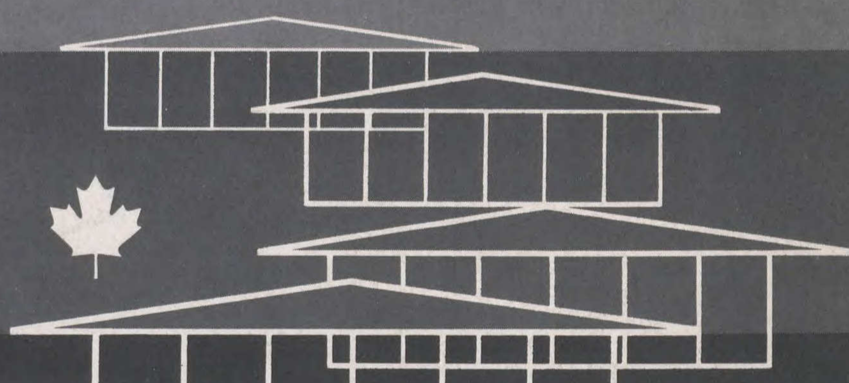
Technical Report

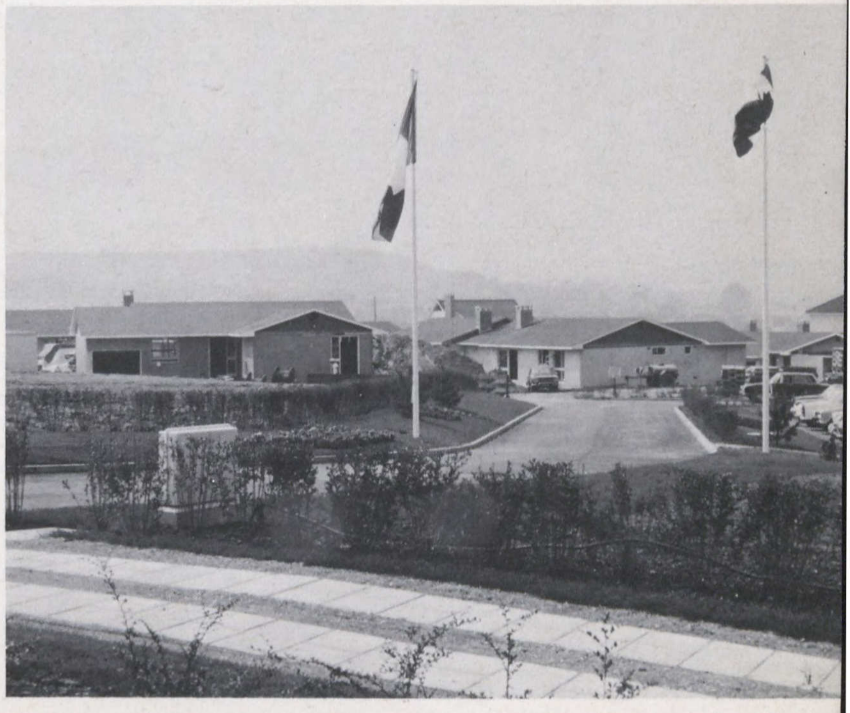
The Igny Project-
Parc des Érables

Canadian Timber-frame Housing in France



Canada. Dept. of Industry, Trade and Commerce.

IGNY Technical Report



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INTRODUCTION

During the last decade the Canadian government through its Department of Industry, Trade and Commerce and its predecessor, the Department of Trade and Commerce, has noted the needs in Britain and Western Europe for housing and for construction techniques and materials which would enable homes with a high degree of livability to be erected economically, quickly and in all kinds of weather. Believing that the Canadian timber-frame house building system offers a competitive solution to these requirements, the Canadian government initiated projects to demonstrate the viability of the system in various environments. The Igny project near Paris was one such demonstration, a successor to the previous Harlow project in England, and provided an opportunity to monitor the operation to obtain meaningful information on progress and results.

The Igny project resulted from an intergovernmental agreement that such a demonstration would be mutually beneficial to the peoples of France and Canada. The decision was based on conclusions of housing authorities and businessmen visiting back and forth between the countries and on a feasibility study on preferred ways and means of proceeding. While the projects in England consisted of row housing of a type required for local authority housing schemes it was concluded that a useful and complementary project would demonstrate timber-frame in single family, owner-occupied units for which there is a rapidly growing demand in France.

A prime objective of the Canadian government was to acquire technical data toward a report to record the events of the demonstration with some interpretations and conclusions. To assure that the information would be comprehensive and complete, the builders contracted to meet the report's requirements. The costs generated by these requirements were recognized as extra to normal building expenses, e.g. keeping records in specific ways, being subject to public inspections, meeting criteria of performance and using desired techniques and materials, and were paid for by the Government of Canada. This was a new approach. The builders co-operated fully to extract and report the data relative to the hundreds of factors involved in making the Igny development a success.

Parc des Érables, as the Igny project is called, now stands with 114 houses of 10 styles completed in a fully landscaped setting. Many lessons have been learned and this report presents the technical information which has been recorded in the process. Similar information on non-technical factors may be available in future reports.

PURPOSE OF REPORT

The interest in Canadian timber-frame construction evidenced by the large number of technically oriented visitors to Parc des Érables indicated a widespread interest among European builders, architects and specifiers in studying the project in depth with a view to applying the techniques in other projects. This report will assist in relating this pilot project to practical everyday residential construction.

The report provides guidance based on experience in France and identifies, measures and accounts for experience over a representative grid of construction activities so that this Canadian building system may be assessed as to its viability in Western Europe.

SCOPE OF THE REPORT

In general, this report covers only technical aspects of the project and concentrates on those activities which make timber-frame construction different from methods conventional in France.

Although ground was broken on the project in December, 1969, and there had been two years of planning before that, the monitoring of construction did not start until April, 1970. Thus the report does not cover site planning nor development work in detail even though they are important in an assessment of results.

Similarly the legal, financial and marketing aspects are only dealt with as they affected actual construction.

The final refurbishing of the display homes before they were turned over to their owners was completed in June, 1971, but the construction of the project was practically finished in December, 1970. Some interior finishing and final landscaping was done in 1971.

The report deals with two phases of construction:

1. Display phase — six model homes were built, decorated ready for the June 12, 1970, official opening by cabinet ministers of France and Canada.
2. Production phase — 108 homes were erected and finished and 60 occupied by owners between June 12 and December 31, 1970.

Neither the Canadian government nor the joint venture contractors had arranged for detailed reporting by subcontractors. Information on their activities relative to the installation of electrical, plumbing and heating services was gained by observations of a resident engineer inspector and by voluntary comments.

An important part of the demonstration was the operation of a component plant, situated 30 kilometres from the site, which produced assembled wall and roof sections for erection on the building site. Representative activities at this plant were also monitored and are reported.

A pre-construction study showed that the cost of construction materials would likely be stable and variations would be known through published national indexes. As material costs were not expected to vary appreciably from estimates and their variations would not be significant, detailed reporting on that aspect was not made. As well, material costs vary with location, number of houses, time of purchase, delivery requirements, bills of material, terms, etc., which each contractor can readily establish for himself relative to his particular project. Conversely, there was a risk that labour productivity and costs could vary from estimates because of the workmen's unfamiliarity with the materials and techniques of timber-frame construction. An elaborate system of reporting and analysis of labour productivity was computerized and this aspect is dealt with in depth for activities peculiar to timber-frame construction.

Activities common to most methods of construction, such as excavating, concrete placing, grading and road building are only mentioned where deviations from the usual occurred. Similarly, overhead and administration costs are deemed to be the private business of the contractors and not important in an objective assessment of the system. Development operations and costs vary from site to site and respond to local conditions and contractors' experience so they are not dealt with in this general report on a construction method which really starts from the top of the building foundation.

PROJECT PLANNING

The Igny project was planned to be typical of a Canadian middle class housing development and large enough to average out experience and costs. Sufficient time was to be allowed for good readings on the productivity of workmen under different seasonal weather conditions and the project was to provide a solid basis for comparison of French and Canadian residential development, financing, construction and marketing methods. Planners felt Igny should be a significant demonstration of modern timber-frame technology and materials giving valid guidance to French and Canadian contractors and material suppliers. It was also hoped public interest in ownership of timber-frame homes would be stimulated by their aesthetic attractiveness and evident comfort.

Of prime importance to the whole project was the need that the Canadian timber-frame method of construction, together with necessary specialized materials, be accepted in France from the points of view of building codes, materials standards and mortgage financing. This was accomplished when the system, as described by the National Building Code of Canada (1965), was accepted by the French Centre Scientifique et Technique du Bâtiment (CSTB) as a "traditional" method of construction.

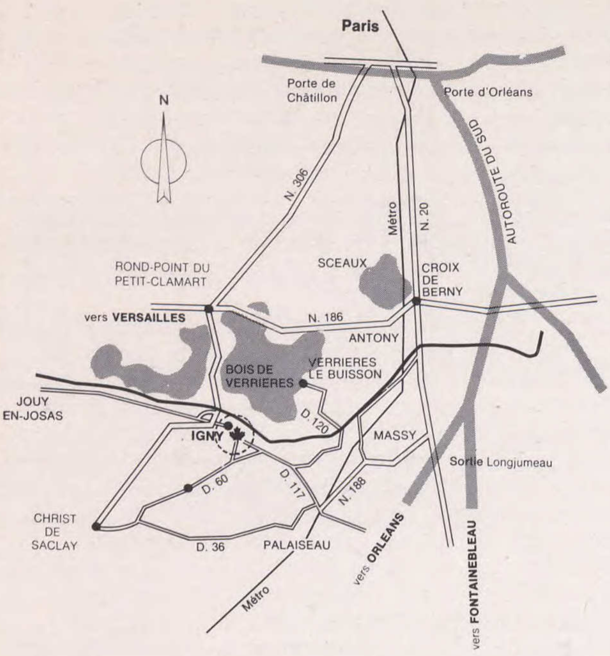
The CSTB will publish the national French version of the code prepared by Centre Technique du Bois (CTB) to be designated as D.T.U. 31-2 in January, 1972.

It was also necessary at an early stage to find a Canadian housing contractor who was interested in and capable of carrying out the project. Campeau Corporation Ltd. of Ottawa responded to the challenge and soon arranged a joint venture agreement with Société Dumez of Paris under the name of Dumez-Campeau S. A.

Another early decision was to make the development through the Société de Gestion, des Études et de Promotion (GEPRO), a member of l'Association Nationale des Promoteurs de Construction.

With the concept accepted and the operating groups organized, detailed planning was expedited. The previously completed feasibility and market reports indicated that, for best exposure, the project should be close to Paris and contain approximately 150 units.

MAP OF PARIS AREA SHOWING LOCATION OF IGNY



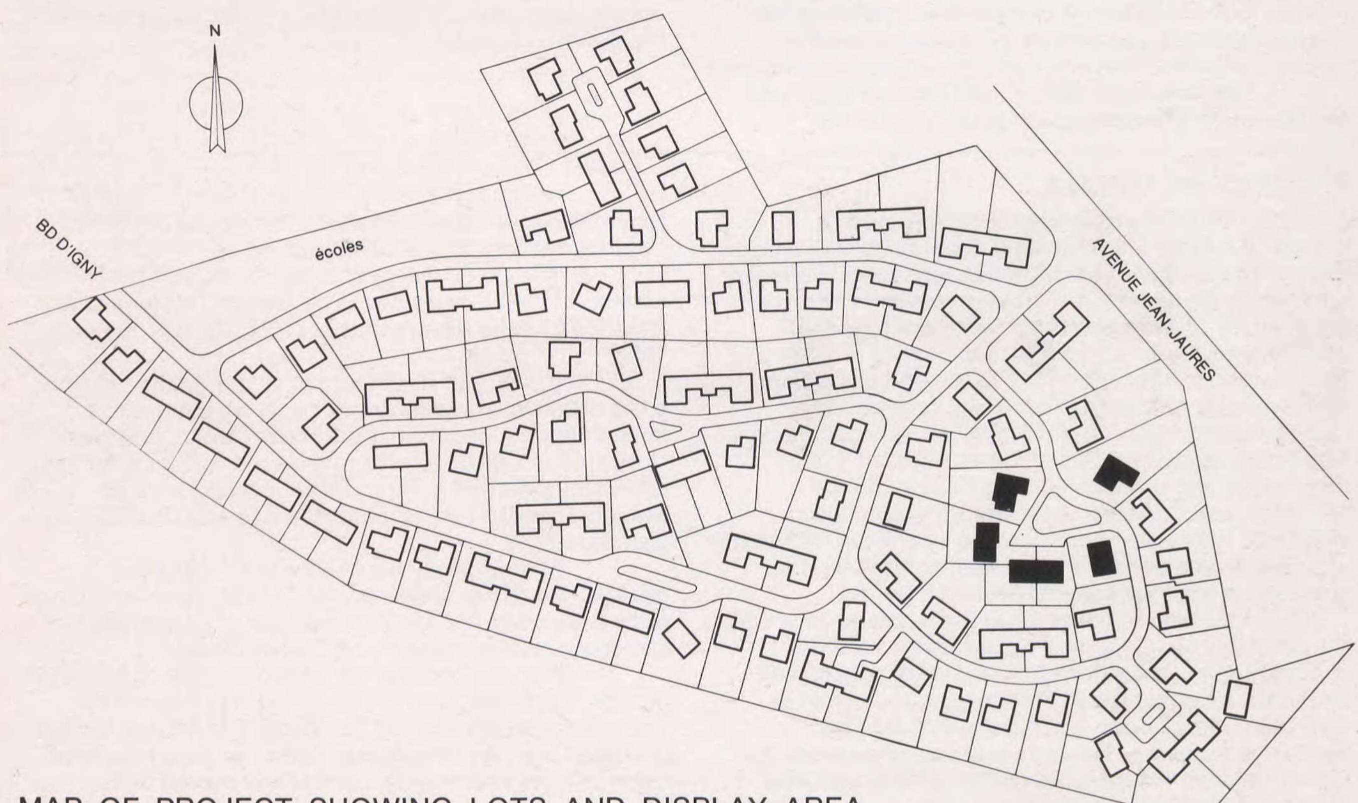
This led to the assembly of 24 parcels of land comprising 78,000 square metres on a sloping site near a main road at Igny, 16 kilometres south of Paris. When the area was acquired, French architects immediately began to work out a subdivision plan for municipal approval. The final plan, approved by the municipality, reserved 10 per cent or 8,000 square metres for roads and other public uses while the remaining 70,000 square metres were divided into 114 building lots. The lots varied from 300 m² for some double houses to 1,100 m² for a large single house for an average of 600 m² per lot. The result is a pleasant open appearance at an acceptable density per hectare. Concurrently with land assembly, the joint venture partners with their professional staffs, in consultation with French architects, were designing houses to fit the site and the selling prices indicated by the location, the incomes of prospective buyers and the requirements of mortgage financing by Crédit Foncier.

OTHER COLLABORATORS ARE NOTED IN THE QUOTATION BELOW

S.C.I. LE PARC DES ÉRABLES, IGNY

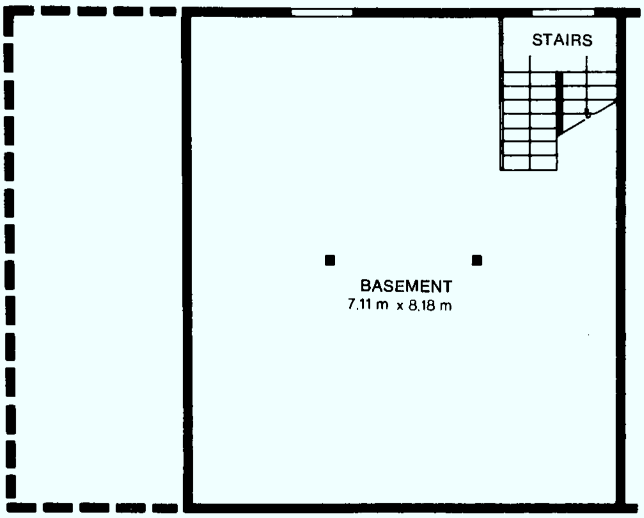
SPONSOR	S.C.I. Le Parc des Érables, Igny, managed by the GEPRO company: Head Office — 90, rue Saint Lazare, Paris IXe. Tel.: 526.82.05.
ARCHITECT	Mr. Philippe Schroeder, government-certified architect.
BANK SURETY	The surety provided for by the law will be supplied by the Union de Crédit pour le Bâtiment (Building Credit Union) — 25, avenue Kléber, Paris XVIe, which is the bank of the sponsor.
NOTARY	Mr. Dupont, 35, boulevard J. Bara, 91 — Palaiseau.
BUILDING PERMIT	Issued by the Prefect of L'Essonne — Permit No. 91.9.31.109 dated February 2, 1970.
C.N.E.I.L.	This programme is subject to the approval of the C.N.E.I.L., 5, rue St-Georges, Paris IXe.
DEFERRED LAND BANK LOANS	Special deferred loans will be requested from the land bank.

