small housing site. At every stage the importance of technical training in the industry at all levels becomes clear.

(ii) Lime: The tendency in the United Kingdom is for hydraulic lime to be replaced by cement, which has somewhat similar properties and uses but is more easily controlled in the manufacturing process and more easy to handle on the building site.

Non-hydraulic limes, which are used in considerable quantities for mortars and plasters, have undergone a drastic evolutionary change. Within the memory of people now working in the industry in the United Kingdom the greater part of the non-hydraulic lime came to the building site direct from the kiln, and the builder had the task of slaking it and removing hard burnt and underburnt material by hand picking. In order to be assured of freedom from unsoundness it was common practice to slake building lime weeks or months in advance of requirements. In contrast today the greater part of the non-hydraulic lime is factory slaked, and supplied ready for use in bags to a standard specification. Whilst there may be a slight sacrifice in workability with the hydrated lime, the advantages to the builder on the site are very great and the saving in labour cost appreciable.

(iii) Gypsum plasters: The evolutionary tendency with plasters in the United Kingdom has been in the direction of segregation into well recognized basic types, conforming to national standards, whereas previously plasters were marketed under a large number of proprietary designations without reference particularly to the basic characteristics of the material. It is probably true to state that plasters are more uniform in properties; easier for the operative to use and lending themselves well to the manufacture of precast partition slabs which has become an important development in recent years.

(iv) Bricks and clay products: These generally have not undergone any striking evolutionary process in the United Kingdom as opposed to practice in the continent of Europe. The tendency in Europe is for the brick to give way to the larger hollow walling block, which offers considerable economies in bricklayers' labour and in mortar usage. This has obvious advantages where exteriors of buildings are almost universally plastered, but over a large part of the United Kingdom, custom and preference alike are for a finish in facing brickwork so that the hollow block is inadmissible.

The conclusion is that there is a slow evolutionary process at work in the manufacture and use of traditional building materials and that this is likely to continue.

(g) <u>Economy in use of materials</u>

Research has been carried out continuously for many years on the strength and stability of building structures, and a very large amount of information has been acquired. The sole object of this work has been to design and construct more efficiently and to reduce the cost of building. In fact, the results have been self-evident and the requirements of building regulations in the United Kingdom have been progressively refined during the last thirty years. Working stresses have been increased and live loads in many cases reduced. More refined methods of design enable further economies to be effected.

There have been criticisms of the retarding influence of "building regulations" in the United Kingdom but, seen in retrospect, the time lag in bringing regulations into conformity with the advance of knowledge has not been very great.

The situation today is improved with the establishment of "national codes of practice" which embody the most up-to-date practice in respect of design and construction. The codes are not mandatory, but so far as essentials are concerned, a structure conforming to the relevant codes of practice would be deemed to satisfy regulations.

The codification affects multi-storied construction more than the small individual house, but since the proportion of new housing in the form of flats is increasing in the United Kingdom, its advantages will be appreciable. Apart from other considerations, it is helpful for the industry to have clearly defined national codes which are applicable to the whole country.

Mention has been made of the advantages of having the essential requirements in code form for the use of firms and individuals who may be introducing new forms of construction. For the guidance of those working on non-traditional house construction, the basic requirements and methods of test for strength and stability were laid down in Special Report No. 1, Structural Requirements for Houses, of the National Building Studies series. In practice, where a proposed form of construction failed to reach the recommended standards of strength and stability, it was a relatively simple matter to make the modification necessary to put it right.

Timber has been used almost universally for the roofs and upper floors of the individual houses which have formed the greater part of the housing programme in the United Kingdom. Owing to the considerable increase in the post-war cost of timber, and because the greater part of the softwood used for carcassing was imported, strenuous efforts were made to decrease timber usage. Roof designs, in particular, were rationalized and the Timber Development Association published a number of designs based on modern design methods, supplemented by full-scale testing, and these have been extensively used and have contributed to the very considerable reduction in timber usage as compared with normal pre-war practice.

Distr.
RESTRICTED
HOU/Working Paper No.97 Add.(c)

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE
(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National monographs

YUGOSLAVIA

Relative importance of traditional and non-traditional methods of house construction

The Yugoslav building industry has remained mainly traditional. Immediately after the war the main efforts of capital investment were devoted to the building up of the productive capacity of the country and were therefore concentrated on industrial buildings. In recent years, however, an increasing proportion of the overall building activity has gone into house building; in 1956 the approximate ratio was 40 per cent for housing and public buildings and 60 per cent for "economic objectives". This situation is now reflected in house building where the scarcity of properly skilled labour is deeply felt. In the year 1951, about half of the total labour force was unskilled and about one quarter semi-skilled.(1) Apart from the availability of unskilled labour, the fairly good supply of traditional materials (clay products, cement, structural timber, gypsum etc.) may partly account for the traditional character of the Yugoslav house building industry.

There has been little or no consistent technical policy at Federal level to sponsor or encourage the use of new building materials or procedures, mainly as a consequence of the decentralized system of administrative control which was set up in the country in the years 1950-1952. Furthermore, in view of the fact that building enterprises, although organized on a collective basis, operate under almost free market conditions, the main guiding factor for adopting new building materials techniques is the final sale price. In this connexion, it is stated that no subsidy had ever been given either by the Federal or by the National

(1) See European Housing Trends and Policies in 1957, ECE, Geneva, 1958, (E/ECE/HOU/77), page 18.

Governments in Yugoslavia to cover the extra expenses incurred by the adoption of non-traditional methods of construction. Nevertheless the setting up of the special house building fund in 1955, by creating the necessary continuity of demand, has made it possible to establish long term house building plans and to propose building contracts covering several years: favourable conditions for a more comprehensive technical policy are thus created.

The trend of building prices shows sharp increases between 1951 and 1952 as a result of the policy of liberalization of building prices and the application of decentralization. The relative proportion of wages to materials' cost has nevertheless remained fairly constant; the sharpest increase can be noted in what is referred to as artisan's work (finishing work in general) which represents a considerable proportion of total building cost. Building materials account for nearly 75 per cent of the total and wages about 18 per cent. This proportion is extremely low as compared to figures for other west and east European countries and may account for the limited expansion of mechanization of building operations which, as a rule, is not economic under existing labour conditions.

Traditional house building, involving the use of solid masonry works (stone bricks or concrete works), rendered inside and out in-situ or semi-precast floor structures, parquet or tile flooring, clay roofing tiles or asbestos-cement sheets, and joinery represents well over 95 per cent of the total. A considerable proportion, however, is gradually evolving towards the use of lighter and more elaborate forms of construction (e.g. hollow bricks or clay blocks, light weight partition elements, hollow slabs infilling blocks) which depart, at least in urban districts, from the purely traditional method of house building. Only recently two systems of comparatively heavy prefabrication have been introduced: in both methods highly finished precast concrete panels are assembled on site, one of them using both prestressing and post-tensioning as a means of obtaining greater rigidity. Although these systems of construction are claimed to have effected great savings in erection time without raising overall costs, their use in Zagreb and Belgrade had for the moment been fairly limited.

Progress towards rationalization of building construction

(a) Technical qualifications of personnel

It has already been said that the proportion of skilled workers is very low. One of the basic reasons for the shortage is that there has been little opportunity for training since the bulk of construction has been largely concentrated on industrial building requiring a small amount of skilled labour. A slow but steady progress is however noticeable in this respect: the proportion of non-skilled and semi-skilled workers to total workers which was 65 per cent towards the end of 1956 fell to 58 per cent two years later; during this period the number of skilled workers increased by nearly 13,000. Qualified engineers and technicians account for 1.2 and 3.0 per cent respectively of total salaried personnel of the building industry. In the case of the middle grades, up to 1,000 potential middle-grade technicians come from the secondary technical schools, where they specialise in building or architecture including the technique of materials, design and costing. Some of them enter the industry as general foremen, some proceed to universities for professional careers.

Qualified professional people, mainly architects and civil engineers, graduate from one of the ten schools of architecture and building existing in the country. Figures for the academic year 1954/1955 show that over 2,000 students attended higher courses in building and architecture, out of which 350 graduated. Separate facilities exist for such professional grades as hydraulic engineers, road and bridge engineers, and surveyors. On the whole the need is felt for greater opportunities to be offered to young technicians of middle and higher grades to acquire practical experience on modern building techniques and up to date organization of building activities in general. Plans are being worked out to expand these possibilities through systematic exchange with foreign countries of students, graduates and qualified operatives.

(b) Organization of house-building

In 1955 the total number of building enterprises was 485 out of which 374 were concerned with house construction, 61 were public works enterprises, and the rest specialized firms. The bulk of finishing work, together with maintenance, is carried out by specialized public enterprises or by private artisan undertakings. The number of the latter considerably increased between 1951 and 1954, when 7,302 of them were last counted, compared with 629 public enterprises. Large house building operations are entrusted to large building firms, some of them real "combinats" which incorporate all facilities for design, the production of building materials and the actual execution of work on site. As a rule, however, the function of designing building is entrusted to design organizations of a public but local character as well as to private architects and engineers.

The activities of design organizations ("bureaux d'etudes") have considerably expanded since the war. In 1957, 186 of these offices were operating as part of building associations; out of these, 36 were overall design offices and 81 were specialized in architectural and constructional design. They employed over 4,000 engineers, architects and qualified technicians and 1,650 middle-grade technicians (draughtsmen, laboratory assistants and so on). There is a definite trend towards a greater specialization of these design organizations, taking into account the increased diversification of work undertaken. Projects are subject to approval by expert committees set up by the public authorities. The appropriate design organization is normally approached directly by the prospective building owner; at other times open competitions are held. Recently there has been a tendency for the larger building undertakings to build houses of their own design for sale to private individuals, a practice which would resemble speculative building in some western European countries.

Open public tendering is the rule for most house building operations, although there is no obligation to conclude the contract with the lowest bidder. Building enterprises are grouped in local associations and federated at national level in the Federal Chamber of Building which is responsible for co-ordinating their activities, exchange of information and experiences and other general tasks.

An interesting aspect of the organization of building is the setting up of special bodies called "centres of building" whose role is to co-ordinate the efforts of a group of prospective owners or those financing the work in a single, more economic, building operation. The "centres of building" set up in many of the larger cities replace the building owner and become the real investors who are qualified to deal with the building enterprise or enterprises and follow up the correct execution of the contract. This policy has had a certain success recently in some of the larger building operations.

Time schedules and careful planning of building operations are not the rule; furthermore, the great proportion of traditional work and the amount of finishing work carried out by small artisan undertakings does not facilitate the preparation of detailed schedules of operations on building sites. Nevertheless, the need is clearly felt for better organization and efforts are being made to improve the existing situation. The original system of time standards applicable throughout the country and compulsory for all elementary building operations has been superseded and so has the uniform costing method. In spite of public control, building enterprises work very much under free market conditions and are responsible for their own profits or losses.