The houses will be built by the Société Dumez-Campeau, 325, avenue Georges Clémenceau, Nanterre — 92.

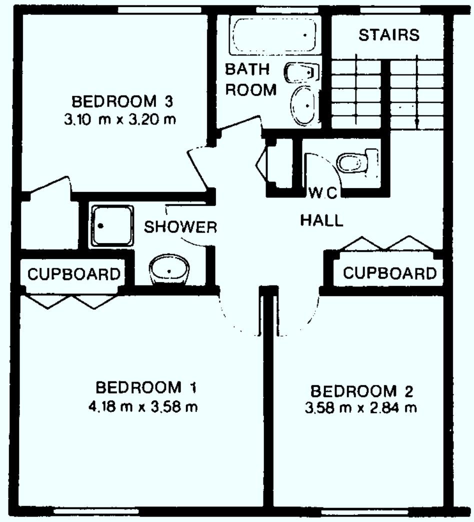


MAP OF PROJECT SHOWING LOTS AND DISPLAY AREA

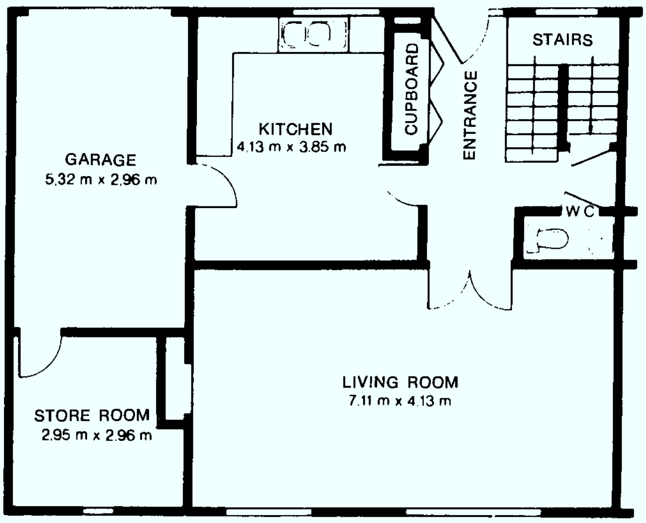
SKETCH AND FLOOR PLAN OF SAINT-LAURENT



PLAN — LOWER LEVEL



SECOND FLOOR PLAN



PLAN — GROUND FLOOR

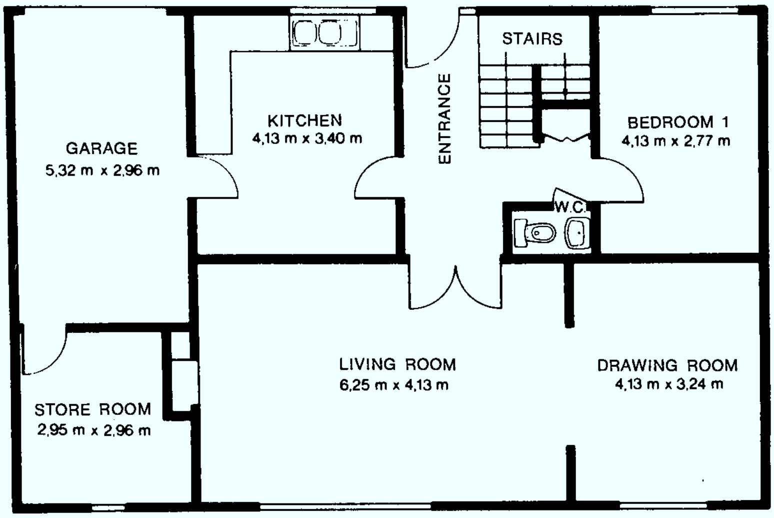
SAINT-LAURENT	
Living space	
Entrance	6.70
Living room	29.11
Kitchen	14.14
Bedroom 1	14.78
Bedroom 2	10.02
Bedroom 3	9.77
Baths	3.64
Shower	3.32
Toilets	2.46
Hallway	6.42
Cupboards	4.80
Total	**105.16**
Service areas	
Stairs	13.19
Basement	54.02
Store room	7.66
Garage	15.53
Total	**90.40**
Total area	**195.56**

SAINT-LAURENT

5 rooms with basement

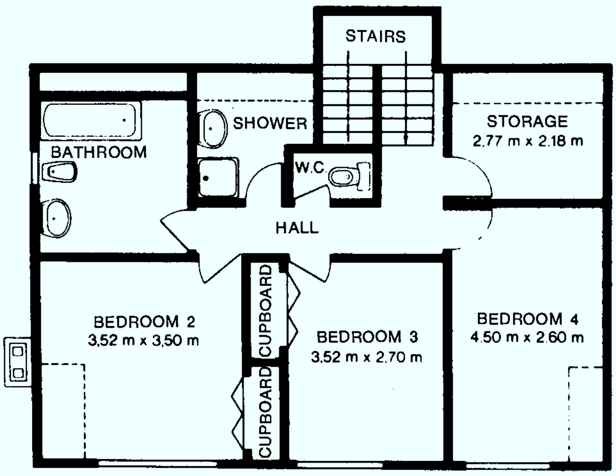
A long house with harmoniously arranged apertures, a partial floor, a restful symmetry, Saint-Laurent was designed to offer you an "intelligent" comfort. Large basement that can be turned into playroom or second living-room, ground floor given over to the vast double living-room overlooking the garden and to kitchen/dinette. The first floor comprises three bedrooms, each with its large cupboard, as well as bathroom, shower and toilet. Garage and store-cupboard communicate with the kitchen on the same level. Usable space: approx. 195 sq. metres.

SKETCH AND FLOOR PLAN OF BOISCHATEL

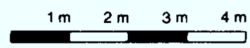


PLAN — GROUND FLOOR

BOISCHATEL	
Living space	
Entrance	7.67
Living room/Drawing room	38.77
Kitchen	13.86
Bedroom 1	11.30
Bedroom 2	11.26
Bedroom 3	9.36
Bedroom 4	10.63
Storage	5.54
Baths	6.50
Shower	4.12
Toilets	2.16
Hallway	4.62
Cupboards	2.56
Total	**128.35**
Service areas	
Stairs	7.70
Store room	7.67
Garage	15.53
Total	**30.90**
Total area	**159.25**



SECONDFLOOR PLAN

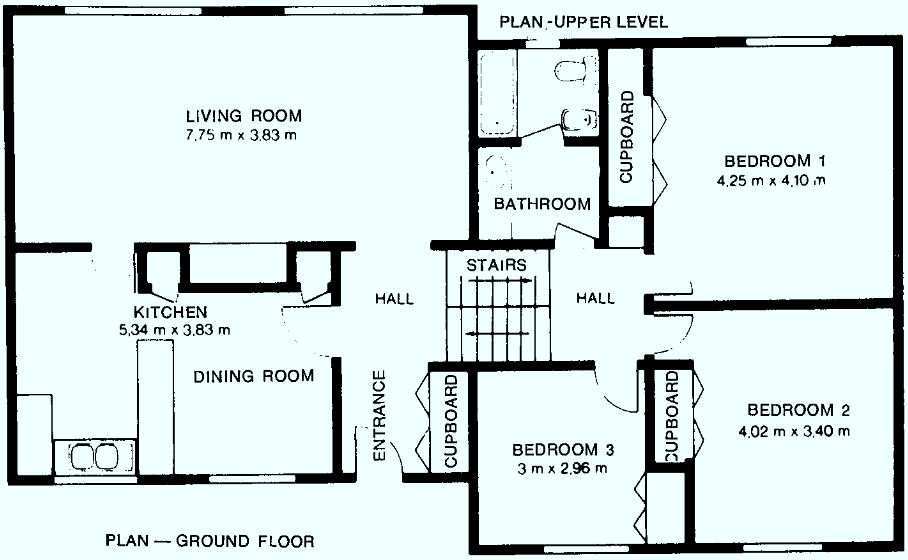


BOISCHATEL

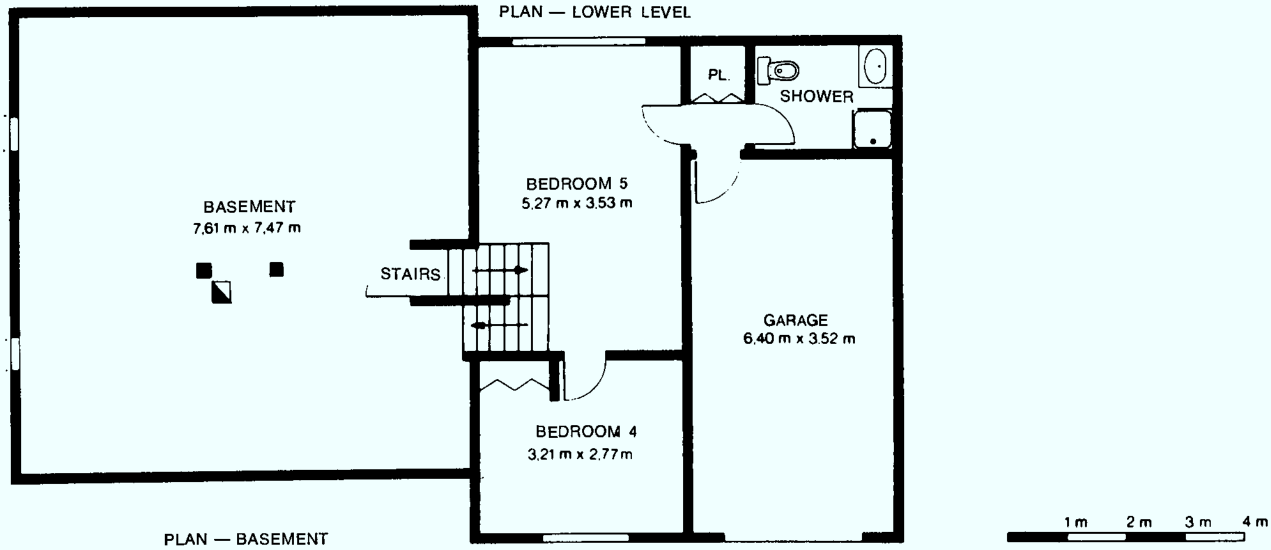
6 rooms with crawl space

Boischatel, whose very large living-room opens on to the garden through two French windows, is a very beautiful house in which comfort and picturesqueness are brought together: its pointed roof comes right down to the ground floor, the bedroom floor has several wall-cupboards, a "roberie", a bathroom, a shower room and toilet. Garage and store-cupboard communicate directly with the kitchen on the ground floor. Usable space: approx. 159 sq. metres.

SKETCH AND FLOOR PLAN OF BEAUPORT



BEAUPORT	
Living space	
Entrance	2.91
Living room	29.38
Kitchen	18.49
Bedroom 1	17.20
Bedroom 2	14.23
Bedroom 3	8.69
Bedroom 4	8.10
Bedroom 5	16.12
Baths/Toilet	6.85
Shower/Toilet	4.43
Hallway	8.62
Cupboards	7.00
Total	**142.02**
Service areas	
Stairs	7.81
Basement	57.80
Garage	22.17
Total	**87.78**
Total area	**229.80**



BEAUPORT

7 rooms with basement

With its split-levels, Beauport offers the attraction of a dwelling in which everyone's independence is fully preserved. On the lower level: a large basement, garage and "children's corner" (playroom, shower). On the ground floor: the entrance, a very large double living-room of 30 sq. metres, and a kitchen/dining-room of 19 sq. metres. A few steps lead to the bedrooms grouped around a hall on to which the bathroom also opens. Each bedroom has its own large wall-cupboard. Usable space: approx. 230 sq. metres.

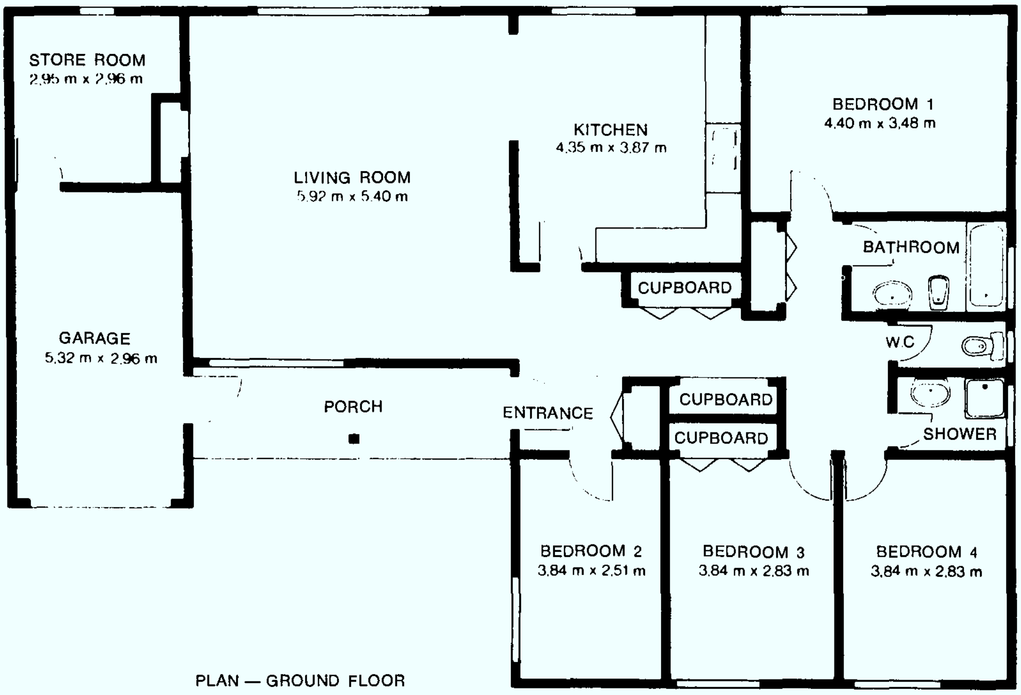
1. Analysis of the selling prices of various models on the basis of cost per square metre of "surfaces utiles" shows that the lowest unit prices are for houses built over full basements. They average about 35 per cent per m² less than single homes of the same model built over crawl space and 30 per cent less than doubles over crawl space. The luxurious Beauport is low priced on this basis.

The full basements are warm and dry and equally as livable as upper level accommodation. They offer the convenience and attraction of family or recreation rooms or extra bedrooms at lowest cost. This is a feature of Canadian timber-frame house design which proved to be a most saleable innovation in France. In fact, the demand encouraged the contractors to change original plans and build more full basement houses and reduce the number of crawl space units.

2. Garages under full basement houses provide hidden parking which enhances the overall appearance of the project and also provides a means of introducing variety into architectural appearance.

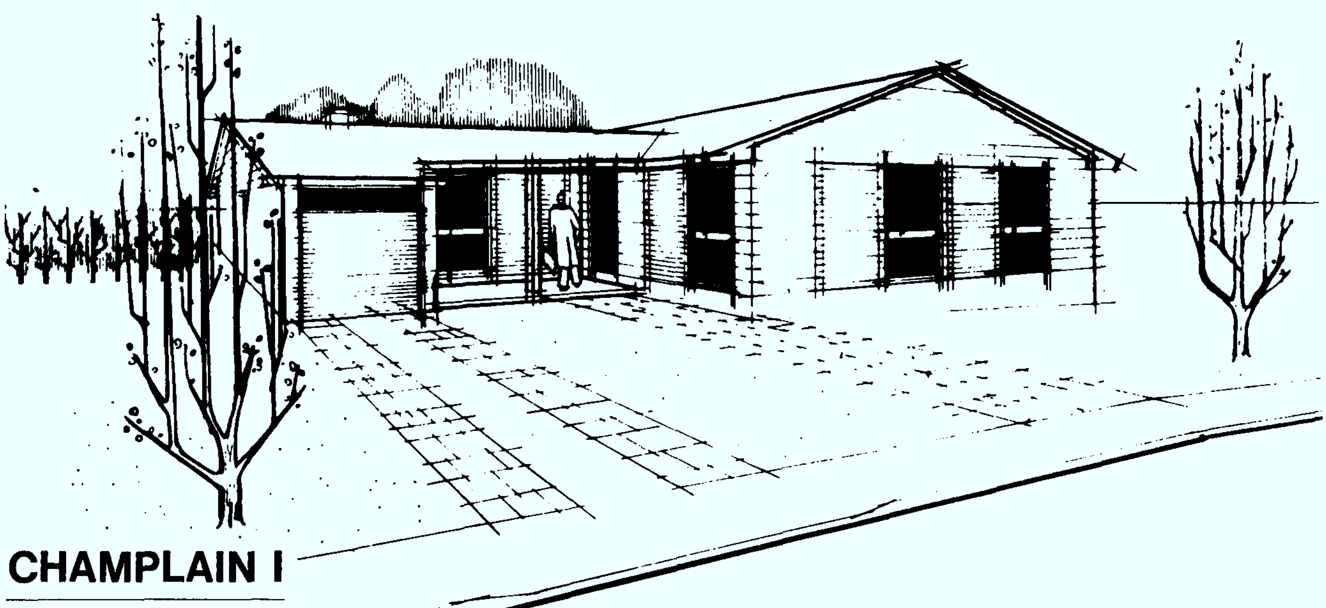
3. All of the house designs could be reversed or flipped to provide added choice to purchasers and offer another means of achieving variety of appearance.

SKETCH AND FLOOR PLAN CHAMPLAIN I



CHAMPLAIN I	
Living space	
Entrance	5.58
Living room	31.67
Kitchen	16.62
Bedroom 1	15.02
Bedroom 2	9.43
Bedroom 3	10.77
Bedroom 4	10.69
Baths	4.26
Shower	2.31
Toilets	1.47
Hallway	8.62
Cupboards	5.52
Total	**121.96**
Service areas	
Porch	6.59
Store room	7.69
Garage	15.53
Total	**29.81**
Total area	**151.77**

1 m 2 m 3 m 4 m

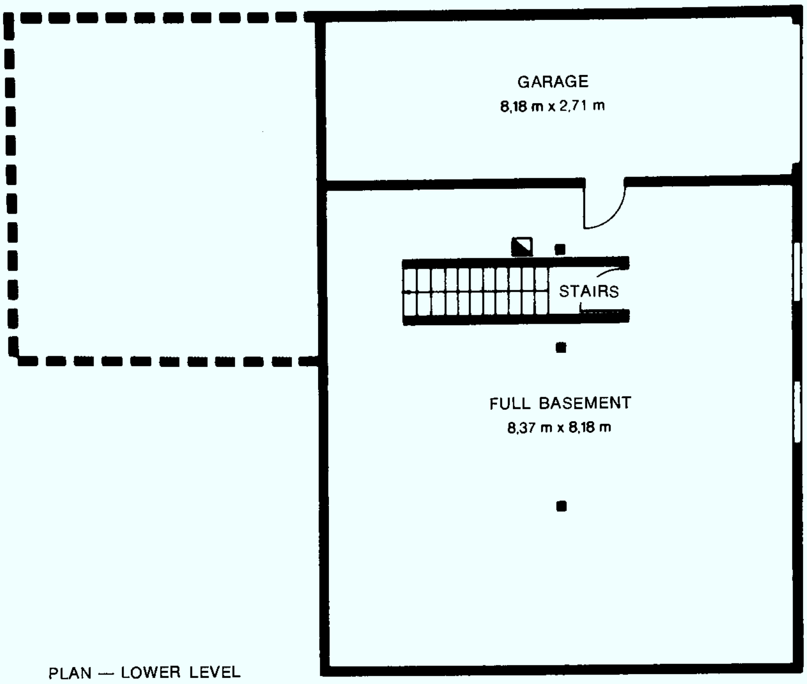


CHAMPLAIN I

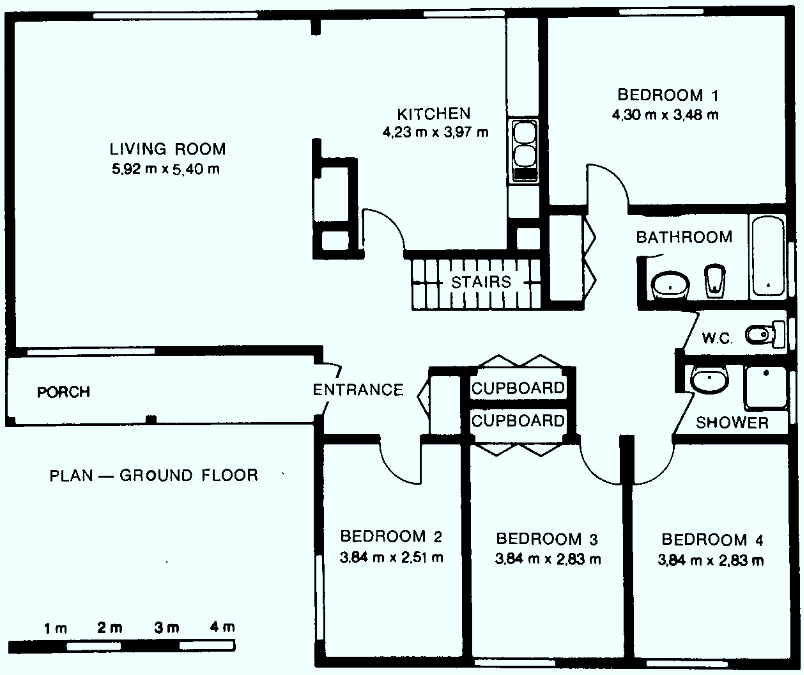
6 rooms with crawl space

Built on a single level, Champlain I owes its principal attraction to the ordering of its large double living-room which opens on to two gardens. In the left wing: garage and store-cupboard, entrance to which is by a covered gallery. In the right wing, the 17 sq. metre kitchen/dinette communicates directly with the living-room. The four bedrooms, the bathroom and the shower are grouped around a hallway furnished with several cupboards. Usable space: approx. 152 sq. metres.

SKETCH AND FLOOR PLAN CHAMPLAIN II



PLAN — LOWER LEVEL



PLAN — GROUND FLOOR

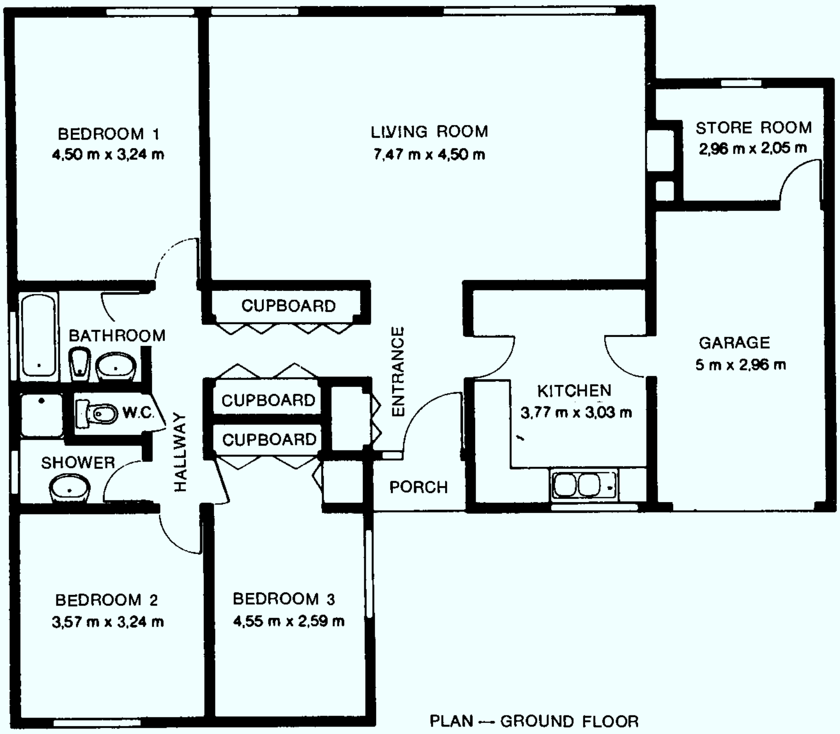
CHAMPLAIN II	
Living space	
Entrance	5.50
Living room	31.67
Kitchen	15.20
Bedroom 1	14.68
Bedroom 2	9.44
Bedroom 3	10.77
Bedroom 4	10.69
Baths	4.10
Shower	2.31
Toilets	1.47
Hallway	8.25
Cupboards	4.07
Total	**118.15**
Service areas	
Porch	6.70
Stairs	6.34
Basement	64.08
Garage	22.17
Total	**99.29**
Total area	**217.44**

CHAMPLAIN II

6 rooms with basement

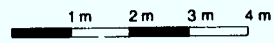
Main attraction of Champlain II, which is built on two levels, is the ordering of its large double living-room overlooking two gardens. Lower level: a 60 sq. metre full basement and a garage. On the ground floor, the living-room communicates directly with the dinette corner of the large 15 sq. metre kitchen. The four bedrooms, the bath and shower are grouped around a hallway fitted with several cupboards. Usable space: approx. 217 sq. metres.

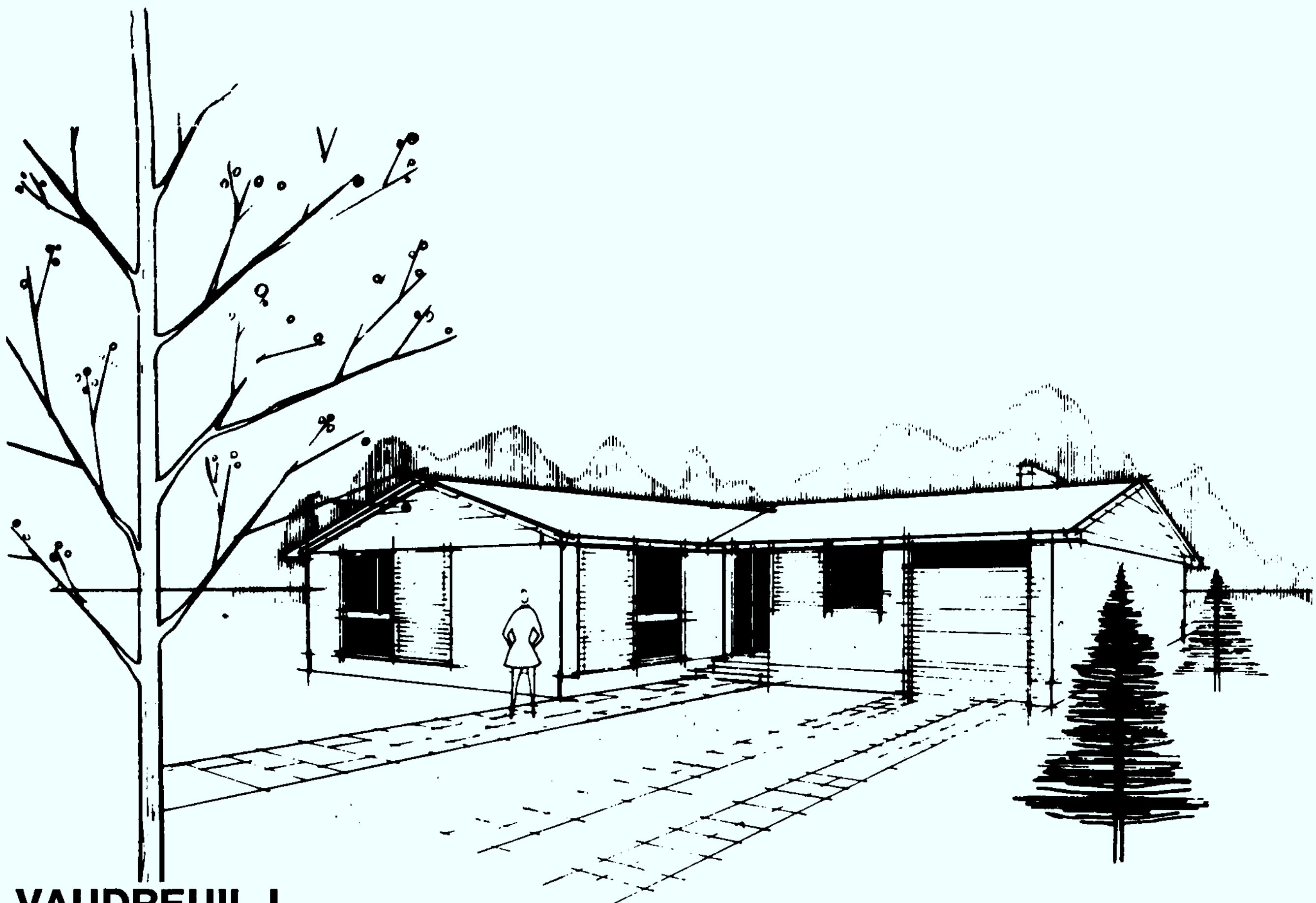
SKETCH AND FLOOR PLAN VAUDREUIL I



PLAN — GROUND FLOOR

VAUDREUIL I	
Living space	
Entrance	4.70
Living room	33.30
Kitchen	11.25
Bedroom 1	14.38
Bedroom 2	11.39
Bedroom 3	10.93
Baths	3.52
Shower	3.20
Toilets	0.99
Hallway	5.96
Cupboards	5.23
Total	**104.85**
Service areas	
Porch	1.67
Store room	4.97
Garage	14.59
Total	**21.23**
Total area	**126.08**



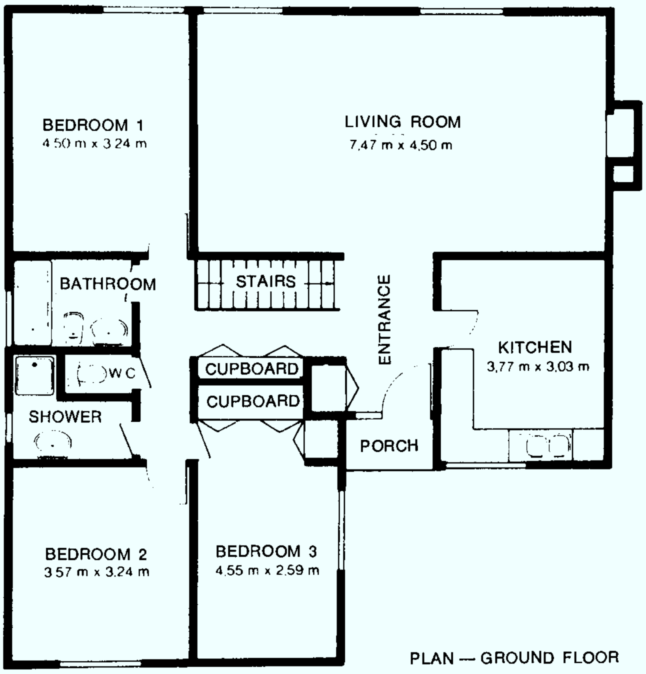


VAUDREUIL I

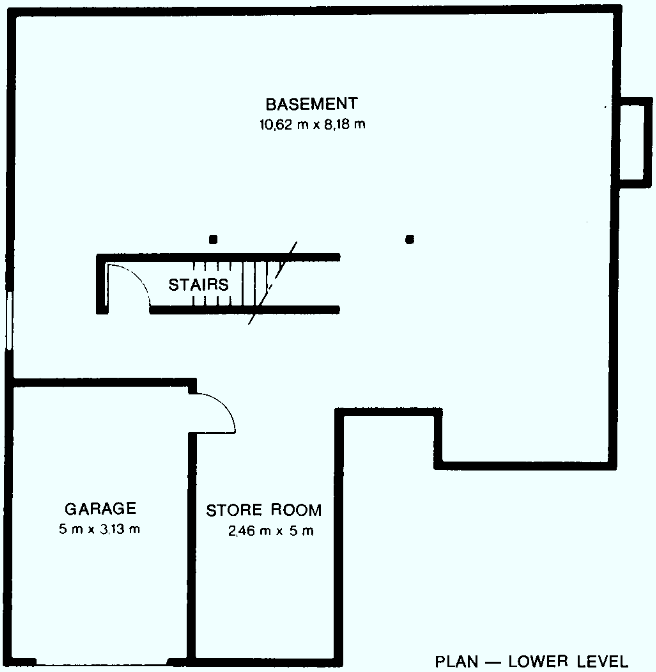
5 rooms with crawl space

Entirely on one level, Vaudreuil I comprises five principal rooms well arranged in an L around a vast entrance: double living-room and parents' bedroom open directly through French windows on to the rear garden. Well separated, the other two bedrooms have their own shower in addition to the bathroom. All "functional" rooms are grouped on one side of the house and inter-communicate: large kitchen, garage and store-cupboard. Usable space: approx. 126 sq. metres.