(c) Mechanization

The scarce resources of building machinery available before the war were virtually destroyed by the end of it. For several years building activities had, therefore, to be carried out without the assistance of the most elementary elements of equipment, apart from those obtained through international assistance. The Government has nevertheless encouraged building firms to acquire heavy or middle-weight machinery with special subsidies or loans, although most of this machinery has been imported. In recent years considerable efforts have been made to develop local production of equipment and the situation has now improved to the extent that types of machinery are now available on the local market, e.g. excavators, small and medium-sized tower cranes, concrete mixers, lorries, tractors, locomotives, vibrators and drilling machines. Loans are granted on particularly favourable conditions to building concerns desiring to acquire equipment. Although the degree of mechanization is four times what it was before the war (it has been estimated that equipment used in connexion with building in general represented the equivalent of approximately 2.5 HP per salaried worker of the building industry), it has not yet reached the stage required to meet the expanding needs of the building industry. House building sites are usually well equipped for horizontal and vertical transport as well as for concrete mixing. The use of mechanical equipment is much less frequent in other structural work and virtually non-existent in most of the finishing work. This applies to a still greater extent to construction in the rural areas which has remained completely artisanal.

(d) Standardization

As a consequence of the policy of de-centralization, the Federal authorities have retained only the right to issue general quality standards concerning certain classes of materials and building components. Work has also been started on the greater use of type projects, especially for individual houses, schools, and small public buildings. Type projects, after being approved by appropriate control committees, are recommended to housing concerns, especially in regions where insufficient design facilities exist. The People's Republic of Serbia, for instance, has published in book form a series of type projects for individual dwellings which are made available to private builders or co-operatives. It should nevertheless be noted that the type projects have not the same obligatory character as those adopted in some other countries and do not, in particular, imply the use of standardized components.

A special general standard, introducing a basic module of 10 cm for house-building has recently been issued, and has become effective and compulsory as from January 1958. Nevertheless, in view of the lack of experience of designers on the use of modular methods of design, the system has not yet been widely applied; special instructions regarding the application of modular design are now in the course of preparation.

National standards for building materials are on a limited scale and concern mainly raw materials (cement, lime, plaster, steel, wood) or semi-finished products (bricks, roofing tiles, asbestos cement products). Building components have not yet been standardized on a Federal level, although work on standardization of joinery is under way. Some of the Republics and the principal cities have issued instructions which can be assimilated to local standards, concerning for example floor areas, ceiling heights and the dimensions of the main building components (such as lintels, staircases, doors and windows, masonry blocks). Although this standardization has mainly local significance and is limited to towns such as Belgrade, Sarajevo, Ljubljana, it will eventually become the starting point for a greater effort on a Federal level. Adequate legal basis is provided by a recent Federal law dated April 16, 1958, whose Article 1 reads as follows:

"House-building must comply with Yugoslav building standards. The Federal Commission for Standardization has to establish basic standards mentioned in the foregoing paragraph".

(e) New materials

The introduction of new materials has been hindered by the general conditions of the building industry referred to above, rather than by the lack of technical "know-how". The introduction of special lightweight autoclaved concretes, slag concretes or special types of steel reinforcement for concrete has been made possible through obtaining licences from foreign inventors. Lightweight panels made of wood-waste or wood fibres with magnesite or cement binders are gaining ground; some of these products are also used in the manufacture of masonry blocks or floor infilling blocks. Considerable efforts are devoted to research into alternatives for timber in house construction, both as a structural material and as material for floor finishes, joinery and so on. This derives from the fact that although timber is in good supply, it represents one of the major items of export; moreover, tree felling has been fairly heavy in the last few years and is likely to be more limited in the immediate future. Prestressed concrete, which is extensively used in public works and engineering work, is being gradually introduced into house-building (floor joists, roof slabs). Expansion of the use of light alloys (window sections) or plastics (water supply pipes, flooring materials, door handles, etc.) is limited by their high basic cost. Glass fibre and framed polystyrene have been introduced recently and production is increasing. The State research institutes are the determining factor in the introduction of new materials and the improvement of the quality of traditional materials, which is dealt with in the following paragraph.

(f) Development of traditional materials

Traditional materials are in fairly good supply but are produced as a rule under rather poor technical conditions. This means, therefore, that productivity is low, the labour content, especially unskilled, high, and most important of all, quality is irregular. This last point results in over safe building regulations and specifications with an uneconomic use of basic materials. Production of fine quality clay products, glazed and unglazed, of higher quality cement, of super-fine or finishing grade plaster, of thin wall concrete blocks, of special types of steel reinforcement, of long fibre asbestos to be used in asbestos cement products are among the points which appear to need attention in order generally to raise the output and the quality of the building materials industry. This is clearly recognized by the authorities; what is lacking is investment in production equipment and adequately qualified technical personnel.

Distr.
RESTRICTED
HOU/Working Paper No. 97 Add. (p)
17 March 1959
Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda
of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

IRELAND

1. Relative importance of traditional and non-traditional methods of house construction:

Fifty years ago the Irish building industry was in a state of transition; it was at the end of the old style of building which depended on stone, bricks, timber and quarry slates as its main structural materials. New materials demanded a new approach to the problems of building and experience had to be gained in the handling of these new materials. In the gaining of this experience mistakes were, occasionally, made but in the long run substantial advances were made.

The material which has done most to alter traditional forms of building in Ireland during the first half of the twentieth century has been concrete - whether as mass concrete, concrete building blocks, reinforced or prestressed beams, slabs, lintels, etc., damp-proofed floors and concrete and asbestos-cement roofing tiles. At first, builders were slow to realise the shortcomings of concrete construction, particularly its tendency to produce shrinkage cracks, but researches during the past 25 years have produced precision made and steam-cured concrete blocks and units and the science of the grading of aggregates has brought about improvements in the strength and quality of concrete products. Traditional methods of building in brick or stone with slate roofs have been almost entirely superseded by semi-traditional methods involving the use of concrete block or poured concrete walling and roofing with concrete tiles. Plaster-boards and expanded metal have replaced timber laths as a base for plastering. Hardboards are used for sheeting and construction in place of T. & G. boardings, steel windows are widely used in place of wooden casements, standard doors, windows, stairs, firebacks, etc., made in factories or workshops, are now used where formerly these items were made in the course of building. Full-scale prefabrication of complete dwelling units has not, however, been undertaken in Ireland.

In recent years, plastic piping has been used instead of lead or copper piping for domestic cold water services and asphalt has been tried experimentally, and with initial success, as an alternative to the traditional type of roofing constructed of timber, felt and tiles. There have been no other important innovations in recent years in building materials used generally in housing operations in this country.

Apart from new materials, building methods in Ireland have been radically changed during the past 20 years by the advent of petrol and diesel powered machinery which has allowed many of the old hand operations to be dispensed with and much of the former human effort has been eliminated by a great variety of machines. The hod has been replaced by the builder's hoist, tower crane and elevator; the concrete mixer has done away with the mixing board; the compressed air spray has speeded up painting. The mechanical excavator does the work of the pick and shovel, while the bulldozer and scraper have revolutionised the preparation of sites and have allowed a fresh approach to problems which would have been considered uneconomical 20 years ago. Timber shuttering is being challenged in major works by standardised steel shutterings and steel supports in various patent systems.

Statistics have not been compiled over the datum period which would enable a quantitative analysis to be made on the lines requested of the evolution of the respective contributions to the house-building programme through traditional, semi-traditional and non-traditional methods of construction.

2. <u>Progress towards rationalisation of building construction</u>

(b) <u>Organisation of house-building</u>

Generally speaking, organisational links between the different parties in building activity are not regulated by statutory provisions.

The position in regard to the organisation of building differs somewhat as between housing operations undertaken by local authorities and by private enterprise respectively.

A number of technical officers are employed on the regular staffs of the more important local authorities. In some cases, the staffs include one or more architects who are entrusted with the work of planning housing schemes and exercising a general supervision over the work of building. Technical duties in connection with the planning and supervision of relatively unimportant housing works, such as the provision of small groups of houses or isolated rural cottages, are usually undertaken by the engineering staffs of local authorities. Where a larger housing scheme is being provided by a local authority whose regular staff does not include an architect, it is usual for the local authority to employ a consultant with a recognised qualification in architecture. The work usually includes: advising on the suitability of the site and surveying it; preparing lay-out plan and constructional drawings for roads and services; preparing specifications; reporting on tenders; supplying instructions to the contractors and ensuring general supervision of the work.

The question whether or not a quantity surveyor should be engaged for a housing scheme is a matter which the local authority must examine and decide on the merits of each case, regard being had to the extent and complexity of the scheme. In cases in which he is engaged, the quantity surveyor prepares a bill of quantities on the basis of the plans and other documents furnished by the architect, he advises the local authority on the tenders received by them for the scheme with special reference to the pricings in the bill of quantities completed by the lowest tenderer, he computes the extras or credits in respect of variations in the course of the contract and he prepares the final statement of account.

The day to day supervision of building work in progress is usually carried out by a clerk of works who, as a rule, holds a qualification in civil engineering and has had previous experience of supervising building work.

The work of building is undertaken by commercial building contractors, but occasionally work is also carried out by direct labour units established by local authorities, especially in areas where difficulty has been experienced in obtaining reasonable tenders. Owing to the general adoption of the system of competitive tendering it is not the practice in the case of local authority house-building to have detailed pre-planning of projects by the architect, builder and local authority in conjunction, as is the practice with some other types of building.

With regard to house-building by private enterprise, it is usual for the landowner, the builder and the architect to evolve agreed development proposals for a particular site. These proposals must be submitted for approval to the local authority, whose town planning consultant and engineering or architectural staff advise the authority if the projects are in order or as to the alterations which appear to be necessary. While the building work is in progress, a number of inspections are made by technical officers of the local authority to ensure that the requirements of building bye-laws and Town and Regional Planning Acts are being observed. Engineering or architectural inspectors of the Department of Local Government also carry out inspections during the erection of houses in respect of which grants are applied for under the Housing Acts. Quantity surveyors are rarely employed in connection with private enterprise housing operations.