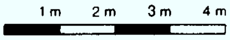
SKETCH AND FLOOR PLAN VAUDREUIL II



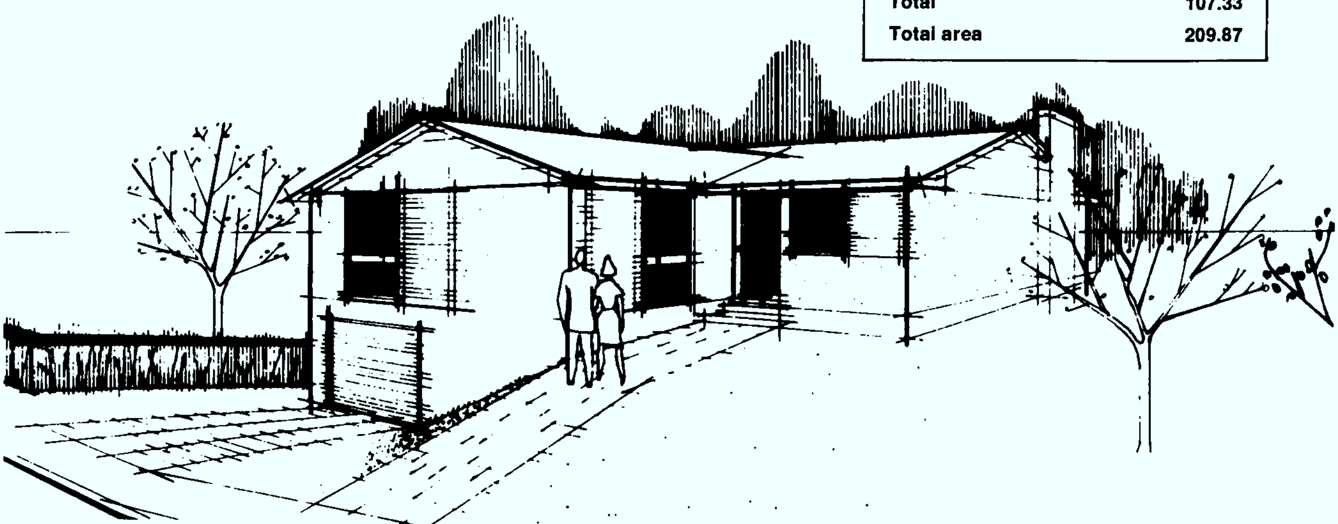
PLAN — GROUND FLOOR



PLAN — LOWER LEVEL



VAUDREUIL II	
Living space	
Entrance	4.60
Living room	33.30
Kitchen	11.25
Bedroom 1	14.38
Bedroom 2	11.39
Bedroom 3	10.93
Baths	3.52
Shower	3.20
Toilets	0.99
Hallway	6.02
Cupboards	2.96
Total	**102.54**
Service areas	
Porch	1.67
Stairs	5.76
Basement	84.25
Garage	15.65
Total	**107.33**
Total area	**209.87**



VAUDREUIL II

5 rooms with basement

Vaudreuil II is built on two levels. The basement comprises a garage and a large space of about 80 sq. metres that could be fitted out as playroom or second living-room. On the ground floor are five main rooms well distributed in an L around a large entrance: double living-room and parents' bedroom open directly through French windows on to the rear garden. Well separated, the other two bedrooms have their own shower room in addition to the bathroom. All "functional" rooms are grouped on one side of the house and inter-communicate: large kitchen, garage and store-cupboard. Usable space: approx. 210 sq. metres.

During the late summer and early fall of 1969 the Société Dumez-Campeau was busy at the organization level agreeing on areas of responsibility, developing bills of material, estimating costs and sourcing materials and subcontractors. The Canadian government requirements for construction inspection, training of French workmen, operation of the display centre and information office and the provision of technical records were incorporated into the planning at this stage.

The planning of co-ordination between the component factory and the construction site was important because the factory location also had to be capable of serving other possible building sites in the future. The selection of the Montsault location connected with existing Société Dumez operations allowed the erection of a building and the delivery of lumber, plywood and processing equipment early in 1970.

Plans called for one-half of the double house in the display area to be developed as an X-ray house, i.e. with sections of wall, ceiling and floor coverings removed, to expose structural framework and normally hidden electrical, plumbing and heating services. When completed, this house unit also served as the Canadian government office and a reception centre for invited visitors and incorporated a literature library and a theatre. It was connected in a traffic pattern with the other half of the unit.

All plans were summarized and expressed on a Project Critical Path chart which showed the sequence and co-ordination of important events in the construction program, based on the production estimates. In this way there was a series of target dates which were considered reasonable relative to Canadian standards and took into account extraordinary requirements.

This brief review of planning considerations indicates that, because of its demonstration aspects, the project was complex and there were many extraordinary demands on the contractors for which they had no experience for guidance. Under these conditions, the planning was excellent and few emergencies developed requiring ad hoc solutions. However, the estimating of costs for activities not directly related to the construction of houses was understandably somewhat difficult.

PROJECT ANALYSIS

A determined attempt was made throughout the planning and construction phases to organize the observation and reporting of progress, events and conditions affecting the timber-frame aspects of the project. This was to provide documented experience for the guidance of others who might become involved in erecting buildings to this system in the future in France and other countries of Western Europe.

In the planning stage, a fine breakdown of construction activities was agreed on for monitoring relative to productivity. Within each activity the number of units involved and the number of man hours to accomplish each unit were estimated. The result was an estimated ratio $\frac{\text{hrs.}}{\text{units}}$ which was compared month by month with the same ratio from actual experience,

i.e. $\frac{\text{actual hours used per activity per month}}{\text{actual units accomplished per activity per month}}$

This planning was done in Ottawa by Campeau Corporation based on its Ottawa experience as of October, 1969. The sum of all these components became the total labour estimate for the 114 houses including the six display homes.

Estimates for the six display homes were included as a part of the total project. However, it was subsequently found that costs of the display units tended to distort the total since they were erected to a time schedule which necessitated working in bad site conditions without the benefit of factory fabricated components and using untrained workmen. The low productivity and resulting high labour costs for this phase strongly affected averages over the whole project. This situation can be isolated by viewing monthly breakdowns and separating the display phase from the production phase at June 12, 1970.

The implementation and operation of monitoring and reporting on the construction activity schedule was done in France primarily by the French partner, Société Dumez. A computerized accounting program was set up which printed out monthly ratios of productivity relative to the original estimates. The mechanics of this scheme worked well. For this purpose it was necessary to obtain accurate "time applied" data recorded by supervisors on the job.

PROJECT

Designation of Activities

00 General Overhead
01 Stake Out
02 Excavation — Crawl Space
03 Excavation — Full Basement
04 Footings — Formwork
05 Footings — Concrete
06 Foundations — Concrete Block
07 Top Plate — Reinforced Concrete
08 Foundations — Concrete — Formwork and Reinforcing
09 Foundations — Concrete — Pouring
10 Concrete Floors — Basement and Garage
11 Access to Crawl Space and Foundation of Garage Wall
12 Installation of Perimeter Drain Tiles
13 Foundation Backfill
14 Foundation Waterproofing
15 Basement Beam and Columns — Placement
16 Block Walls in Garages
17 Foundation Parging
18 Exterior Stoops and Stairs
19 Concrete Blocks — Party Walls
20 Tie Foundation Floor — Sill Plate
21 Crawl Space Ventilation — Per Grill
22 Chimneys
23 Floor Framing
24 Insulation of Floors over Crawl Space
25 Wall Framing
26 Roof Framing
27 Soffits and Facias
28 Building Paper on Exterior Walls
29 Insulation of Walls
30 Insulation of Ceilings
31 Ventilation — Various — Grills — Soffit and Bathroom
32 Roof Shingles

33 Flashing — Various
34 Preparation and Control before Plasterboard
35 Plasterboard — Walls and Partitions
36 Plasterboard — Ceilings
37 Metal Lath — Exterior Finish
38 Rough Coats — Exterior Finish
39 Cresotex — Exterior Finish (colour coat)
40 Aluminium Siding
41 Brick Veneer
42 Exterior Wood Trim — Windows and Doors
43 Sliding Shutters — Installation
44 Rolling Shutters — Installation
45 Garage Door
46 Windows Metal Protection — Grill, Basement and Bath Retainers will be an extra (may not be installed)
47 Interior Doors
48 Cupboards
49 Basement Stairs
50 First Floor Stairs
51 Interior Wood Trim
52 Miscellaneous Work per House (Attaching Handles — Mail Slots)
53 Final Touches and Cleaning per House
54 Prefabrication of Steel Parts — Reinforcing Rod Bending for Foundation
55 Bad Weather Interruptions
56 Watchman — Heating of Houses at Night
57 Scaffolding
58 Workman's Compensation
59 Plasterboard Finish, Joints and Angles
60 Rough Landscaping by Bulldozer
61 Wages in Lieu of Notice
62 Equipment Maintenance
63 Equipment Downtime
64 Security Work — Fire Protection
65 Removal of Fireplace Cover Panel
66 Repair to Perimeter Drain at Foundation
67 Not assigned
68 Roads — Final — Layout (Road Building is Subcontracted)
69 Roads and Services — Sewers and Drainage
70 Trucks — Unloading
71 Handling of Material
72 Temporary Installations — On Site
73 Bulldozer — Operator
74 Crane — Operator
75 Ferguson (Front End Loader) — Operator
76 Drivers
77 Direction of Personnel on Site — Supervision
78 General Service Manpower, Watchmen
79 Work Done and Paid for by Others
80 Lost Time Accidents
81 Prefabrication of Sheet Metal for Flashing for Houses and Roads
82 Prefabrication of Wooden Shims — Various
83 Prefabrication of Concrete Chimney Tops
84 Painting — Prime Coats on Steel Beams
85 Site Cleaning Outside of Houses
86 Miscellaneous Work Outside of Houses — Rough Grading Grounds and Cleanup
87 Preparation of Cupboard Shelving
88 Layout Stakes — Wooden Pickets
89 Concrete Covers for Crawl Space Access
90 Drainage for Wet Area of Project
91 Wellpoints for Wet Area of Project
92 Construction of Transformer Substation
93 All Work with Respect to Water Meters
94 Supplementary Drainage
95 Maintenance of Turbosol Machine

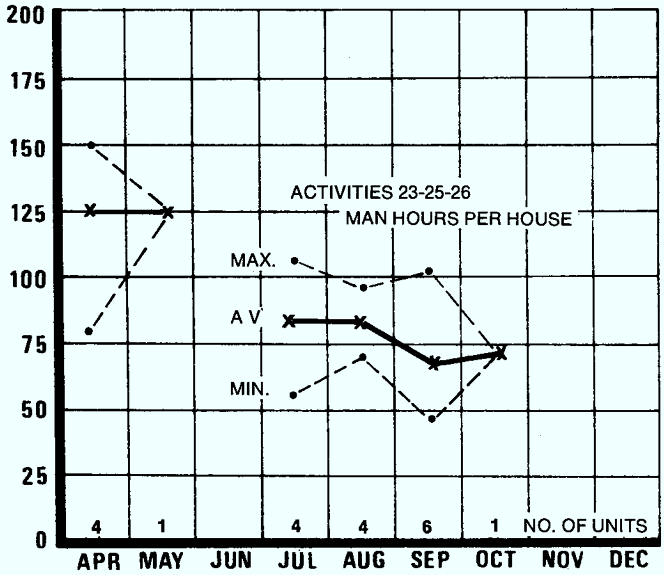
COMPONENT PLANT

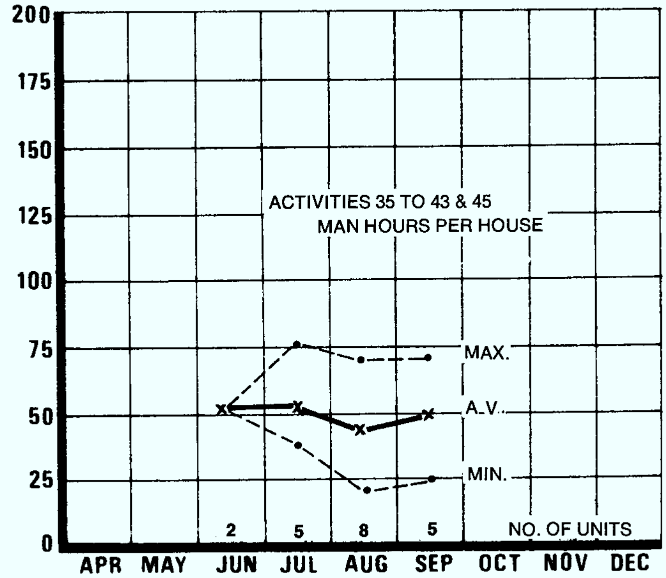
001 Pickets — Prefab
2 Fencing
10 Installation of Shop Equipment — Set Up
12 Handling of Incoming Raw Material
14 Treatment of *Lumber* — Preservation
16 Prefab of House Parts — Walls and Trusses (Check Against Production)
22 Organizing Time for Production
23 Labour by Others
24 Clean Up and Maintenance of Shop
26 Various Work

PER HOUSE MODEL

118 Labour in Prefabrication
134 Prefab of Floor (Joints — Marking and Bundling)
135 Wall Panels Exterior — 2′ o.c. (Bungalow)
136 Wall Panels Exterior — 16″ o.c.
137 Wall Panels Dwarf — 16″ o.c.
140 Interior Partitions — 2′ o.c.
141 Interior Supporting Partitions — 16″ o.c.
142 Dwarf Wall Partitions — 2′ o.c.
143 Dwarf Wall Partitions — 16″ o.c.
145 Roofing — Trusses, Gables, Lookouts

VAUDREUIL V.S. 20 UNITS





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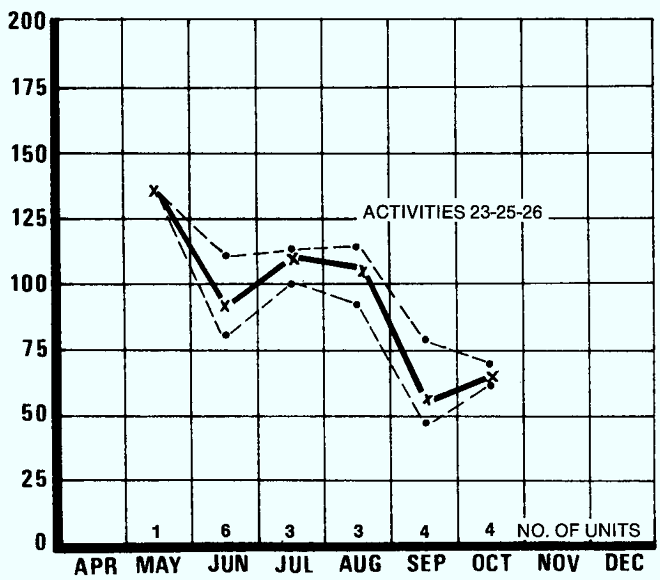
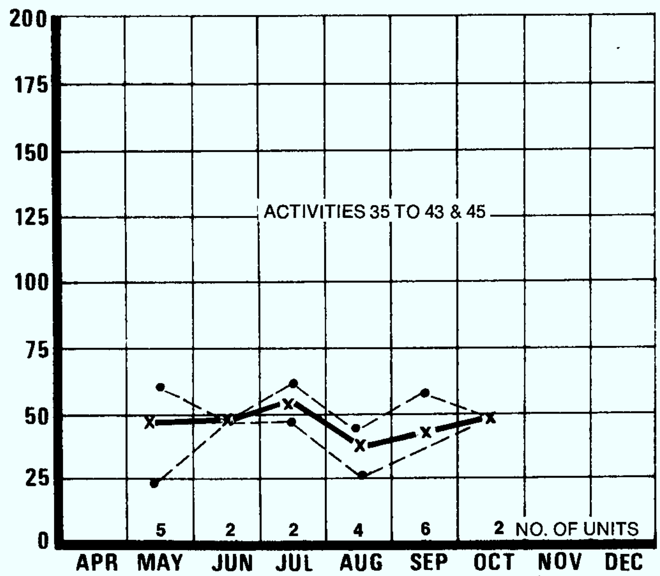
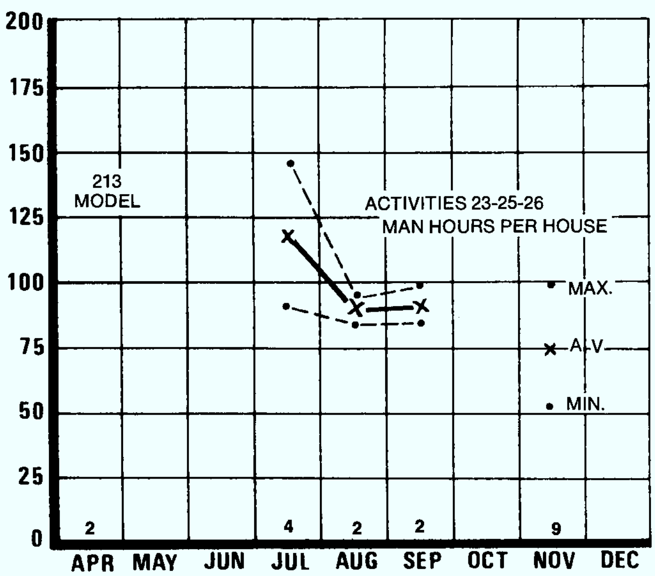
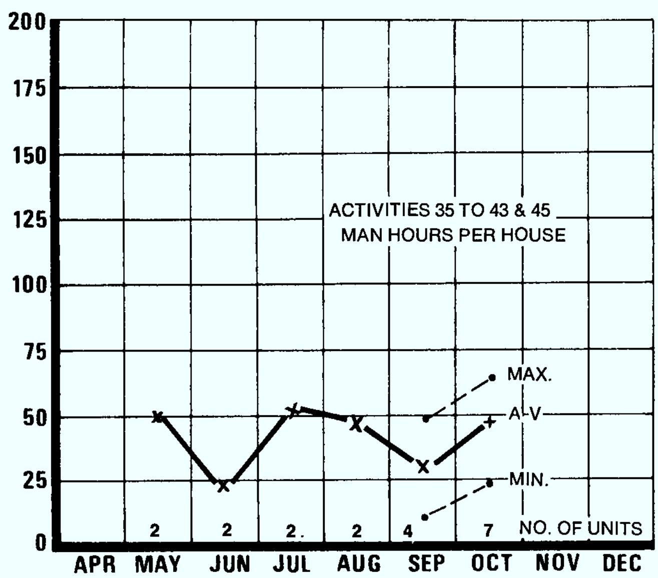


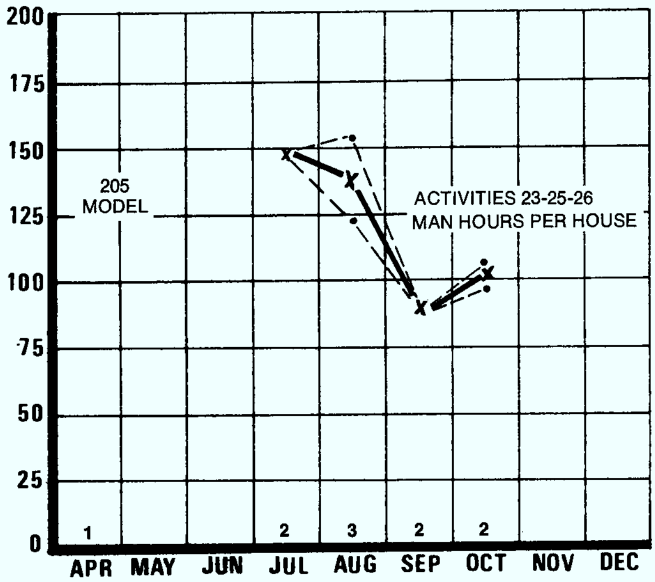


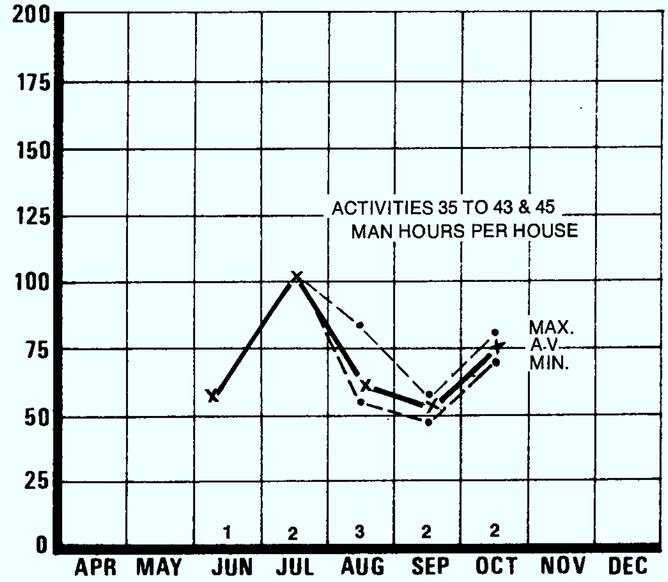
ST. LAURENT S.S. 19 UNITS



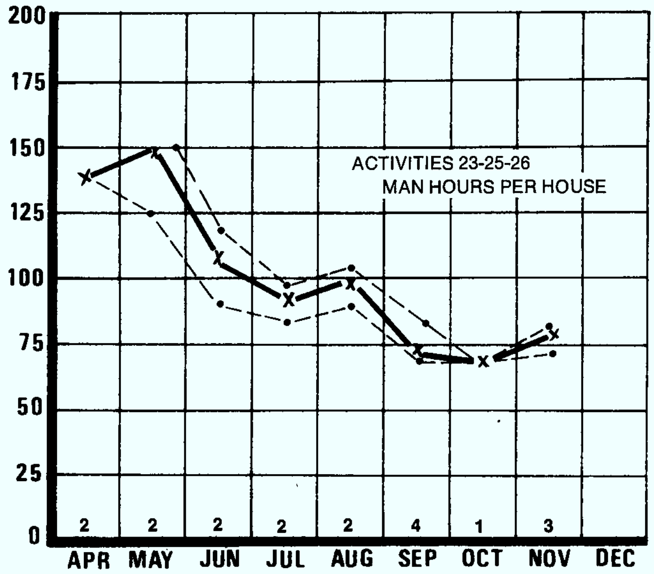


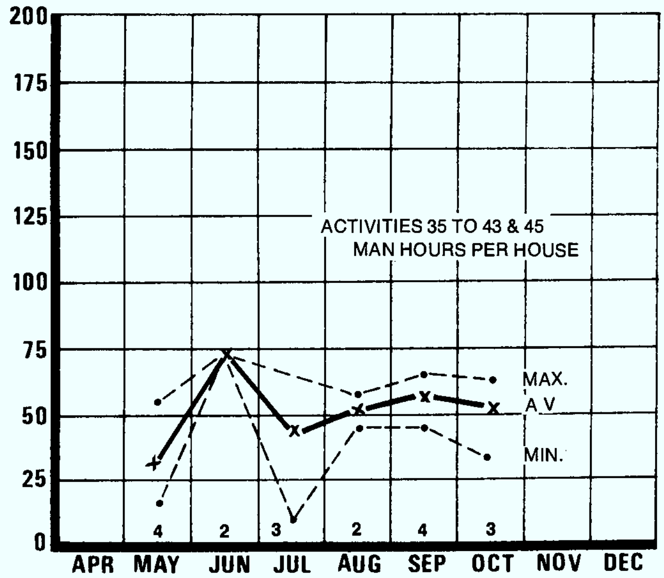
BOISCHATEL 10 UNITS



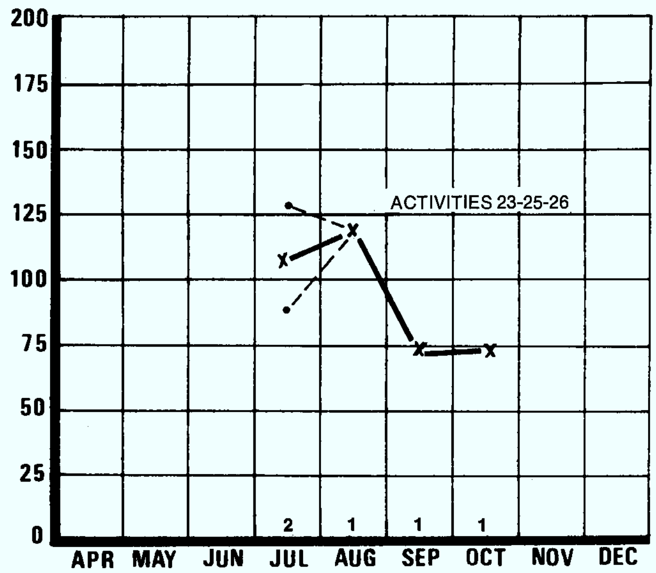


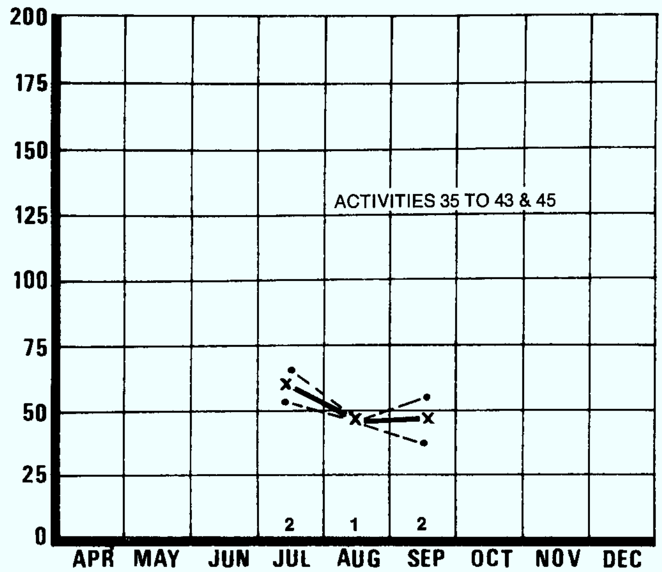
CHAMPLAIN V.S. 18 UNITS



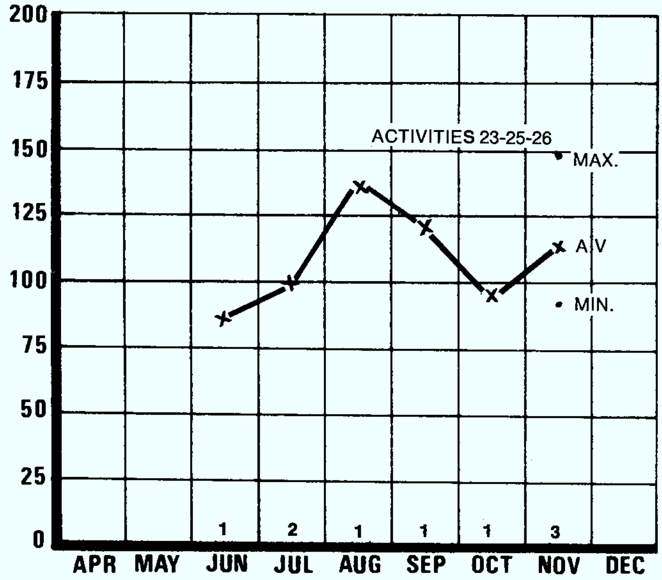


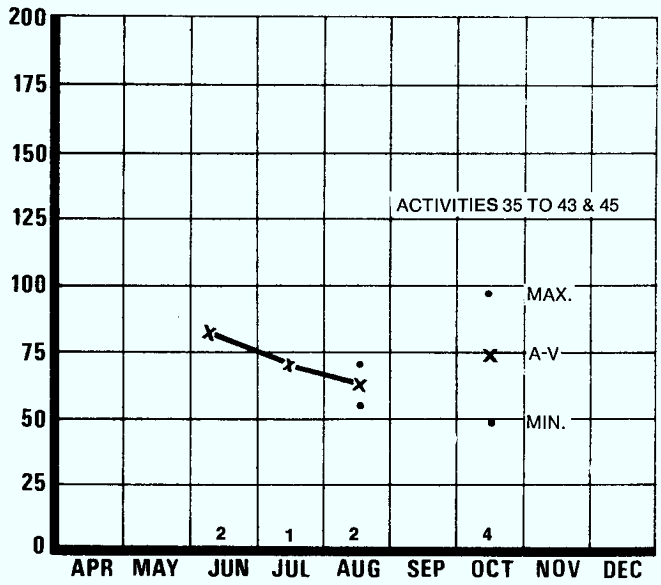
CHAMPLAIN S.S. 5 UNITS





BEAUPORT 9 UNITS





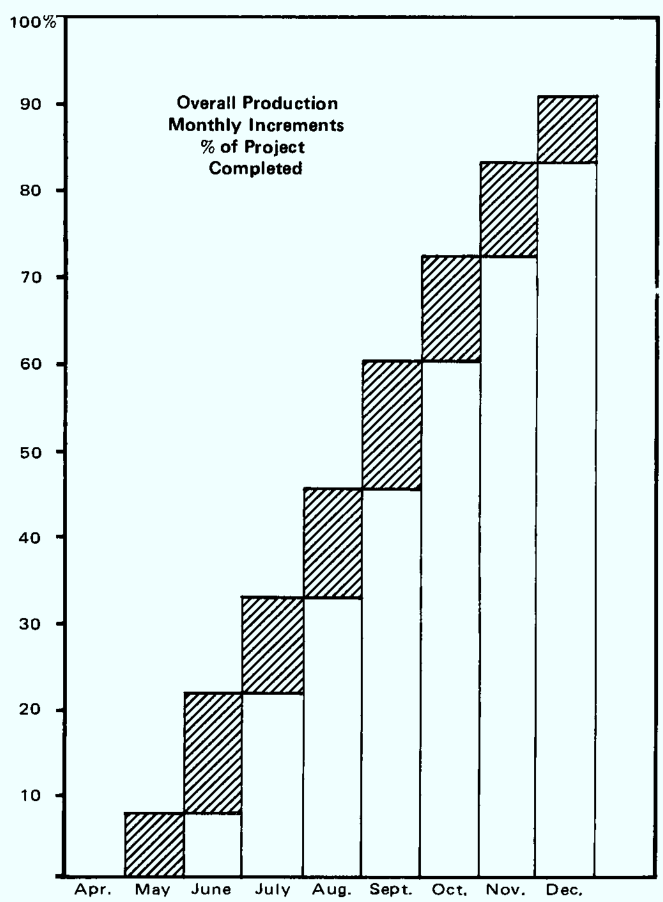
To view labour productivity with full consideration for the conditions under which it was achieved, the number and experience of workmen, the temperature and weather conditions, holidays and incidental lost time and other such influences (see detailed report under Production Factors) were recorded and analyzed with respect to total production and individual activity production.