Contracts for the erection of houses are usually made on the basis of competitive tendering by interested building firms. The differences between the competing quotations for schemes is generally small. Contractors are, accordingly, compelled to utilise all practicable methods which will enable them to cost projected works accurately and to build economically and efficiently. This encourages the optimum use of appropriate mechanical plant and equipment but guards against over-mechanisation. As a general rule, conditions of contract provide for sub-contracts for certain stages of the work and sub-letting and assignment of some portions of the work is not uncommon, but there does not appear to be the scope for specialisation in house-building that exists in the case of major constructional works such as hospitals, factories, cinemas and large commercial premises. In these cases one has, on the construction side, sub-contractors for excavation and heavy site work, the structural steel contractor, the steel window specialist, the plastering sub-contractor, paint spraying companies and very often the roofing contractors with a variety of asphalt, rubber felting and other roofing materials. Major housing schemes, on the other hand, are carried out entirely by the main contractor, or minor jobs such as electric wiring, plastering or painting, are sub-let. New building techniques relating to the various aspects of house-building make ever-increasing demands on the building contractor to plan and organise the progress of his work and they make demands on his finances to acquire and maintain new or improved plant. One result of this trend is to widen the gap between major building firms and smaller contractors. The small contractor, lacking modern mechanical equipment, cannot hope to compete successfully against highly equipped firms for large housing contracts and, on the other hand, small housing schemes are no longer economically attractive to the larger firms.

(c) Mechanization

Much of the modern mechanisation in the building industry resulted from war-time developments in connection with the application of petrol, diesel and electric motors to work previously done manually. The scarcity of suitable labour (especially skilled labour), the prospects of a large volume and steady sequence of work extending over a probable period of about ten years and the relatively easy availability of the necessary capital in the immediate post-war period prompted large-scale building firms to invest in the purchase of modern plant and equipment. The trend towards mechanisation has stemmed also from efforts by builders to keep down costs in the face of rising wages and prices, by increasing man-hour production. Mechanisation has had a far-reaching effect on the industry generally and on the firms comprising it. Any group proposing to enter the industry today must be prepared to lay down large sums on capital equipment before any work is undertaken. This has not completely closed the industry to new firms, but it has brought an increased measure of stability to the industry.

Modern machinery includes excavators, which are used in preparing sites for building and are used also in excavating the materials required for the production of concrete, bricks, plaster and other items essential to the building industry.

In excavation, mechanical devices have largely displaced handwork, and it is a very small job now on which it will not pay to use a small excavator for trenches and drains and, indeed, to use a loading shovel or scraper on the bulk site excavation. The economy of these machines is also evident throughout the country in land drainage and heavy earthworks, the cost of which would have been prohibitive before the advent of such machines.

Woodworking machines range from motorised saws, used in felling and cutting up trees in forests, down to the finishing machinery used in the final production of doors, roofing and other joinery. The introduction of machinery such as primary breakers, granulators, sand and gravel washing and screening plants, have considerably speeded up the laborious process of stone and aggregate production and have reduced the cost to the builder. In most centres of extensive building, firms specialising in the production of aggregate are now at the service of builders. The supply of ready-mixed concretes of uniform composition and prepared to required specifications and the production of high-grade concrete blocks by major manufacturing units have improved the quality and reduced the cost of building. The placing of these and other components in the course of construction is accelerated by the use of platform hoists, tower cranes (first introduced into Irish building in February, 1953), fork lift trucks, conveyors, dumpers and even hand-operated power barrows. The employment of tower cranes facilitates the use of large precast concrete units, such as floors, and of larger containers of concrete blocks and bricks, and in some cases of prefabricated timber-roof sections. The advantages of factory-made precast products and the increased safety in the prefabrication of timber structures on the ground have been made available to builders by these cranes. The tendency has been to use good materials less wastefully, as the reduction in the cost of placing has allowed a better finish.

With plastering, little progress has been made in mechanisation except, perhaps, in mechanical production of the paper-backed scrimless slab. Also, through more efficient production techniques, it is now possible to get a larger paper-faced self-finished slab. In concrete finishing, some of the major contractors have adopted the American mechanical finishing float which produses a very fine finish over a concrete floor.

There has been little improvement in joinery machines over the past ten years. The tendency has been towards greater cutting speeds and to the use of mechanical feeding and handling devices. More and more electric hand tools are, however, appearing in the hands of the site carpenter, freeing him from much time-consuming drudgery and allowing him to apply his energy to the more highly skilled aspects of his job. It seems that development is largely to be expected from such small electric tools, such as chasing hammers, screwdrivers, saws and drills of all types, as the cost of these tools is quite small and their use is, therefore, within the means of small builders.

There are many other machines which, in the past ten or fifteen years, have become essential to large-scale building contractors at some stage or other during the progress of a scheme, including such items as bulldozers, scrapers, diesel rollers, loading shovels, dumpers, pneumatic tools, vibrators, rammers, water pumps, bar benders, etc. The use of cement silos, for example, can effect a reduction in cost of nearly £10 per house in larger schemes against the cost applicable where cement is delivered in hundredweight bags.

Statistics of the types and numbers of machines being used by building contractors are not compiled by the Department of Local Government.

Mechanisation helped to expedite the development of large-scale building operations when housing was resumed after the Second World War and it has helped to make practicable reasonably accurate advance planning of housing work. It has appreciably improved the general quality of building and has cut the number of man-hours required to carry out many speeific operations, thereby increasing the average output per operative engaged in building work as a whole. Efforts by the building trade to meet the rising costs of wages and materials by the use of new mechanical devices have, however, met with only limited success as the size of the country and the overall extent of work coming forward obviates the general use of the largest and most expensive machinery which has produced most spectacular results in large and highly industrialised countries.

The degree to which building organisations have been mechanised, varies directly with the sizes of the organisations and the nature and extent of the work which they normally have on hand. Approximately 30% of all houses now in course of construction by local authorities are being built on single rural sites or in small groups not exceeding 10 dwellings. The contractors erecting these houses usually possess very little plant and equipment and, in present circumstances, where a sharp increase in the volume of building seems improbable, they would have little incentive to lay out capital on the purchase of new and more ambitious equipment. The mechanised plant normally available to such small contractors comprises a lorry, concrete mixer, small block machine and, occasionally, a power saw and a hoist. At the other extreme are contractors who are equipped to undertake schemes comprising hundreds of houses or flat-dwellings. Mechanical plant in these cases comprises tower cranes, bulldozers, scrapers, major block-making machinery, cement silos, fully equipped joinery workshops, etc. Many such firms own sand and gravel pits and excavate, wash, grade and deliver the aggregate required for jobs on which they are engaged. Smaller local authority housing schemes (20 to 80 houses) and the majority of private enterprise schemes in the county boroughs are carried out by contractors whose mechanical equipment is considerably less than that of the major concerns but is also more extensive than that of contractors who build isolated rural cottages and small groups of serviced houses.

The hiring of mechanical plant by building enterprises arises only in the larger cities. The position in these areas is that major contractors generally possess sufficient plant to enable them to undertake, without drawing on outside resources, the level of building work which might normally be expected to come forward for construction by them. If an increase in the volume of work appears likely to arise and to be maintained, the amount of their equipment will be expanded correspondingly. Occasional pressure of work, which cannot be met by existing plant, is relieved by hiring the necessary equipment, either from specialist firms or from other major building concerns who are not working to capacity at the time.

Conversely, when machinery is not being utilised to an economic capacity, building contractors endeavour to rent out idle machines or to obtain sub-contracts in which the plant could be employed.

Outgoings in respect of running costs and amortisation of mechanical equipment are costed by contractors against appropriate sections of contract. In the case of larger housing schemes, it is estimated that such expenses in respect of plant and equipment account for approximately 2% of the total contract price.

(d) Standardisation

So far as Ireland is concerned, scope for standardisation exists principally in respect of building materials and components. A special body - the Institute for Industrial Research and Standards - has been established to prepare national standards, including standard specifications governing many important building materials and components. These standard specifications are qualitative but, where appropriate, they lay down dimensional standards also.

To some extent a measure of standardisation has applied also to the planning of low cost houses, both private dwellings and those built by local authorities. The Department of Local Government has prepared, and revises from time to time, an outline building specification for the guidance of local authorities and private individuals intending to build houses. The Department maintains an administrative control over the planning of local authority houses. It lays down certain minimum standards of floor area, accommodation and construction in the case of private houses for which grants will be claimed under the Housing Acts and makes available plans for a number of different grant-type houses which are fairly widely adopted either as issued by the Department or with some adaptations to suit individual requirements. The Department's intervention encourages the reduction to the minimum desirable of the variety of house plans used in the provision of low cost dwellings.

Having regard to the limited extent and dispersed nature of the housing operations to be undertaken in this country it has not been found necessary or desirable to apply standardisation to entire housing projects. Certain broad, general planning principles affecting such aspects as densities of development, building lines, siting of shopping centres, public buildings, open spaces, etc., govern important housing schemes undertaken by local authorities and by private enterprise and impose some measure of standardisation on lay-outs, but within the scope of these considerations a great degree of flexibility and variety of planning is feasible.

No appreciable difficulty has been experienced in adapting standard plans to suit local conditions.

With regard to the share taken by standardised materials in the total production, it may be taken that materials complying with Irish Standard Specifications are almost universally used in the building of houses by local authorities and by private enterprise assisted by grants under the Housing Acts. The Department of Local Government presses local authorities to use or secure the use in their housing operations and other constructional work of materials and components which comply with the standard specifications. Similarly, in the case of private house-building, applicants for grants are enjoined by the Department to ensure that materials and appliances used in the execution of the works conform to the current standards.

The move towards standardisation has applied in general to houses and flat-dwellings built since April, 1947, by local housing authorities and to private grant-type houses. The programmes completed by these bodies up to 31 December 1958, or in course of building or at the contract stage at that date, comprised some 107,000 dwellings, made up as follows:-

	Built	In progress or in tenders
Local authorities	54,817	3,443
Private builders	46,700	2,500 (estimated)
Totals	101,517	5,943

Dwellings comprised in the above totals are estimated to represent approximately 95 per cent of all houses and flats constructed in the country during the period in question. It is further estimated that about 80 per cent of the local authority dwellings and 75 per cent of the private grant houses in these totals have been built in accordance with standard plans - either plans prepared or approved by the Department of Local Government or plans which have been generally based on such approved plans.

As indicated previously, it has not been the practice to use standardised projects in housing operations in this country.

(e) New materials

(f) Development of traditional materials

Apart from the use of plastic piping for domestic cold water services, it has not been the practice in this country to use to any appreciable extent new materials such as light-weight aggregates, pre-stressed concrete elements, new alloys, etc. in the course of housing operations. Houses are constructed of concrete blocks or mass concrete with timber or concrete floors and are roofed with tiles of concrete or asbestos-cement. Building bye-laws, operated by many local authorities, contain provisions intended to ensure minimum standards of structural strength and stability which would preclude the use of some novel forms of modern construction. Amendment of the law in this regard would be necessary to permit of the general use of such modern building innovations.