The overall analysis shows that the weather had little effect on the erection and finishing of the houses because of the use of factory-made components, the fast closing in of the structures and the use of the modern timber-frame construction system. On the other hand, inclement weather strongly and adversely affected efficiency in excavating, grading and concreting, i.e. those activities preparatory to the actual erection of houses and which are not directly related to timber-frame construction.

PRODUCTION FACTORS

This section of the report records the extent and timing of the major factors which affected the efficiency of production. Comments and explanations are added to improve the guidance aspect for European contractors interested in the interaction of modifying factors to be considered in weighing the merits of the timber-frame construction system for residential buildings.

All these factors should be viewed relative to the time frame, which was one calendar year (1970), with consideration of the seasonal weather conditions and business activity cycles. The graph below shows the total production of 114 houses as 100 per cent, in monthly increments. Following graphs dealing with specific factors and construction activities are similarly presented so that concurrent events can be compared.



Notes:

1. This graph is based on the monthly reports of the resident engineer inspector M. J. Trepanier, Central Mortgage and Housing Corporation, Montreal, Canada.

2. The monthly reports gave the percentage of completion at 28 stages of construction of the project as a whole. There is no correlation with the activity designations used by the contractors.

3. At June 1, 1970, the 7 per cent completion indicated that the six display homes were virtually complete and some start had been made on a few additional production units.

4. At Dec. 31, 1970, 10 per cent of the project was still to be completed consisting of interior finishing of a few houses and the final grading and landscaping to be done when ground conditions permitted in the spring of 1971. This final 10 per cent also includes the refurbishing of the display homes in June, 1971, before turning them over to owners at July 1, 1971.

5. In the six months of June through November, 75 per cent of the project was completed (equivalent of 85 houses) at a steady rate of 12 per cent or 14 to 15 houses per month.

Site Conditions

Timber-frame houses can be built on concrete slabs at ground level which creates minimum disturbance of soil on a construction site. In fact, the timber-frame can be erected on any solid foundation giving support to the exterior walls of the structure.

At Igny none of the houses were built on slabs. All were either over full basements, partial basements or crawl spaces. This was because the project was to introduce Canadian-style housing in which a habitable basement is an important feature and in which suspended wooden ground floors are universal.

Since all the houses required from 0.5 to 2.0 metres of excavation and the installation of concrete perimeter walls, the project required considerably more site work than a similar project with the houses on slabs. The presence of ground water close to the surface and an unstable (when wet) stratified mixture of clay and sand introduced problems in excavating for the basements, in trenching for services and in building and maintaining roads.

Two aspects showed up as different from Canadian experience where winter site work is common and efficient. There was insufficient frost to keep the soil firm during January, February and March and the local labour force was inexperienced with the work to be done, particularly under winter conditions. Productivity improved dramatically from May onward and the average experience was reasonable.

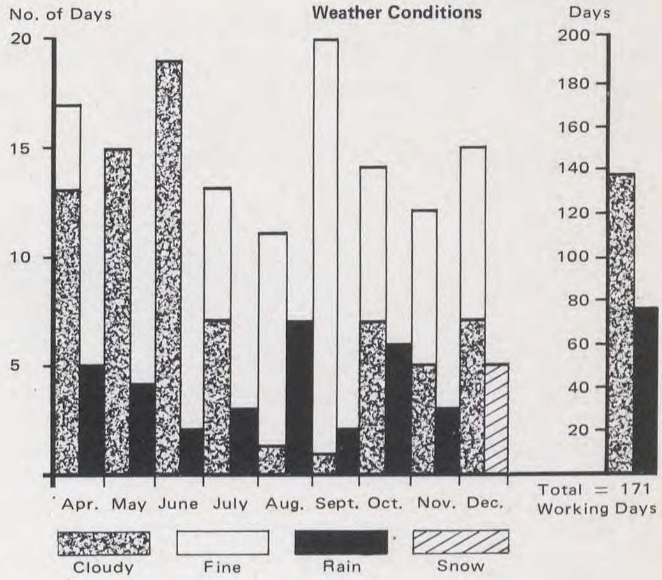
All the operations connected with the installation of basements are highly dependent on stable soil and good site conditions for best productivity:

1. The size of the excavation can be minimum when the sides can be cut sharply.
2. Concrete forms remain clean and require less bracing.
3. Perimeter tile is less subject to misalignment.
4. Delivery of already mixed concrete in heavy trucks is reliable and can be more efficiently placed.
5. The placing and compacting of backfill can be done more quickly and safely.

These operations are preparatory and secondary to the erection of Canadian timber-frame houses. They are subject to local drainage, soil and weather conditions which must be adequately investigated and due allowance made in estimates for deviations from normal conditions. The need for local experience relative to site work was one of the reasons for having a competent French partner in the joint venture and for hiring local subcontractors.

Weather

As stated earlier, weather conditions do not seriously affect productivity in the erection and finishing of timber-frame houses from the subfloor upward. This can be verified from Igny experience by viewing the graph of weather conditions (below) together with the production graphs.



Overall production levels achieved during the excellent weather conditions of June and September were not significantly different from those achieved during a rainy August and a cool, dull November. There is no indication that weather was a factor in such exposed operations as the erection of exterior walls, framing of roofs or laying of shingles. Once the building shell was enclosed, usually within 24 hours, weather had no effect on the interior activities of installing services, insulation, wall cladding, floor laying and further finishing and decorating.

Initially, it took time to convince the labour force which was used to concrete, brick and masonry construction which do not handle as well in cold or wet conditions, that operations could proceed at a normal pace during bad weather. In the last half of the project bad weather slowdowns were negligible.

Labour

A major lesson learned during the Igny project was the rate of improvement in productivity of the locally available labour, inexperienced in timber-frame construction.

In Canada, timber-frame construction and the timber and plywood involved are so commonly used that any workman has an almost instinctive basic knowledge of its use and some skill with the tools to work it.

In Britain, when the system was introduced on a similar project in 1963, the local workmen had some affinity for wood construction although their basic familiarity was with masonry. As well, they were familiar with the British system of measurements so that communication and training was made easier.

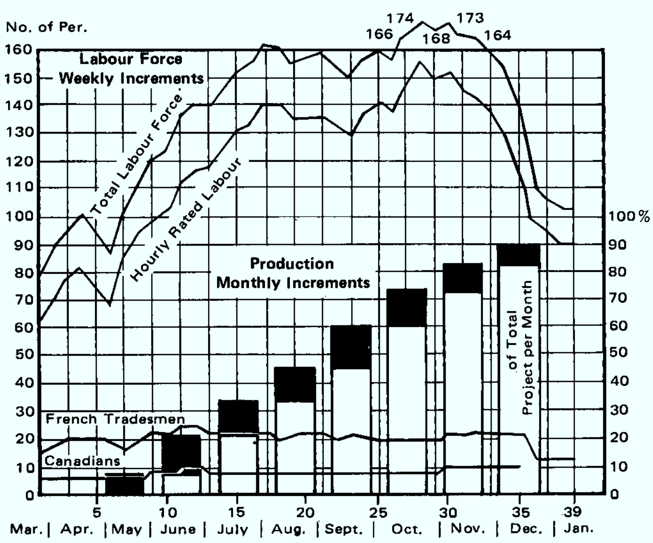
In France, it was realized in the planning stage that labour orientation would be different and that it might be difficult to estimate the success of training. There was confidence in the essential simplicity of timber-frame construction and that it could be taught efficiently provided the project was large enough to provide sufficient repetitions of activities to average out experience and costs.

Communications were simplified because Campeau Corporation, whose Canadian operations are conducted mainly in French, could make available French-speaking supervising personnel. The involvement of a French contractor in the joint venture aided the recruitment of French tradesmen with some skill as carpenters.

A further planning problem was to estimate the probable performance of up to 150 casual immigrant labourers with little background applicable to timber-frame construction. Would such men be, in fact, trainable in a reasonable length of time? What was a reasonable length of time? Would they stay with the job and employ their new skills?

Now, the Igny project stands completed with better than standard quality throughout and on time. All the foreseen and unforeseen problems were overcome and there is no doubt that the timber-frame system is transportable and will transplant successfully into European labour environments.

GRAPH OF LABOUR FORCE MAKEUP — WEEKLY WITH OVERALL PRODUCTION INCREMENTS SUPERIMPOSED



Notes:

1. To visualize overall productivity, this labour breakdown should be viewed in terms of the kind of work being done and the number and qualifications of the men involved.

2. This graph does not include the specialist workmen of subcontractors. The number of experienced tradesmen was therefore higher than shown.

The training of workmen went through two stages —

1. Learning to do the job at a satisfactory level of quality;

2. Learning to maintain that level of quality and increasing the speed of operating to a satisfactory productivity level.

The acceleration of production from the display home phase to the full production phase without the use of pay incentives of any kind was a major success for supervisors.

Number of foreign labourers by qualification ratings

M1	M2	OQ1	OQ2	OQ3	OHQ	OS1	OS2
20	5	5	32	14	6	2	3

Total = 87

Numbers of Workers by Nationality

Tunisian	**Algerian**	**French**
13	20	37
Portuguese	**Yugoslav**	**Italian**
6	3	2
Spanish	**Senegal**	**Moroccan**
3	1	1

Note:

This was the labour component at the end of May. Subsequently, in July, August and September, the foreign labour component rose to 140 with a similar nationality breakdown.

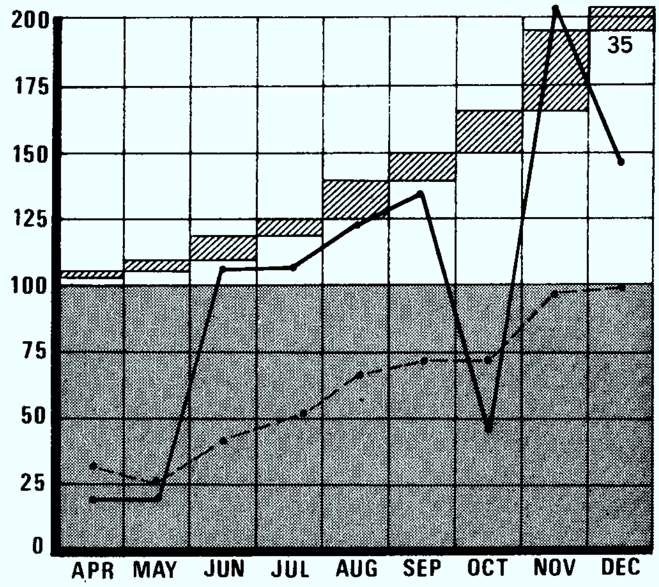
It was soon evident that training was much more efficient in the controlled environment of the component plant at Montsault than on the job at Igny. The plant products were available at estimated rates and costs soon after it started.

Some individuals showed considerably more aptitude for certain skills than others and some of those also had qualities of leadership, initiative and drive. An effort was made to develop these men quickly and promote them to lead hands as pacesetters. In some cases, it was possible to have such men become subcontractors and rely on them with a small crew of their own choosing to do work on a per unit basis rather than at an hourly rate. This method, which is common in Canada, became effective at Igny and is now recognized as feasible and desirable.

A factor that affected training was that some French building materials (e.g. insulation) were not designed for timber-frame use so that statistics on the productivity of using that material could be misleading. Cutting and fitting was a mechanical loss of time unrelated to the ability of the workmen to be efficient in terms of the training and productivity estimates which dealt only with application of the product.

An early matter of education was soon resolved in which tradesmen learned the difference between carpentry as applied in timber-frame construction and joinery as applied in cabinet making. The question was the acceptable degree of tolerance in working of structural and non-structural wood components for good construction. Most carpenters soon developed a sense of proportion and balance between painstaking detail and structural adequacy and acceptable speed of production.

The use of power tools for sawing and nailing was a skill which had to be learned by even experienced carpenters. Efficient use of this labour-saving equipment requires considerable job organization — e.g. like operations should be grouped and the operator and tool used as a small temporary factory. When the time came for practically continuous application of plasterboard, specialized joint finishing machines were used which resulted in productivity quickly becoming better than estimated.



Except for the salaried French tradesmen who were supplied by Société Dumez, the general labour force was recruited for the job and conditions of work, holidays, compensation and overtime were standard for the industry. The average overall direct labour cost was almost five francs per hour. Fringe benefits and administrative overheads added a similar value to labour costs. There was no labour strife on the project. Although there was a greater turnover of labour than hoped for, it appears that turnover levels were normal. Most separations were either voluntary as workmen returned to other countries or because of their inability to learn the required skills and reach a reasonable level of productivity.

Materials

Many types of building materials are compatible with the timber-frame system and provide for variations in finish and elevations.

In Canada, labour is familiar (compatible) with the system and building materials are universally compatible. They are produced in sizes, shapes and content to work with and add to the efficiency of the system. In France this is not always the case.

The technology of Canadian timber-frame construction has historically been expressed in British inch-pound units of measurement and predominantly uses a four-inch module (approximately 10 cm) which is directly related to standard lumber sizes. Although many French materials are designed to the 10-cm module, there is a slight difference from 4 inches. This must be taken into account in working drawings and design.

The National Building Code of Canada (1965) accepts the standard products of the Canadian lumber and plywood industries. Lumber is produced to CLS (Canadian Lumber Standards) sizes whereby all lumber is smoothly finished with rounded edges for convenient handling and is graded and marked to identify its suitability for different uses. These procedures permit the lumber of many tree species to have internationally recognized stress ratings. They facilitate the selection of proper sizes and species of lumber for different combinations of load, span and spacing requirements. Incorporated in the code are span tables based on using CLS lumber.

Similarly, the code provides tables for the use of Canadian softwood plywood which has been produced to Canadian Standards Association's standards. These standards assure uniform quality in sizes and strengths suited to timber-frame construction. All Canadian Douglas Fir plywood is Exterior Grade — bonded with waterproof adhesives and both water and boil proof.

These products are also manufactured to metric dimensions. The Igny project used three common species, Western Hemlock and Eastern and Western White Spruce, in the sizes 40 x 90 mm and 40 x 140 mm and 40 x 240 mm. The plywood was Douglas Fir, "Economique" and "Bâtiment" quality 8 mm and 13 mm thick in panels 244 x 122 cm.

French building materials were used extensively when price considerations prevailed for other than structural parts including all the services and sanitary fixtures. French drywall (plasterboard) panels were available but had not been developed for horizontal application to wooden stud walls spaced on 16-inch centres. Extra wide panels were procured to cover the 250-cm wall height and eliminate fitting cuts. Fibreglass insulation batts were not dimensioned to fit between studs and did not have a strong vapour barrier included on one side with lips to facilitate lapping and stapling to studs and ceiling rafters. These differences from Canadian materials meant compensating procedures had to be worked out on the job. Some specialty construction products required for timber-frame construction were supplied from Canada — e.g. H-clips for plywood joints; galvanized nails and formed steel basement window wells.

Plywood roof sheathing, supporting trusses and exterior load bearing walls may be designed for any required dead loads and snow (live) loads according to climatic experience and serve equally well with any type of roofing such as the asphalt shingles chosen for this project. The application of asphalt shingles with sheet metal flashing and guttering was relatively new to French workers but they responded well to training and achieved satisfactory production quickly.