(g) Economy in the use of materials

Public control over building is exercised by two methods. On the one hand, legal powers are given to local authorities especially under the Sanitary Services Acts and the Town and Regional Planning Acts to regulate building development in their administrative areas. On the other hand, schemes of grants and loans from State and local authority funds to assist private housing work provide an effective inducement to comply with principles of planning and construction regarded as desirable by the appropriate local authority as financial assistance is given only in respect of projects which have the approval of the local authority.

Statutory control over building is generally exercised in pursuance of local authority byelaws. Model byelaws were circulated to local authorities in 1906. This model was based on building materials and methods generally adopted at that time. No revised model has since been prepared but one is at present in course of preperation by the Department of Local Government which will provide for new materials and methods which have become normal building practice in the intervening years. Although a modern model set of byelaws has not been issued, a number of local authorities have themselves compiled and brought into operation in their areas revised building byelaws which cover present day building practices. Dublin Corporation, for example, adopted revised byelaws in June, 1949 which regulate building in which forms of construction such as the use of a structural framework of metal or of reinforced concrete are utilised and also covers the use of materials, such as hollow bricks or concrete blocks, which have come into general use only in recent years.

While building byelaws are necessary to ensure that building work can be made to comply with certain minimum standards, the system of control has its shortcomings.

The procedure for the revision of byelaws is rather cumbersome and the provisions of the byelaws are generally inelastic. It may be accepted that these regulations have followed, rather than facilitated, the technological evolution of the building industry and the introduction of new materials and techniques. The supplementary control over forms of building, exercised in connection with grants under the Housing Acts, is much less rigid and gives scope for innovations in materials and methods. The regulations governing the position in this case provide that an applicant, in building a house, may adopt a form of construction other than brick, stone or concrete with roof covering by slates or tiles with an underlay of felt, provided that he submits and obtains advance approval to a description of the method to be adopted. Approval under this heading has been given, for example, in respect of the erection of timber houses, the use of timber shingles and of asphalt in roofing, of large pre-cast concrete slabs in house walls, etc.

Distr.
RESTRICTED

HOU/Working Paper No 97 Add.(p) (continuation)
6 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs - Additional information

IRELAND

(a) Technical qualifications of personnel:

It is the established practice of public authorities and of all important commercial concerns to entrust to trained personnel the preparation of plans and other documents relating to projected constructional work and the supervision of the actual work when in progress. Depending on the nature of the work to be undertaken, the preparation of contract documents and overall supervision is carried out either by qualified architects or by engineers. The course of training for these professions are adapted to cover current technological developments in building materials and methods.

The recognised qualifications for architects in Ireland are either membership of the Royal Institute of the Architects of Ireland, or a degree in architecture from the National University of Ireland. Candidates are also admitted to the Institute by examination, the following numbers qualifying in this way for membership during the past three years:-

1956	...	4
1957	...	4
1958	...	8

A whole-time diploma course in architecture is also conducted at the College of Technology administered by the City of Dublin Vocational Education Committee. This course extends over a period of five years and leads to graduateship of the Royal Institute of the Architects of Ireland. Approximately 50 students attend this course.

The membership of the Royal Institute of the Architects of Ireland has numbered 314 persons during the past three years.

The degree of Bachelor of Architecture is obtained through instruction and examination in the National University of Ireland. Holders of the degree are admitted to membership of the Royal Institute of the Architects of Ireland and also of the corresponding British Institute. The following numbers of students obtained degrees between 1956 and 1958:-

1956	...	16
1957	...	30
1958	...	13

The recognised qualifications for engineers in Ireland are either membership of the Institute of Civil Engineers of Ireland, or a degree in engineering from a recognised university. The output of engineers from the universities in the past three years has been:-

Year	Civil	Mechanical and Electrical.	Chemical
1956	98	43	-
1957	93	56	-
1958	81	64	3

It is estimated that the number of practising architects and engineers in the country are distributed as follows:-

Employment	Architects.	Engineers.
Civil Service and Army	104	450
Local Authorities	32	560
Electricity Supply Board	5	460
Turf Development Board	-	66
Industry and Private Practice	173	500

The Dublin College of Technology also provides a whole-time course in quantity surveying. The course extends over a period of 2½ years, at the end of which time students take up employment in surveyors' offices and prepare for a final examination. About 50 students, on average, attend the course. At present 93 quantity surveyors are practising in this country.

Technological, technical and trade courses are provided throughout the country in vocational education schools under local authorities. The technical courses are provided for craftsmen and technicians who hope to qualify for positions as clerks of works or building supervisors. The courses, which cover a period of five years, are open also to builders' clerks, estimators and draughtsmen. They are attended by an average total of 110 students who are prepared for the exaination in building technology of the Department of Education. Trade courses are of three types:-

(a) Day apprentice whole-time courses;

(b) part-time day release courses; and

(c) evening courses.

Whole-time day courses are now held only in plumbing and brickwork. They run for two years, with six hours instruction daily. Students are placed in employment as third-year apprentices at the end of the second year. They usually continue their training in evening courses and take the senior trade certificate examination of the Department of Education in their fifth year.

Part-time day release courses are provided for apprentices who are released by their employers - usually for one day or two days in each week - and who attend evening classes. Evening trade courses are held in many vocational education schools throughout the country. They are usually held on three evenings per week and may cover a period of five years.

Distr.
RESTRICTED
HOU/Working Paper No.97 Add.(q)
14 April 1959
Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

Country Monographs

NORWAY

1. Relative importance of traditional and non-traditional methods of house construction

The traditional dwelling in Norway is a small wooden house for one or two families, owing to the scattered population and plentiful supply of timber. Nearly 70 percent of dwellings are still built of wood and most of them are small individual houses. Between 25 and 30 percent are constructed through building societies which are, as a rule, constituted on local initiative with a limited geographical coverage. The building industry in Norway is therefore highly decentralized; many of the firms and handicraft enterprises which act as sub-contractors are small in size. As a result, rationalization and mechanization have been hampered.

The traditional small wooden house in Norway has a 4" x 4" frame covered internally and externally by two layers of panelling and two layers of building board. Wood is thus used both as a load-bearing and insulating material. However, recently new materials have appeared on the market which provide better insulation at a lower cost. It is therefore technically and economically advantageous to restrict the use of wood to the frame and facing. At the same time, a standard frame based on American methods has been developed with 2" x 4" posts spaced at 24". The typical external wall at present consists therefore of external panelling in building board, 2" x 4" posts, rock wool or glass fibre insulation and internal panelling in gypsum board. This method, which may be called semi-traditional, is rapid in execution and ensures better thermal insulation at lower cost. It may be employed advantageously in small-scale building. Nevertheless, much inertia has had to be overcome. Full statistical data on the construction of wooden buildings in recent years are not available but the trend can be seen from the following percentages of small wooden houses financed by the Housing Bank:

	1955	1956	1957	1958
Traditional frame construction	62	61	42	26
With mineral wool mats in cavity	17	25	51	70
Other insulating methods	21	14	7	4
	100	100	100	100

Since the war there have been several attempts to produce small houses based on prefabrication of heavy elements. As a rule, however, small handicraft firms using power tools and small transportable machinery have been able to build at lower cost. For blocks of flats, traditional construction has until recently been in brick cavity walls. Since 1950 this method has been largely replaced by solid brickwork with lightweight concrete or other material as an insulating layer, or by concrete walls similarly insulated. It has become common to use load-bearing cross walls with lightweight construction in the outer wall. Walls in lightweight concrete slabs also account for a substantial proportion of recent output. New methods are continually being introduced, particularly lightweight outer walls such as curtain walling, which may be regarded as semi-traditional. Non-traditional construction based on heavy prefabricated elements has also been successful recently in terms of a saving of labour on site, although comparatively few houses have so far been built by this method.

The quantitative evolution in recent years can be seen from the following statistics on blocks of flats financed by the Housing Bank, the different types of construction being expressed as percentages of the total:

	1952	1955	1957	1958
Brick walls	43	26	10	7
Lightweight concrete	27	31	20	33
Concrete, or concrete cross walls with curtain walls	23	35	63	60
Other materials	7	8	7	0
	100	100	100	100

Particularly in the case of wooden houses changes in construction methods are the result of efforts by public authorities. Owing to shortage of timber for house-building and the heavy demand for timber from paper and pulp mills in the early post-war period, it was essential to reduce consumption of timber in house-building. A general switch-over to other materials was not possible. Full use was thus made of the capacity of the cement and brick industries. Furthermore, there was sufficient labour to construct wooden houses but a shortage of skilled workers for construction in brick and concrete. In 1951 the public authorities made building licences more freely available for houses which saved timber. This measure led to a virtual revolution on Norwegian building sites. Special incentives to new methods were discontinued after two years and there was a certain reaction. Recently, however, new methods have made further progress which may be partly ascribed to the loan policy of the Housing Bank which, since 1957, has made available larger loans for houses with good thermal insulation. This has been possible without additional subsidy since heating costs are substantially reduced. Compared with traditional construction, the consumption of timber has been reduced by nearly two-thirds and thermal insulation more than doubled, the heat transmission coefficient now being less than 0.4. In 1958 70 percent of all wooden houses financed by the Housing Bank had insulation of this standard.

The public authorities have contributed less directly to the development of methods for building blocks of flats, but one measure may be cited. On the initiative of the Housing Directorate ten civil engineers and architects were given a special training in problems of rationalization and they acted in 1957 and 1958 as consultants for rationalizing the building industry, organizing study groups and giving lectures and free advice all over the country. Another important factor has been the supervision by the state banks of building methods and progress with a view to reducing costs.

2. Progress towards rationalization of building construction

(c) Mechanization

Mechanization has naturally been most evident in the construction of blocks, and owing to its special conditions, Norway has lagged behind many other countries in this field. Nevertheless, considerable efforts have been made in the post-war years.

The 1953 industrial census recorded the type of mechanical equipment at the disposal of firms engaged in private building construction, with the following results:

Passenger cars and station wagons	1,187
Trucks with crew-cab	35
Platform trucks	869
Delivery trucks	1,495
Truck trailers	18
Trucks with concrete mixer	5
Bulldozers	30
Excavators	75
Concrete mixers (stationary)	1,927
Tractors	36

It should be noted that out of 6,795 establishments, 3,210 only reported owning machinery of the types indicated.