Publicity

As a promotion aid, a display of furnished model homes available for public inspection throughout the project was required. Occasionally it was necessary to have the houses which were under construction inspected during working hours. Workmen tended to react to the distraction of a flow of visitors including the press and cameramen. The contractors often chose to clean up particular areas for high level critical inspection before the ordinary operation of the job required it.

The "open door" policy encouraged visitors to inspect the project and resulted in a widespread general awareness of the practicability of Canadian timber-frame housing in France.

EXPERIENCE — NON WOOD-FRAME ACTIVITIES

This section reports on activities which are more or less common to all residential construction methods and often relate more to local conditions than to timber-frame construction. The construction activities covered are excavation, concrete work, masonry work, exterior finishing and ventilation. Labour productivity data based on a comprehensive breakdown of these activities has been analyzed and is presented in graphical form. The actual monthly productivity for each activity is shown as a percentage of the original estimate and the activities are grouped according to their relative importance in the timber-frame system. Experienced local contractors building in familiar conditions and to a satisfactory time schedule can expect to improve on the experience achieved at Igny.

The datum is 100 per cent of the originally estimated productivity rate in units per man hour —

$$\frac{\text{No. of Units}}{\text{1 Man hour}} = {}^{R}_{e} = 100\%$$

($^{R}_{e}$ is the estimated productivity ratio).

If twice as many units of work were done as compared to the original number of hours estimated per unit productivity is plotted as 100 per cent above estimate. If twice as many units were completed per man hour — $\frac{\text{2 (No. of Units)}}{\text{1 Man hour}} = {}^{R}_{m} = 200\%$ which is plotted as 100 per cent above datum. ($^{R}_{m}$ is the actual productivity ratio per month.)

Conversely, if half as many units were done per man hour — $\frac{\text{.5 (No. of Units)}}{\text{1 Man hour}} = {}^{R}_{m} = 50\%$ which is plotted below datum at 50 per cent.

Since production per activity does not necessarily parallel overall production month by month, each individual activity graph has its own production bar graph superimposed in order to indicate under what conditions of season and rate of production the experience occurred. Other comparisons are also available by viewing other experience graphs at the same time:

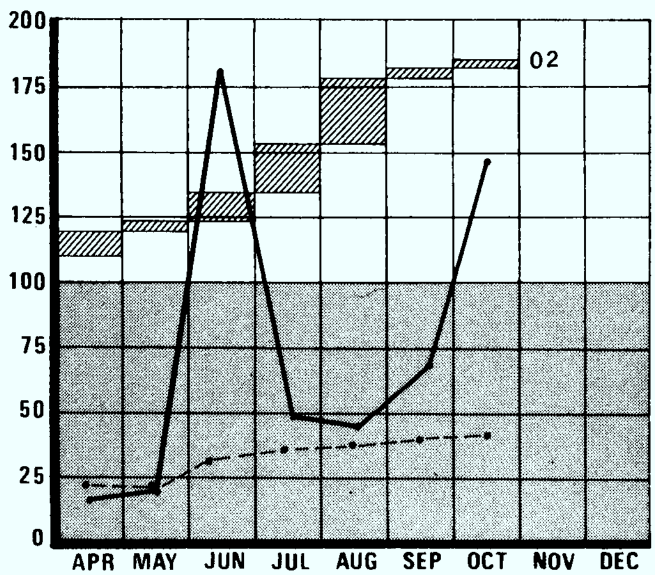
- Timing of individual activities relative to overall project completion.
- The experience of groups or families of related activities, e.g. site work, timber-frame erection, interior or exterior finishing.
- The comparison of labour intensive operations with others.

The effect on costs is a function of the number of units which were handled per activity as well as on the per unit deviation from estimates. To demonstrate this aspect the number and kind of units is given on each graph.

Problem areas are pointed out for the guidance of contractors.

Site Operations

02 Excavation — Crawl Space 3,274 m³



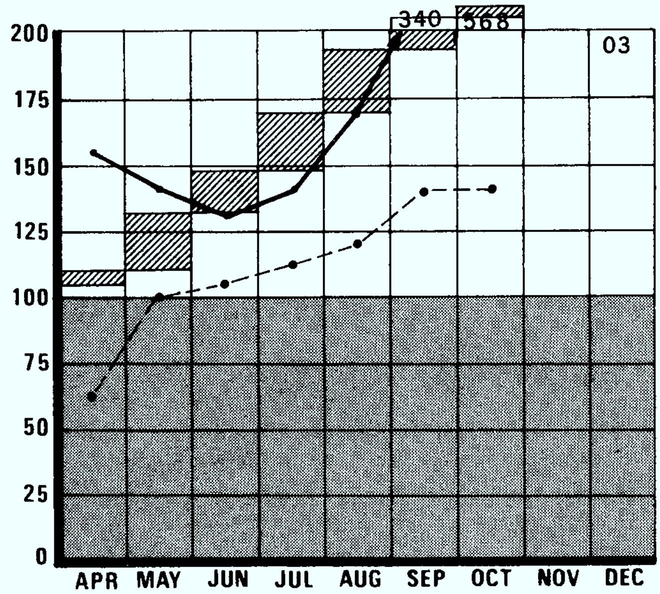
Notes:

1. The good dry weather in June and September was an improving influence.

2. High output in July and August did not compensate for the high labour input involved in moving from lot to lot in rainy weather.

3. High phase one (display phase) costs fell sharply when production started on the main project at mid-June.

03 Excavation — Full basements 12,745 m³



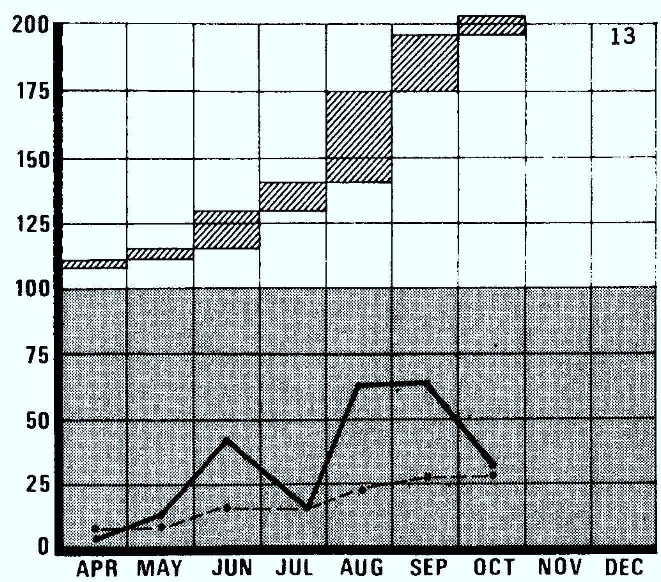
Notes:

1. The estimated number of units was exceeded by 10 per cent, i.e. 1,200 more m³ of soil were moved.

2. Experience was consistently below estimates in spite of difficult early site conditions.

3. There were approximately four times as many units involved in this activity as in activity No. 02.

13 Foundation Backfill 4,120 m³



Notes:

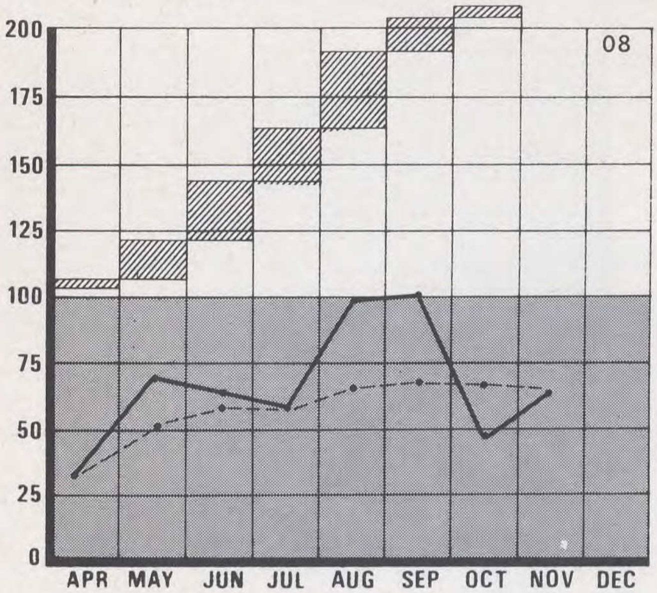
1. Full control of this operation was achieved only when the job was well advanced.

2. Backfilling was interrupted continually in the early stages because of fluid sand conditions which made the operation of heavy equipment next to basement walls extremely hazardous.

3. Productivity dropped again at the end when equipment was used on a disjointed schedule to serve widely separated sites and to fill local depressions around the project.

Concrete Operations

08 Foundations — Concrete — Formwork and Reinforcing 8,563 m³

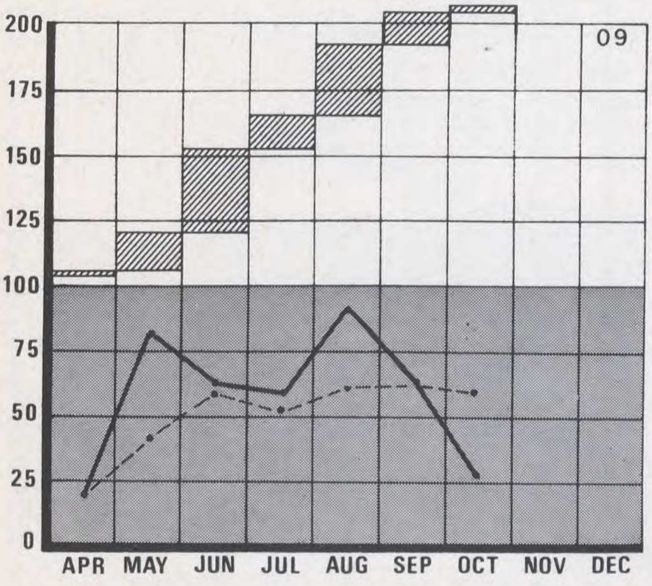


Notes:

1. This is a fairly typical experience with the low productivity at the beginning and end of the project when there was little foundation work.

2. During August and September, 40 per cent of the units were completed within productivity estimates.

09 Foundations — Concrete — Pouring 837 m³



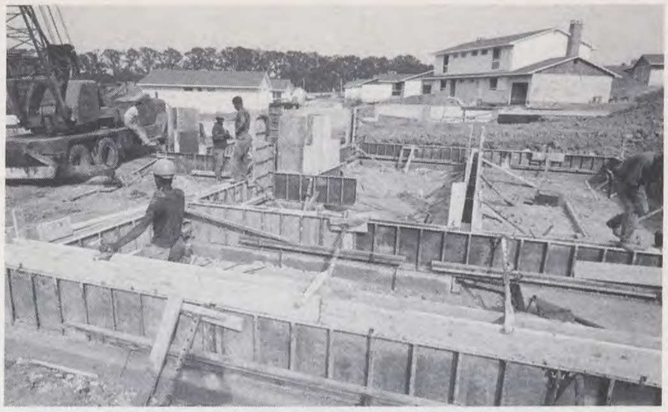
Notes:

1. Similar experience to activity 08 which indicates the expertise of French workmen in handling concrete.

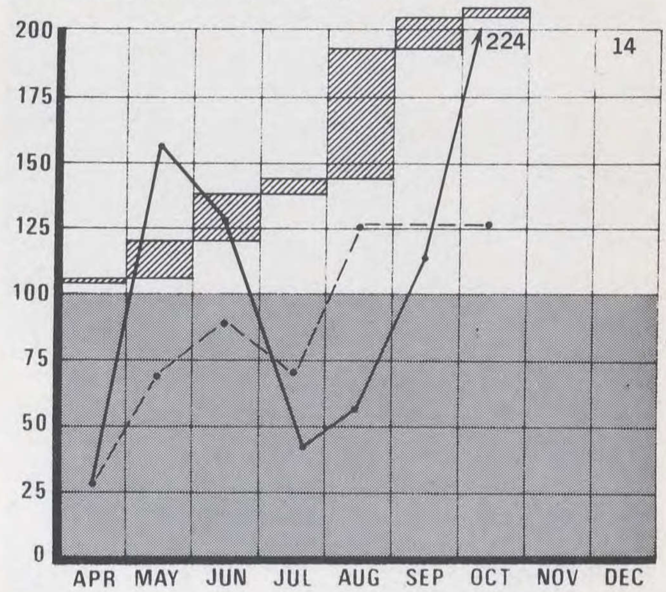
2. In both cases quantities were within 10 per cent of estimates for 114 houses.

3. Concrete work was completed in October, 1970.

4. Reusable Douglas fir plywood concrete forms were designed by Campeau Corporation.



14 Foundation Waterproofing 3,695 m²



Notes:

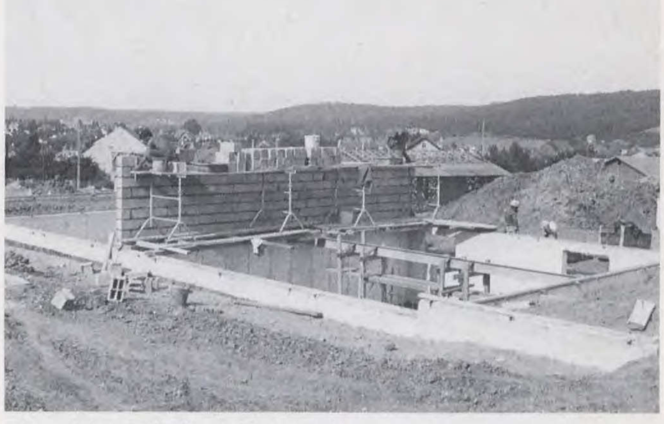
1. Compare the timing of this activity with that of No. 13 (Backfilling) which followed immediately in the construction sequence.

2. This operation improved quickly with the experience of workmen.

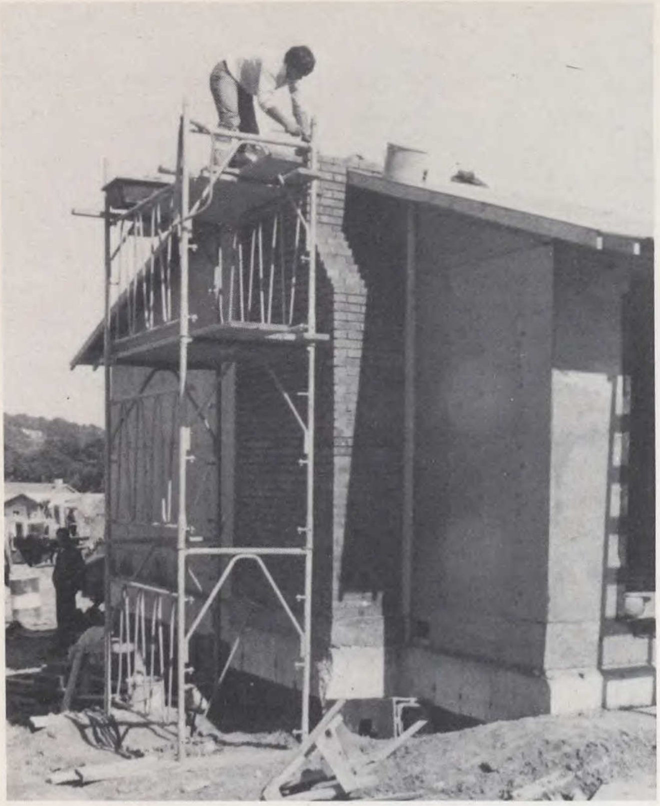
3. Productivity was generally lower than anticipated by Canadian estimates because the mastic was applied by hand mopping rather than by subcontract spraying as in Canada.

Masonry Operations

There was generally low productivity relative to estimates for the following activities.