Excavators are used on the larger building sites in towns. Since the war, bulldozers, excavators and compressed air drills have been used on almost all sites and have revolutionized this part of building work. Several firms specialized in excavation work have been established. The progress in blast technique has also been important. Concrete mixers were commonly used also before the war. At present, ready-made concrete is usually delivered to bigger sites and concrete mixers are used on almost all smaller sites. Cranes have come into general use on the larger sites in towns in recent years. Primitive lifts were commonly used on large buildings before and immediately after the war, but more modern lifts capable, for example, of holding a loaded wheelbarrow, have now been introduced. The introduction of electric power tools has been of real importance, particularly for carpentry work. Mechanical spray apparatus for paint and plaster are also playing an increasingly important part.

In addition to mechanization proper, the use of new scaffolding made of steel tubes, and particularly developments in shuttering resulting in substantial reduction in plaster work should also be mentioned.

Up till now, there has not been any particular interest for special machine stations for the building trades. Most of the bigger machines are owned by special firms engaged in site work, or by the main contractor. In rural areas, however, some machine stations for farming have also played a part in building.

An important factor in the relatively quick and extensive mechanization of site work has been the great expansion in hydro-electric development, which has created the basis for large investments in civil engineering equipment, also partly used in the building industry.

(d) Standardization

The Norwegian Standardization Association, through its special house-building board, has issued standards covering most basic building materials (cement, plaster, bricks, cement blocks, structural steel, fibre boards, etc.) and simple components (doors and windows, pipes, concrete steps, kitchen fittings, etc.). They are voluntarily applied by the industry, with increasing success; in some cases the standards are actually laid down as a minimum requirement for obtaining building permit. The indirect action of the Housing Bank is also important in connection with the introduction of better techniques and the adoption of planning modules. Modular co-ordination, based on 10 cm module, is being studied by an inter-Scandinavian group, to which Norway is contributing in particular with work on fitting and tolerance problems.

Typical building details are also prepared and issued in leaflet form by the Norwegian building research institute; they may, in fact, be regarded as tentative standards and are frequently referred to.

The Housing Directorate has also prepared or approved over 100 typical plans for small houses. In the years 1948-1958 more than 30,000 typical plans have been sold, and in recent years approximately one quarter of the new small houses have been erected according to these plans. The primary object of preparing typical plans is to improve building methods in general, but it must also be reckoned that the widespread use of typical plans will promote an extended use of standards in house-building.

(e) New Materials

Among the most important new materials are lightweight concrete (Ytong, Siporex) and expanded clay (Leca) which have been extensively used in recent years both as structural elements and as insulation in association with brick or concrete walls. Consumption of these materials in wall constructions has grown from 25,000 m^3 in 1956 to 100,000 m^3 in 1958. The new insulating materials (rock wool and glass fibre) which have revolutionized wooden house construction, have already been mentioned. The more extensive use of wallboards both as panelling and as insulation (porous boards) is also worth recording. In 1955 about 40 percent of the total consumption of roofing material was asbestos-cement slates and corrugated sheeting. This percentage has probably increased further subsequently. Asbestos-cement slates are also extensively used for the outer cladding of walls. A number of new plastering materials and paints have appeared, in connection with substantial improvement in shuttering, which have introduced new and improved finishing techniques. Plastics have been introduced, in the first place as floor covering, but also as pipes for water supply and sewage.

Distr.
RESTRICTED

HOUSING AND HOME FINANCE AGENCY
OFFICE OF THE ADMINISTRATOR
WASHINGTON 25, D.C.
JUN 2 1959

ECE/HOU/Working Paper No. 97 Add (r)
7 April 1959

Original: FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National monographs

HUNGARY

1. Relative importance of traditional and non-traditional methods of house construction

In order to meet the need for housing and to ensure a considerable increase in the amount of house-building, the weight of blocks of flats must be reduced and less work must be required on the actual building; the various methods of building must therefore be improved. In Hungary the traditional system of house-building still prevails, but prefabricated components and structures are being increasingly used, mainly joists, panels, floors, lintels, staircases, landings, roofing units, etc. Masonry is still usually of ordinary brick, but the manufacture of concrete, clinker and strass blocks has progressed considerably in the past two years, as has the output of larger hollow bricks.

Constructing blocks of flats with large components is not yet very widespread, but several hundred dwellings are built each year experimentally, with different structures and by different technical systems. These experimental building sites are intended to enable new methods of building to be introduced and applied in accordance with the best systems of construction and technique. Experience so far shows that medium-sized components will be the most suitable for use during the next five or six years.

Although new methods of building are being introduced, the traditional methods, which will be used for a long time yet, must be developed if the growing need for building is to be met.

The new building methods include construction with light materials and larger components, and this in turn requires further mechanization and prefabrication. In contrast, the following methods are regarded as traditional:

masonry of brick or other materials erected by hand without machinery, building with single-slab reinforced concrete, and the use of all structures and accessories required by such building methods.

In accordance with the plans for continuous research and experimental building, the new tested building methods are to be applied on a large scale in house-building under future five-year plans.

2. Progress toward rationalization of building construction

(a) Technical qualifications of personnel

The rapid progress in building requires skilled staff well-trained in organization and execution. To this end, much importance is attached by the Government to the training of building staff. An index of the progress made is that whereas the total number of students at the Polytechnic in 1937-38 was 1052, in 1955-56 11,400 attended day courses, 2,000 attended evening courses, and 3,000 took correspondence courses. There were 458 architects and 282 civil engineers among the 2,948 graduates in 1956. Second-grade training is given to several hundred skilled staff every year as part of secondary education in the technical schools. Between 6,000 and 7,000 workers received vocational training. There are also post-graduate courses at the universities, higher schools and scientific institutes.

The nationalized sector employs about 77-80% of labourers and 20% of skilled tradesmen and administrators. In the planning offices the executive side (experts and engineers) accounts for about 70% and the administrative side for 30% (see table 1).

(b) Organization of house-building

Plans for house-building financed by the State are prepared by nationalized planning offices. The councils and their subsidiary bodies, or - for a smaller proportion of buildings - the nationalized undertakings and the institutions, may be regarded as the principals. The building itself is done by nationalized building undertakings.

Plans and bills of quantities are drawn up in accordance with regulations and instructions. The building, settlement for, and operation of housing are also subject to regulations.

Relations between principals, builders and the planning offices have grown closer in recent years. Their respective responsibilities are now more precisely defined, although close collaboration between the three parties is required.

The building plans must be drafted by a general planning office in direct contact with the principal. The general planning office may call in various specialized planning offices. For single buildings the principal may select the planning office, but for larger buildings it is designated by the ministry responsible.

The principal supplies the planning office with all necessary information, and must supervise the planning and settle for it in accordance with the provisions relating to the fees fixed for the plans.

Where there is a general planning office the principal may not enter into direct relations with the specialized planning offices, which act as sub-contractors for the general planning office. Principals must supervise and approve the plans and bills of quantities and submit them to the competent authorities for approval.

The planning office must draw up the plans within a time-limit fixed by contract, and deliver the plans to the principal without fail, in accordance with the required technical, economic and quality conditions. The planner must protect the national economy against any unjustified demands by the principal, who manages the invested money. The planning agency also exercises periodic supervision while the building is going up, to see that performance is in accordance with the plans. The supervision is therefore not constant, but for a special order the planning agency may assume constant supervision.

The plans and bills of quantities must be delivered to the builder by the principal. The rule of general undertaking, i.e. that all work must be given to a single undertaking, governs the conclusion of the contract. The principal must appoint a permanent technical supervisor with specialized technical knowledge to supervise the work on the spot.

The builder works on the plans and in accordance with a working contract; he must finish the work within the agreed time-limit, submitting his accounts in stages as the work progresses. The general undertaker is responsible for all the work, even for that carried out by his sub-contractors. The principal acts as an intermediary in relations between the builder and the planning agency.

The principal is responsible for taking over the finished work and for the management and ordinary operation of the building. A record of any defects or inadequacies in construction will be drawn up when the work is handed over and accepted, and the undertaker must repair any defects entered in this record.

Before the work is started, any disputes between the principal, the planning agency and the builder are settled by the supervisory authorities; whereas during the work and after it is finished all issues are submitted to an arbitral commission.

Permits for occupation are issued by the competent building authorities.

With regard to the organization and structure of building undertakings, it should be noted that before the second world war Hungarian building was done on a craft basis. Only a few undertakings in the whole country regularly employed more than 1,000 persons. There was practically no mechanization or production of prefabricated components. Building began to move forward with nationalization in 1948. Most progress has been achieved in the erection of industrial buildings using prefabricated components.

Nationalized building developed fast. In 1957 it accounted for about 80-85% of total building capacity. The nationalized sector comprises all undertakings working under the Ministry and the organs of the Council, and the special building services maintained by undertakings and institutions. The undertakings under the Ministry erect industrial and agricultural buildings, communal buildings and housing of national importance. The undertakings in the sector working under the direction of the councils deal with lesser work on new building, renovation and repairs. The sector directed by the councils comprises about 15% of the nationalized building capacity. The capacity of the special services maintained by undertakings was about 20-23% of the total building capacity in 1957. Smaller construction work for private persons and public bodies, not requiring very ample technical equipment, is carried out by co-operatives, accounting for about 5% of the total building capacity. Private craftsmen, whose capacity is twice that of the co-operatives, work solely to fill the need for new buildings and repairs ordered by private persons.

(c) Mechanization

One of the striking points about modern building is the high level of mechanization. This was developed in Hungarian building after the nationalization of the building undertakings. At the end of 1954 nationalized buildings had a machine pool of 120,000 h.p. or 1.1 h.p. *per capita*. The heaviest work was mechanized at that period (see tables 2 and 3). The equipment then comprised about 300 earth-moving machines, 15,000 concrete mixers, 1,000 cranes and 300 belt conveyors. Smaller machines which can be used on medium-sized building sites for composing aggregates (mechanized mixing shovels) have recently been introduced. Not much has yet been done, however, to mechanize bulk loading.

Under the present provisions for the technical improvement of building, the following three objectives must be achieved by increased mechanization: (1) the requirements must be met for new machinery suited to modern building methods and the manufacture of new structural components; (2) a pool of machinery must be set up suited to traditional methods, one part of which might also be used for the new methods; (3) machinery must be built for operations which have not yet been mechanized.

To fulfil the purposes of technical development, building sites must be supplied with the carrying, loading and hoisting machinery required for building with small and medium sized components and with hollow concrete. This entails not only manufacturing or buying new machinery, but also modernizing available machinery. Another important need is to supply light travelling machinery which does not require expensive carriage and mounting (self-propelling cranes, self-propelling rapid hoists and the like). In mechanizing earth moving one of the first things to be done is to supply fairly small building sites with machinery of suitable capacity and mobility. The mechanization of finishing work should also be mentioned. Hitherto almost all such work has been done by hand, but experience has shown that output could be considerably stepped up by suitable mechanization at comparatively small cost. Such investment can be speedily amortized.

The building industry is complex and employs a large variety of machines, which are not necessarily in use continuously and at the same time. Organizing methods have therefore had to be found to lengthen the time during which the machines are at work. Hence undertakings ought to keep on their inventory only the equipment which they can be certain to operate themselves. It would be desirable if equipment of which equal use can be made only by a group of undertakings were handed over to a hiring concern organized specially for the purpose. Most of the machines used in structural work are therefore owned by a hiring concern which lets them out at the request of the building undertakings for a period fixed in advance and for an agreed hire.

Specialized undertakings are responsible for repairing the machines. These undertakings, however, deal only with renovation, since each building enterprise has its own service for minor repairs within its vertical structure.

(d) Standardization

The principles for standardization were defined in Hungary by an order of the Council of Ministers in 1944. One year later a building section was set up in the Bureau of Standards to work out basic concepts and specifications and standardize materials and commodities for structures and equipment. Nearly 1,500 building standards were issued between 1950 and 1957 relating to most building products and components ranging from raw materials for grindstones, cement, lime, semi-finished materials, bricks, concrete blocks, tiles and asbestos cement parts to complex components such as electrical installations heating units, external and internal wooden and steel joinery and the like. A parallel process of rationalization is under way for planning instructions, regulations for the organization and execution of building, particular lists of specifications, and regulations as such. As in most eastern European countries, the type plans, which are of particular importance, include both type plans for structures and type plans for sections or entire buildings. Dimensional co-ordination has been very thoroughly studied since 1950 and has led to the production of a 10 cm base module and a 40 cm preferential multiple. Work is at present under way on the very exact delimitation of the scope of standards, instructions for design and type plans, and on revising standards already issued which have proved in practice to be of little use.

(e) Introduction of new materials

(f) Development of traditional materials

Owing to the increase in building, improved methods and efforts to reduce costs, new materials have had to be used extensively and traditional materials developed. Widespread use of new materials is unlikely in the near future, but research and experiment on their production and use are under way. On the basis of experiments, these materials may come successively into wide use if produced in sufficient quantity. The question of costs must of course be related to that of use. It is especially necessary that the cost of prefabricated structural components be lowered; on a national scale, in particular, there can be room for economy only when the cost of these materials can be lowered and only so far as this reduction can balance any larger expenditures caused by their use.

Particular attention should be given, so far as research and use are concerned, to reducing requirements of raw materials, shortening haulage distances, recovery of waste, use of disused materials, and reduction of costs.

Hitherto, solid or perforated clay bricks have generally been used in Hungarian building. Mass production and the use of hollow bricks is now contemplated. Research into brick-making is being conducted. Equal resistance with better insulation and a weight reduction by two-thirds, can be obtained by adding pulverized fuel ash. The manufacture of sand-lime bricks, and in particular perforated bricks, is proving very useful in areas where there is little clay. Earth bricks bound with lime are used for smaller rural buildings. New stone-cutting machines are making it easier to work facing stone more economically. Foamed slag, granulated furnace slag, pulverized fuel ash and expanded clay are used in panel building.

Expanded perlite seems to be widely used for insulation. The requisite raw material is abundant. An insulating material of peat, for which good-quality raw material is available, has been produced successfully to replace imported cork.

The production of white Portland cement and high initial-resistance cement, long demanded by the building industry, is to be resumed. There are plans for manufacturing vitrified ceramic slabs to remedy the shortage of facing slabs; they can be made thinner, only one-half or two-thirds the normal thickness.

Research is also being conducted into more practical and economical use of traditional materials. The important need here is to find and record deposits of local materials and determine the technical conditions for their use.

Table 1

Distribution of technical staff engaged in building and in the planning office, by profession

Year : 1955

Profession	Nationalized building	Nationalized planning offices
Engineers		
Architects	551	942
Surveyors	5	20
Hydraulic engineers	33	92
Highway engineers	110	296
Mining engineers	5	46
Qualified mechanical engineers	186	1115
Electrical engineers	15	133
Civil engineers	351	819
Others	149	260
Technicians		
Architecture	1777	876
Machinery	327	522
Installation	36	..
Electricity	87	133
Other occupations	603	747
Industrial draughtsmen	215	1211

Source : 1949-55 évi Statisztikai Évkönyv/Statistical Annual, 1949/55, p.142.

Table 2

Mechanization of main work

(%)

Year	Earth moving	Preparation of concrete	Preparation of mortar
1952	36.1	80.9	40.6
1953	37.1	83.2	55.2
1954	47.9	72.0	51.9
1955	47.4	73.3	42.3
1956	50.5	79.3	48.4

Table 3

Number and capacity of main machines in pool of building enterprises and hiring enterprises

Situation at end of 1956 and 1957

Type of machine	1956		1957	
	Units	HP	Units	HP
Various tower cranes	82	3350	93	3483
Other cranes	906	6894	998	9735
Excavators	98	8919	130	10586
Bulldozers	5	186	...	..
Mechanical grabs	63	5070	72	5294
Ditchers	10	612	11	548
Concrete mixers	1750	12434	1883	12263
Vibrators	4412	5857	4221	5621
Mortar mixers	658	3500	644	3315
Belt conveyors	3171	10911	3190	10082
Narrow-gauge locomotives	186	5725	168	5207
Steam rollers	318	8797	338	8995
Compressors	717	32337	890	31744

Source: 1949-55 évi Statisztikai Evkönyv/Statistical Annual, 1949/55, p.143.

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.(s)
14 April 1959

Original: ENGLISH/FRENCH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE BUILDING COSTS

National monographs

FRANCE

1. Relative importance of traditional and non-traditional methods of house construction

The French building industry has gradually adapted itself to a housing programme which has been expanding rapidly for the last ten years, although the number of workers employed has not risen in proportion to this steady increase.

Thus, according to the figures given by the Contractors' Federation (Fédération des Entrepreneurs), the number of wage-earning workers was 500,000 in 1950; 575,000 in 1955; 651,000 in 1956 and 670,000 in 1957, while the number of completed dwellings rose from 71,000 in 1950 to 210,000 in 1955, 236,500 in 1956 and 273,700 in 1957. It should be noted, however, that housing standards have changed in the meantime, that in 1950 a far greater proportion of the industry was certainly engaged in carrying out repairs (war damage) than in 1957, and that it is difficult to estimate the total effort of the industry merely from the number of dwellings completed.

It can, at any rate, be stated that there has been a marked improvement in the general output of the French building industry and that this progress is not so much due to the development of a pre-fabrication industry as to a steady movement on the part of firms towards rationalization of traditional building techniques. France, however, has been the scene of many experiments in industrialized building since the last war and even from about 1930. The Government has not only supported, but has assumed responsibility for, many and various efforts to help develop new techniques.

At the end of the war in 1944, a large-scale competition was launched by the technical services of the Ministry of Construction to encourage the development of industrialized processes for various building operations. An experimental housing estate was established in 1945 at Noisy-le-Sec where comparisons were made of numerous prototypes manufactured both in France and in various other countries (United Kingdom, United States, Scandinavia, etc.).

In 1947 and 1948 a series of experimental housing schemes was launched - with arrangements for the appraisal of results similar to those on United Kingdom sites of the same period - each scheme consisting of fifty dwelling units, generally detached or semi-detached houses, but in a few cases of rows of two-storey terrace houses.

In 1949 a competition was held for the erection of blocks of flats (Villeneuve St.Georges), five-storey houses (Creil) or detached one-family houses (Chartres). After this competition, known as the "200 dwelling competition", because each scheme was for that number of units, a large competition was organized for the rapid erection of 800 dwelling units at Strasbourg (1951).

These experimental building sites, directly due to the initiative of the Ministry of Construction, facilitated the steady evolution of various processes of prefabrication or mechanized construction. Side by side with those at the regional level, other experiments such as the prefabrication of walls and floors for the reconstruction of St. Malo, the first use made of large panels in house-building schemes at Le Havre and an experiment in the prefabrication of complete window-frames at Orleans, were conducted with some local successes but without leading to any major industrial application on a national scale.

The "industrialized" sector was set up by an Act of 24 May 1951, its establishment, incidentally, being inspired by one of the earlier recommendations of the Housing Committee. By spreading the work over annual batches of 12,000 to 15,000 dwellings this programme produced a volume of output that hardly ever fell below 600, was very often more than 800 and could exceed 1,000 dwellings. It made possible the wider use of some prefabrication processes but was not confined to prefabrication. Experience in this sector, the main idea of which was based on the thorough study of specifications and the organization of the building site, demonstrated the need for careful preparation of work, for a steady succession of schemes covering a large number of buildings and the importance of the building capacity and, more particularly, the equipment of firms. Although based on the principle of uniformity of planning and construction by a single team, this special programme, known as the "Paris area 4,000 dwellings scheme", might be assimilated to the industrialized sector and was one in which prefabrication processes for producing heavy components in a permanent factory at Montesson were employed. The results of this heavy component prefabrication have aroused some interest but it is too early to pass objective judgement on them.

1954 saw the launching of a new scheme, the purpose of which was to build family houses costing less than 1 million francs (or 1.2 million francs in the Paris area). Most of the 600 schemes thus completed, comprising a total of nearly 50,000 dwellings, formed the subject of a competition, embracing planning and execution, in which architect and builder were closely associated from the outset.

A competition in processes for saving skilled building labour, held in 1956, provided an opportunity for taking stock of the prefabrication or industrialization techniques actually on the building market. Twenty-one processes regarded as already sufficiently developed were selected to be used on moderate-rental housing (HLM) schemes comprising between 200 and 1,000 dwelling units.

Government efforts to foster the establishment of a new building industry and create conditions conducive to a lowering of costs have thus been considerable and, despite occasional flagging, lasting. Their example has been followed by many persons connected with building - architects, engineers and contractors - who have made a number of experiments, several of which had an undoubted technical value and were found of practical use <u>in situ</u>.

Special consideration has to be given to processes covering a large field of building work, since partial prefabrication has analogies with the production of standard materials or units (joists, facing panels, lintels, etc.).

Large-scale projects have, of course, been carried out by prefabricating walls, floors, partitions, landings, flights of stairs, etc. in a permanent factory. These are used in multi-storey concrete constructions; at the outset their height was limited to 4-5 floors but experiments are now being made with 13-storey "tower" buildings. Factory-cast panels include the fixing devices for various fittings and the surfaces are generally finished off, with the exception, in certain cases, of a light coating to be applied to the interior surfaces. The factory usually delivers within a radius of about 30 kilometres. Panels are joined by pouring concrete into grooves left between them. Other construction techniques using large panels, in which the concrete is replaced by clay elements, which are much lighter and easier to adapt to the needs of various schemes, are now being widely practised.

Six systems are at present being operated in France on the lines which have been briefly sketched above, four of them using concrete and two clay. As the cost of setting up the factories is fairly high, they must be assured of a sufficient volume of production of highly standardized projects within their sphere of action. After the preparations necessary for setting up the factory, housing can be produced very quickly.

In addition to these processes other techniques are being used which do not necessitate such major equipment or permanent installations. A concern engaged in prefabrication may manufacture elements in a travelling factory or in a workshop <u>in situ</u>. These elements may be less completely finished than in the cases mentioned above, but they are often sufficiently complete to permit a considerable reduction in finishing work. Special equipment is needed: moulds (automatic or other), concrete heating apparatus, and handling devices which can, however, be moved from one large site to another. The elements manufactured are large or medium size and prefabrication may be combined with operations carried out on the site, such as the pouring of floor slabs in individual frames.

Other types of prefabrication are used to produce small units, floor or wall blocks, in combination with floor elements, staircases, etc. Much research has been done in the field of small scale prefabrication, which may be carried out by either of the methods used in the prefabrication of heavy units: production in a permanent factory or on the site. In the case - which is fairly frequent with concrete blocks - where there is a central factory, its sphere of action, however, may be fairly wide. The weak point with these types of prefabrication has lain in the fact that it is generally only the main structure which is prefabricated, the interior structure being completed (finishing and fitting) in the conventional way, except for improvements to a few details. Apart from concrete blocks and reinforced concrete or pre-stressed joists, the prefabrication of such light units does not seem to be increasing, although three or four methods are being used successfully by some well-equipped but rather small firms.

Another trend in prefabrication in France is the construction of metal houses for which the main structural units, framework, facing panels, floors etc., are prepared in the factory. This technique has been made possible by new methods of protecting sheet iron. It does not require very big capital investment and permits rapid assembly and the use of standardized interior equipment owing to the precision with which the main structure is manufactured. For a number of reasons this trend is not increasing, despite the advantages of metal for prefabrication.

It is, unfortunately, seldom possible, on the basis of the observations made, to evaluate the results obtained by these various methods, the last of those described being only methods of partial prefabrication. In some cases there seems to have been some saving on the cost price of conventional construction, but some of the industrialized sites have not yielded the results anticipated. It depends entirely on the conditions governing the amortisation of the equipment, on the length of the job (continuity) and on how far a job can be simplified and repeated. In the best cases skilled manpower is greatly reduced or, rather, traditional skills are replaced by others which are easier to acquire. This is a most important economic and social factor.

From a purely quantitative point of view, it may be said that the volume of work done by prefabrication methods has, on the whole, remained very limited. A recent survey made by the _Fédération parision du batiment_ (a member of the _Fédération nationale du batiment_) demonstrates this clearly, establishing as it does that the number of cases in which prefabrication methods were applied to the main structure rose from 10 to 16 per cent in 1957. This proportion, however, applies both to buildings partially prefabricated and to buildings wholly prefabricated, to prefabrication done on the building sites as well as to prefabrication done in the factory.

Taken by itself, the type of prefabrication described by some people as "highly industrialised", i.e. that in which the factory plays the main role and which bears most resemblance to a new branch of industry with its own fixed capital and characteristic methods, shows only slight development. This new type of building industry accounts in final analysis for only 2 or 3 per cent of the whole. While 2 or 3 big manufacturers of prefabricated materials have been relatively successful, as a result, incidentally, of constant official support, one can even detect a trend in the opposite direction towards the development of processes applicable _in situ_ without setting up permanent workshops.

Thus the building industry has remained largely conventional in type, though this, as will be shown later on, is far from meaning that it has not evolved. It has, in any case, benefited very greatly from the various ventures in prefabrication and rationalization made outside or inside its own borders.

2. <u>Progress made towards rationalization of building construction</u>

(a) <u>Technical qualifications of personnel</u>

It would be useful to ascertain more or less exactly another factor which largely determines to what extent firms are technologically efficient: namely, the ratio of technical personnel (supervisory staff and technicians) to the total number employed in the building trade. From information supplied by the Contractors' Federation (<u>Fédération des Entrepreneurs</u>), this proportion would seem to have remained fairly constant from 1950 to 1955 - the figure would appear to be about 4.5 per cent but a more detailed analysis would be useful.

The training of building workers is still largely based on semi-artisan methods of apprenticeship. In the matter of professional training reference may be made to the experience of centres for short courses of professional training. The Decree of 18 January 1949 set up a board of management ANIFRMO (<u>Association nationale inter-professionelle pour la formation rationnelle de la main-d'oeuvre</u>), which is supervised by the Ministry of Labour and has a governing body composed of employers and workmen from the trades or professions concerned and of Government representatives. The Association's technical services deal with questions of selection (Study and Techno-psychological Research Centre), the study of teaching methods and the training of instructors (National centre for the training of instructors). The building trades also take an increasingly active part in organizing short courses of professional training through their national committees (building and metals) which sit in Paris, their specialized national committees, which are an offshoot of the above-mentioned committees, and also through the sub-committees in the various départements. The students, after passing a medical examination and a test of their mental and technical qualifications, are given six months professional training which enables them later in their respective posts to qualify very quickly as skilled workmen.

Though more detailed information is lacking it can, nevertheless, be said that the proportion of supervisory staff and technicians has, on the whole remained constant, as a result of the growth of technical schools and training centres.

(b) Organization of building operations

French building firms have made no changes in their organization or methods but they have had to adapt themselves, without losing their traditional characteristics, to the needs of new building programmes. Spurred on by the need to cope with a larger volume of demand, sensitive to the spirit of research and renovation that actuates the prefabrication engineers and producers of materials, and following in the wake of the other branches of industry from which it obtains its supplies, the conventional type of firm has gradually evolved and it is the broad lines of this slow but real evolution which characterize the present situation in the building industry from the technical point of view.

It is, unfortunately, difficult to discern accurately the factors contributing to improvement as seen by the impartial expert, but there can be no question that the measures adopted to regulate the building market have borne their first fruits and that some progress has been made in the organization of undertakings. The introduction of organizational principles among all sections of an undertaking has been helped by the energetic propaganda carried on by the public authorities and professional bodies, by the increased stability of the industry, achieved while retaining the competitive system, and by the impact of a somewhat uneven, but in the last resort, continuous expansion. This trend has been encouraged by a certain tendency towards concentration or more exactly towards an increase in the average size of undertakings; it has not yet resulted in a reduction in the number of firms but in an increase in the number of workers engaged. This increase is much more marked in medium-size and large-size undertakings than in small ones (from 1950 to 1955 the number of workers in firms with fewer than 50 workmen rose by 24%; in those with 50 to 100 workmen by 84% and in those with more than 100 workmen by 64%). It is easier to organize labour in large or medium-size undertakings than in small ones.

In this connexion, it is of interest to establish a relationship between the structure of demand as defined in terms of the size of house-building operations and the output capacity of the building industry. On the first point valuable information can be obtained from Table 1 which is taken from a study recently made at the request of the Ministry of Construction.[1]

(1) Report No. 5 of the Working Party for the study of the industrialization and augmentation of productivity in building (multigraph document), Paris, 4 December 1958, page 82.

(c) Mechanization

The French Government's reply gives fairly detailed but incomplete information on the equipment stocks held by firms. The mechanization of building is one of the chief features of the present development of this industry and is an important factor in its progress. The information supplied, however, does not differentiate between building and public works and refers mainly to heavy equipment. Moreover, the expansion of equipment stocks in France cannot be adduced with precision as statistics have only been available on the subject since 1954. However, the statistics produced by the Commissariat Général aux entreprises de travaux publics et de bâtiment show that some 20,000 million francs are spent annually on the purchase of equipment and parts, an annual investment of about 25,000 French francs per worker. The list of machines and tools which make up the equipment stocks serves mainly to bring out the number of large machines and of the special machines used in certain civil engineering operations. It should, at least, be completed, particularly as regards low-powered cranes and concrete mixers holding less than 750 litres.

The bigger undertakings apparently have large quantities of material which can be used both for public works and for building and they are often well equipped for erecting large buildings and for certain types of heavy prefabrication. It is, however, impossible to get a proper idea of the actual extent of mechanization in the building industry as a whole. To judge from the comments received, the equipment, although appreciably increasing on the whole, is still inadequate in the medium-size undertakings and even more so in the small ones, particularly those operated by master tradesmen who are still plentiful. In the latter sector a special effort may be discerned but it is beset with technical and financial difficulties and is still embryonic; it is infiltrating solely among the smaller builders, a fact which makes it all the more important to follow this trend over a longer period.

(d) Standardization

Theoretical work on standardization has a long history in France. Many difficulties, however, have impeded its implementation - the fact that architects have too free a hand, the irregular flow of orders, the scepticism of undertakings - frequently only too well founded - and the excessive individualism prevalent among all sectors of the building industry. Progress has, however, been achieved in the work done in recent years - architects are coming more and more to recognize the need for modulation and the trend thus initiated has been strengthened by official requirements, chiefly through the adoption of standardization for economic and social housing and low-rental dwellings and also by the action taken by some manufacturers of building materials and construction units. Recent years have been marked by some practical achievements such as the standardization of doors and some interior fittings for which large-scale orders have been placed, with a consequent drop in prices. Concrete blocks with gravel or light-weight aggregates have recently been standardized as a result of the work done in 1956 by the Centre scientifique et technique du bâtiment (CSTB). Modular co-ordination on a 10 cm. basis is being adopted more widely, but research into larger modules viz. multiples of 10 cms, which requires agreement among manufacturers, builders and architects, has been tackled in the form of an international survey made under the aegis of the European Productivity Agency. The public services have for the past year been engaged in negotiations for the standardization of exterior wall panels. There is, therefore, some sign of a brake being applied to the inordinate diversity of building plans and this seems little by little to be making headway, thus contributing to the gradual rationalization of building.

The above paragraph deals only with dimensional standardization. The standardization of quality, i.e. the unification of the technical specifications applicable to parts and to the actual materials has become very widespread, either by way of national standards or through the specifications issued by the Ministry of Construction, or lastly, as a result of the effort to co-ordinate technical texts made by some leading architects in close co-operation with research institutes. Both public and professional bodies have greatly enlarged their field of action and thereby facilitated the checking of quality and the better planning of work.

(e) Introduction of new materials

(f) Development of traditional materials

Firms of both the conventional and the non-conventional type have profited by the results of technical and industrial research, even when they have adhered to traditional methods. They have, in fact, had new resources at their command in the shape of the now numerous materials produced by other industries to meet their requirements. These materials have been introduced only gradually, and their use is still far from general. Attention may, however, be drawn to the introduction in masonry of concrete blocks made of light weight aggregates (pozzolana or expanded slag), aerated concrete blocks, special types of bricks (with interrupted joints) and large size clay blocks (these are still rare). Considerable use has been made of plastics in floor coverings, and recent statistics from the Contractors' Federation show that in the Paris region their sale covers about one third of the total surface of floors constructed - a quite substantial development. Plastics are also used for pipes, thermal insulation material, light and transparent roofing materials, protective coatings (especially for plywood) and paints. The reinforced plastics are not yet, however, employed for structural components, but it is not unlikely that a use will finally be found for them after the requisite research and adaption. Some use has been made of converted, plasticised and reconstituted woods and timber derivatives for partitions, linings and insulating walls; fibre glass (plasticised or not) and rock wool have been widely used for insulation. Certain metals have also been introduced - aluminium alloys for roofing, curtain walls and joinery and thin steel sheeting with special protection against corrosion (a new development made possible by the continuous production of galvanized steel sheeting, known by the trade name of "galvaband").

In the building industry as a whole, many uses have already been found for these new materials, but they are not yet generally employed on a wide scale. They have, however, played their part in conferring "a new look" on building work. The foregoing list has, of course, been hastily assembled and is very summary, but one striking fact should not be overlooked: the widespread use of concrete and concrete blocks, despite the modernization of the older materials (quarry-cut stone and new types of bricks). The above-mentioned survey of the Paris region shows a high proportion of concrete blocks being used; for load-bearing walls 45%, for framed buildings 40%. At the same time, firms adhering to conventional methods have used many partially prefabricated pieces, more especially prefabricated joists and hollow filling blocks or plates for floor construction - processes which have now become usual.

In conclusion, it may be of interest to note, purely as an example, that the turnover figures of various manufacturers and constructors for new materials and processes recognized by the Centre scientifique et technique du bâtiment are in the region of 100,000 million francs.

Table 1

Volume of building operations, in terms of building permits

Some remarks on the regional concentration of operations in terms of their size should be supplied to complete the figures shown in this table. Thus, 34% of construction work on units of from 150 to 500 dwellings and 54% of construction work on units of more than 500 dwellings are in the Paris region, which comprises 23% of the housing constructed in France. On the other hand, construction work on units of less than 50 dwellings, which represent 57% of the national total, predominates in the départements (85%) and amounts to only 37% of building activity in the Paris region.

It is harder to supply figures for the production capacity of the building industry. An analysis of the size of firms is given in Chapter III of the report; to put the problem simply, firms can be grouped according to the size of their labour force or the degree to which they are organized and annual global requirements by type of operation can be correlated with the sectors or methods of production thus defined. Table 2, which is also taken from the above-mentioned study, shows the results of such a comparison.

Table 2

Structure of demand and production

Such a correlation is not, of course, absolute; it is, nevertheless, true "that there is a normal level which can be expected of undertakings, based on their capacity to cope with the volume of operations undertaken".(1)

It should not be forgotten either, in making a study of building organization, that the construction or maintenance of housing (excluding rural housing) represents only about 60% of the total activity of the building industry and only 2/3 of this activity is devoted to new construction.

(1) Report of the Working Party, No.5, op. cit. pages 104 and 106.

Table 1

Volume of building operations in terms of building permits

	Size of units (annual programme)	Building operations			Housing units (thousands)				Average Value
		H.L.M. for renting	Others	Total	H.L.M. for renting	Others	Total	%	
High density	500 and over	8	9	17	5,0	7,8	12,8	4	753
	150 - 500	36	90	126	8,0	23,3	31,3	12	248
	50 - 150	347	620	967	25,-	47	72	27	74
	Total: over 50	391	719	1.110	38,-	78,1	116,1	43	105
Low density	10 - 50	(400	2.100	2.500	15,6	38,4	54	20	22
	2 - 10	(-	9.000	9.000	-	24,3	24,3	9	3
	Detached houses	-	75.600	75.600	-	75,6	75,6	28	1
	Total: less than 50	400	86.700	87.100	15,6	138,3	153,9	57	1.8
	Grand total	791	87.419	88.210	53,6	216,4	270	100	3.1

Table 2

Structure of demand and production

DEMAND					CORRELATION	PRODUCTION	
Scope of operations	Global number of units, in housing units	"Staggering" and annual rate of output	Total length of time scheduled	Annual amount in 1957		Estimated annual capacity	Structure and method of production
Very large-scale operations	2.000	4 x 500	4 yrs	13.000		63.000	Highly industrialized production - Advanced prefabrication - Equipped and rationalized building sites (specific equipment)
Large-scale operations	300 - 2.000	3 x 150 - 500	3 yrs (2 - 4 yrs)	31.000			
Medium-scale operations	50 - 300	2 x 50 - 150	2 yrs	72.000		84.000	Average production: - Organized and well-equipped firms
Small-scale operations - minor local authorities - small groups - individual dwellings	10 - 50 1 - 10 singly	1 batch	1 yr	154.000		80.000 60.000	Small production: - Average firms - Small firms, co-operatives or "artisan" groups - Master tradesmen
TOTAL				270.000		287.000	

Distr.
RESTRICTED

HOU/Working Paper No.97 Add.(t)
22 May 1959

Original: ENGLISH

ECONOMIC COMMISSION FOR EUROPE

HOUSING COMMITTEE

(Item 6 of the provisional agenda of the eighteenth session)

EFFECTS OF GOVERNMENT MEASURES DESIGNED TO PROMOTE THE TECHNOLOGICAL DEVELOPMENT OF THE BUILDING INDUSTRY AND REDUCE HOUSING COSTS

National Monographs

BULGARIA

1. Relative importance of traditional and non-traditional methods of house construction

The latest figures available show that in 1956 over 1,700,000 m^2 of dwelling floor space were built in Bulgaria. This represented more than twice the volume of dwelling construction as reported in the years 1951 - 1952.(1) The fact that this considerable increase coincided with a net decrease of employment in the construction industry (82,000 employed in 1953 as compared to only 59,000 in 1957) may partly be accounted for by a shift of building activity from industrial to dwelling construction. Over the same period the production of building materials has steadily increased at a rate varying between 15 to 30 per cent according to the material concerned.

Dwellings erected in Bulgaria are mainly of a traditional type. This is partly due to the fact that Bulgaria still has one of the highest proportions of rural population of all eastern European countries (75 per cent in 1946 and 66 per cent in 1956).(2) One should also recall the fact that the percentage of dwellings built by private persons, with or without state aid, has gone up considerably in the last five years. In 1956, only one quarter of the dwellings erected were built by the State and less than 0.2 per cent by cooperatives. The volume of private house building, particularly in rural areas, is extremely high; housing policy throughout the post-war period has favoured on a large scale individual housing in accordance

(1) See "Annual Bulletin of Housing and Building Statistics for Europe", ECE, Geneva, 1958

(2) See "Financing of housing in Europe", ECE, Geneva, 1958 (E/ECE/328), p.37.

with a national tradition of home ownership in urban as well as in rural areas.

It is only recently that non-traditional methods of house construction have been systematically introduced, although different types of precast concrete construction were used as early as 1949. The main trend in the use of prefabricated construction is the replacement of traditional methods of construction by reinforced concrete structural elements for floors, roofs and staircases. Load-bearing walls built with bricks are still the most usual method of construction; but a variety of types of precast beams, trough-shaped floor elements or hollow slabs are gradually introduced for the horizontal members of the structure. The average weight of these components, most of which are room-length, varies between 200 and 1,500 kilos according to the width. Precast concrete steps and flights of stairs are also frequently used to replace traditional construction. It was only in 1958 that the Academy of Sciences sponsored the construction of a 4-storey experimental building incorporating the use of large panels of slag concrete; other experimental buildings are at present under way.

Precast concrete components are made either on the site in temporary work shops whose equipment is determined by the volume of the investment required, or in permanent plants. In 1955, eight field shops were built, with a total planned capacity of 80,000 m^3 of precast concrete components. The plan envisages that 100,000 m^3 of prefabricated concrete elements for house construction will be produced in 1965. Two-thirds of this volume will be represented by precast floor elements for the equivalent of 830,000 m^2 of floor area, in dwellings with brick load-bearing walls and precast roofs and staircases.

2. Progress towards rationalization of building construction

(b) The organization of house building

The general organization of house building follows the pattern of most other eastern European countries. The housing programme, part of the annual state plan, is adopted by the State Planning Commission and ratified by the Council of Ministers. Houses, according to their type, location or source of capital, are built by different organizations. State, public, collective and cooperative housing is carried out by specialized state building enterprises or by industrial labour building cooperatives. Individual houses can be built either by their owners, by state building enterprises or by the industrial labour cooperatives and the building brigades organized by the agricultural labour cooperatives. Members of agricultural cooperatives obtain most of the local basic materials at prices which are 30 to 40 per cent lower than current prices. This, together with the great share of unpaid voluntary labour, accounts for the low cost of rural dwellings. The Ministry of Building and Building Materials has separate administrations carrying out building for all types of construction in the country; while local building organizations attached to the Ministry of Communal Economy, Public Services and Communications execute state housing on a local basis. Lastly a special building organization, "Sofstroi", has recently been set up for collective and cooperative housing in the capital town.

(c) Mechanization

Efforts towards the mechanization of building operations have been mainly concentrated on the result of vertical transport and bulk excavation. The handling of precast concrete components which are increasingly used on house building sites has required the introduction of different types of machines; thus apart from light elements (up to 230 kg) which can be assembled by hand, elements of up to 600 are transported vertically by winches or cranes and horizontally by wheel carts. Elements up to 2 tons require the use of special equipment and tower cranes. As a rule the machines belong either to the building enterprises or to specialized organizations who hire them to the contractors.

(d) Standardization

Standardization measures are an integral part of the overall state plan for economic development. The Institute for Rationalization and Standardization created by the State Planning Commission is responsible among other things for preparing annual plans for standardization, for examining, promulgating and publishing the standards prepared by the Standardization Committee (UKS), and for keeping a card index on technical subjects (SOTO). The responsibilities for standardization are also shared by the State Committee on Building and Architecture, which promotes through its Institute for Type Projects and Industrialization the establishment of standards in the field of building. The Committee is in particular responsible for bringing to the attention of the Project and Building Institutes new accepted standards prepared by the Institute for Rationalization and Standardization mentioned above. The technical departments of the State Building Organizations also contribute to standardization work in the form of systematic research into new methods of building and building technology in general. They also take into account the specific requirements of the building materials industry which requires standardization for the mass production of its components. The basis for the dimensional coordination of standards in Bulgaria is the 10 cm module which has already been adopted in most eastern European countries.