16 — Block Walls in Garages

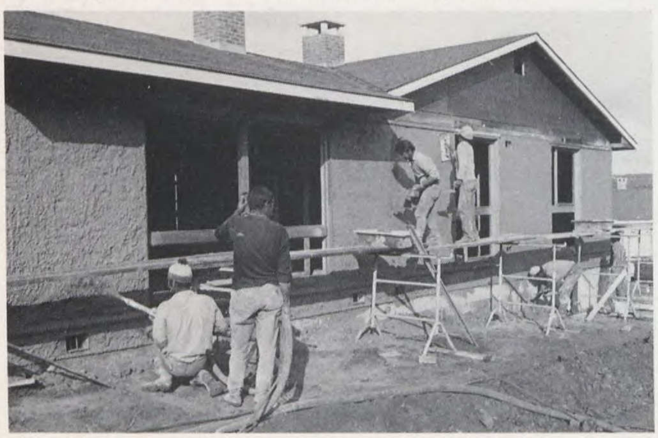


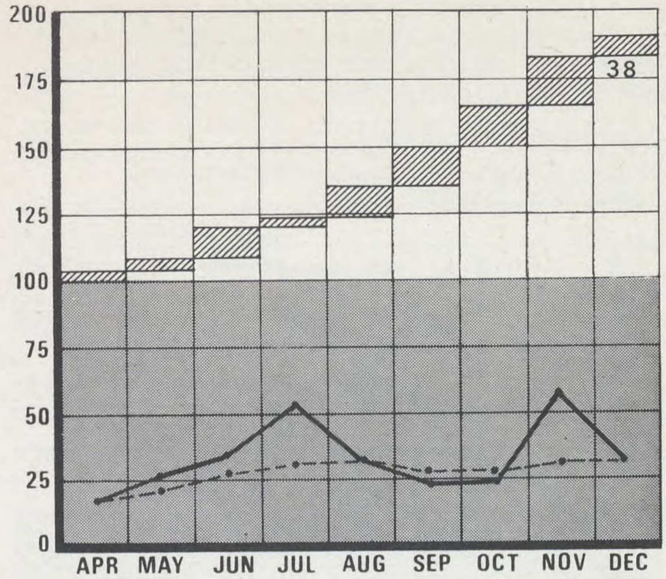
22 — Chimneys

41 — Brick Veneer

In Canada it is usual for masonry to be mixed with and/or applied to timber-frame construction — the workmen are experienced and the specialized materials such as anchor ties are common. In France there was a general lack of experience in this and the small amount of masonry work did not give sufficient experience to raise productivity.

38 Rough Coats — Exterior Finish 9,674 m²





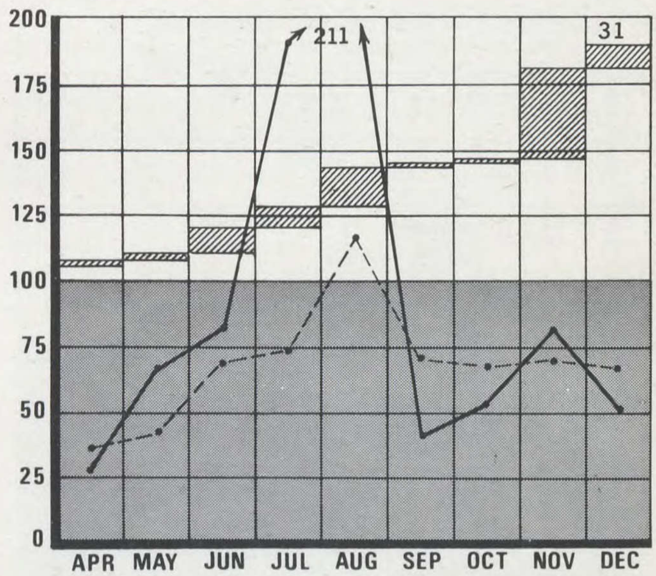
Notes:

1. This was the predominant exterior finish at Igny.

2. Original methods of application were unsatisfactory for the rate of production required to keep up with timber-frame construction.

3. New methods and equipment were introduced in September which, when they became familiar to the workmen, produced dramatic improvement in November. Instead of a two-coat hand application, one coat was applied mechanically.

31 Ventilation — Various — Grills — Soffit and Bathroom 1,114 per grill. (U)



Notes:

1. While ventilation grills are required in France, they are not used in Canada.

2. Installation productivity varied directly with production.

3. There is some parallelism between activities 38 and 31 which followed each other, i.e. when the rough coating was going poorly there were few grills installed.

Supervision

The need for supervision was underestimated. Experience at Igny proved that contractors must be prepared to train workmen in new skills and to provide continuous job control to maintain quality and speed of production, especially on those activities which are usually considered to be "common" and part of traditional construction.

Supervision was most expert and continuous on the direct timber-frame construction activities both in the component plant and at Igny with the result that training and subsequently productivity were best and closest to estimated performance in these operations. This experience substantiated the fact that timber-frame construction in itself is relatively easy to teach.

Igny experience suggests that the problem of labour turnover can be best resolved by increasing the proportion of components built in an associated factory where job control is effective and turnover least. This benefit is an addition to others inherent in factory production, e.g. efficiency in materials handling and quality control and independence from weather and site conditions. Smaller projects which can be completed in a few months should experience fewer labour turnover problems, especially if contractors purchase factory built components.

It is recommended that, if possible, local supervisors should be taught the philosophy of timber-frame construction under classroom conditions before going on the job. This could well assist in viewing the building process as a system. Tradesmen should be aware of the sequence of activities and have an appreciation of how and why particular things are done in preparation for succeeding events. The lack of this basic understanding of assembly techniques was troublesome and difficult to correct on the job.

There appear to be differences in the need for and the means of achieving job control in residential construction between France and Canada. Comparison of a few points may be interesting toward indicating different approaches to control.

(*a*) Tradesmen on the Igny project were not certified by trade unions as to their skill. Therefore, proving time on the job was required resulting in some turnover of personnel and a need for close supervision, especially during the training period.

(*b*) The pay differentials between labourers and supervisors were established according to local custom. However, these were such as to encourage potential supervisors to work as crew leaders, rather than becoming skilled, production-conscious job organizers.

(*c*) Subcontracting is an effective method of control which is well developed in both France and Canada but was not fully available at Igny because of the newness of some trades.

(*d*) When subcontractors are not developed or available, specialist crews may be organized as distinct from a general labour pool. These crews are expert in a particular construction activity and move from house to house doing only that job. Thus the whole project is organized as an assembly line. This approach was not used at Igny as much as it might have been because of the desire to give broad experience to workmen and because there was not time to develop real specialists.

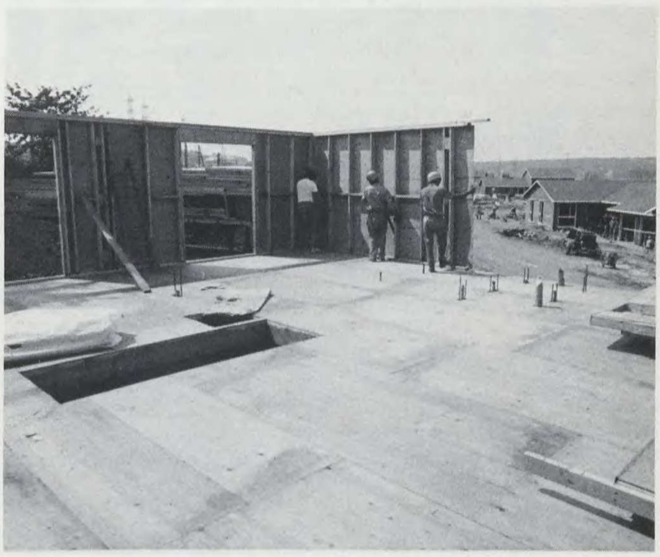
EXPERIENCE — TIMBER-FRAME ACTIVITIES

This section deals with those construction activities in which wood is the major material and which produce the structural shell of the house. The same techniques of assessing productivity apply in this area of activity as in the preceding section.

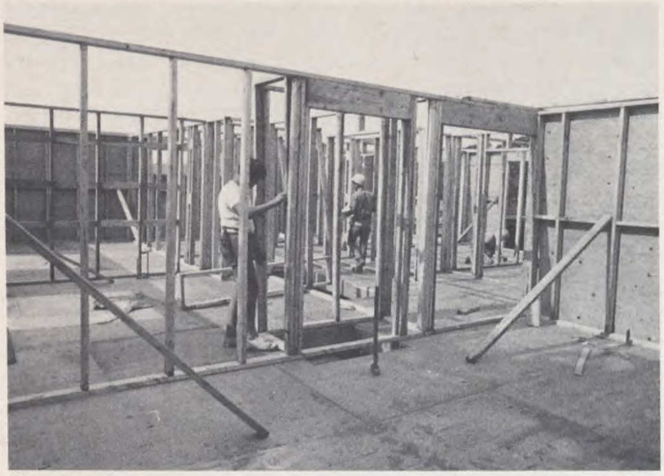
Timber-frame construction progresses through four stages:

a) The building of the ground floor, suspended over a basement or crawl space which provides a clear, level work platform.

b) The erection of exterior walls in prebuilt sections complete with the exterior sheathing.



c) The erection of interior partition frames which tie into and brace the exterior walls.



d) The erection of prebuilt roof trusses bearing on the exterior walls and sheathing the trusses with a plywood structural diaphragm for rigidity.

The prebuilt components for operations b, c, and d above were delivered by motor truck from the plant at Montsault — one house per load. The semi-trailer was parked beside the prepared floor and off-loaded by hand in order of assembly. Three men formed the erection crew, carrying the components to position, tilting them up and securing them in place. Erection and enclosure of the house took one working day. No scaffolding was required. At this stage the structure was completely and permanently secure without any need to wait for materials to set or dry to achieve ultimate form and strength. It was also relatively weatherproof so that materials could be stored in it and the installation of services and finishing could proceed as scheduled. There was no formwork or temporary bracing to remove or work around.

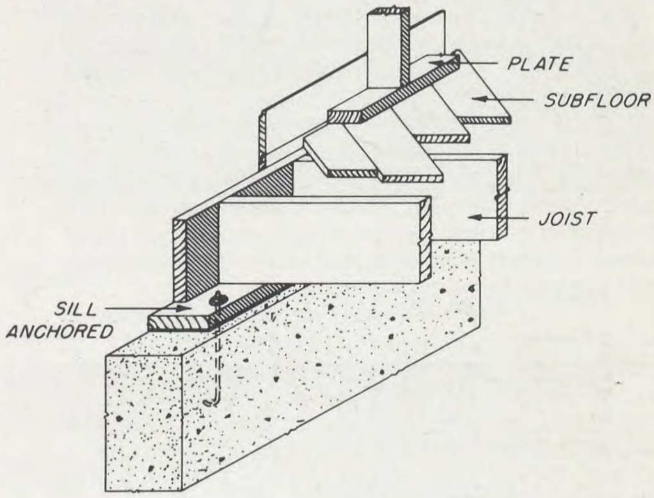
The availability of enclosed storage had value beyond weather protection by reducing the risk of theft and vandalism. By not having materials lying around, a night watchman was able to provide fire and security protection.

Psychology and experience had a strong effect on the productivity of labourers during the timber-frame part of construction. Most were steel and concrete oriented where weight is popularly related to strength. The concept that wood has a better strength to weight ratio took time to grasp so that there was initial reluctance to climbing around the lightweight timber structure and a resulting slowness in manoeuvring on the job without the usual mental security of scaffolds.

A planned demonstration early in the training program of the physical characteristics of wood and the immediate strength of the structures could well be included in future projects to speed up production through understanding and confidence.

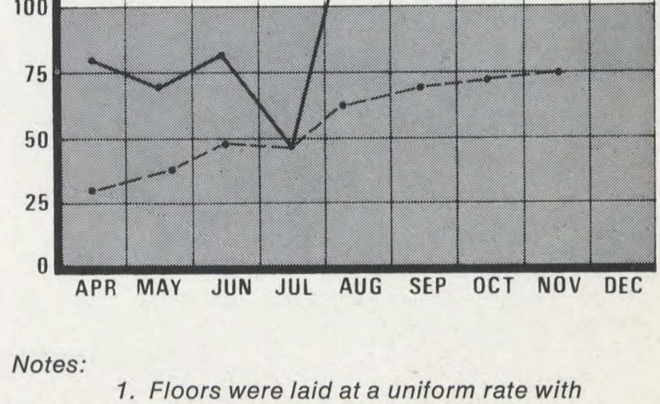
23 Floor Framing 14,122 m²

This activity refers to ground level floors wherein joists span from exterior basement walls to a central steel I beam and are covered by a plywood subfloor.



To make this operation go smoothly, the top of the concrete foundation should be level, smooth and square. The anchor bolts should be upright and uniformly spaced. These characteristics were achieved by close supervision to assist workmen to realize their importance toward fast laying of the floor joists.

The central beam was supported by adjustable posts which allow the beam to be levelled with the perimeter walls. For installation experience see activity No. 15 in the next section.



Notes:

1. Floors were laid at a uniform rate with productivity experience improving steadily.

2. Low production and training on the first

10 per cent of the job during April, May and June account for the lower productivity in that period.

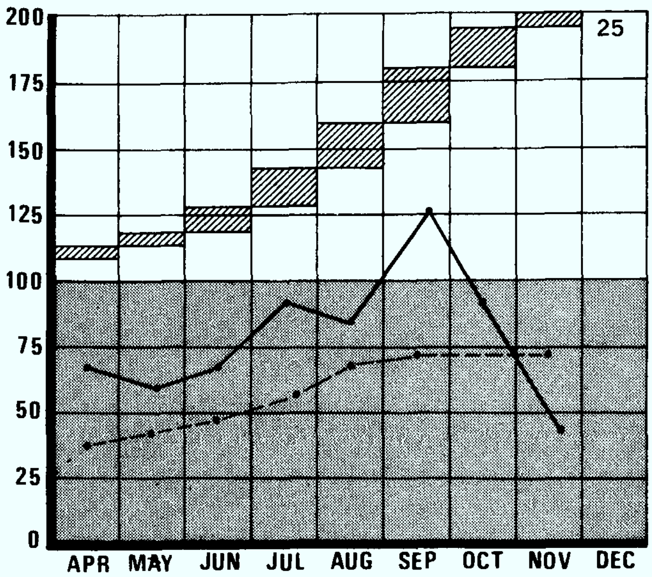
3. The poor experience in July is not accounted for.

4. During August, the rainy month, the largest increment of work was done at the best productivity.

5. Of the floor laying, 50 per cent was done at a productivity rate better than estimated.

25 Wall Framing 25,613 m²

The erection of prebuilt wall sections on a clear subfloor platform is relatively easy and can be estimated accurately. Good productivity was expected here and little allowance for training was included. The closeness of experience to estimate bears this out.



Notes:

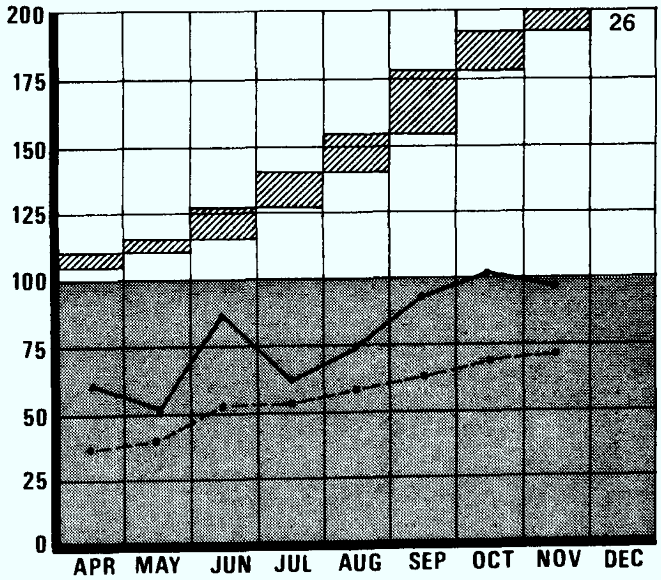
1. 60 per cent of the wall erection was done at the estimated productivity rate.

2. Low productivity usually associated with bad weather and in erecting the display homes did not materialize as significant in activities Nos. 23-25 and 26.

3. The rate of erection was steady due to the good production of subfloors in August.

26 Roof Framing 18,150 m²

Roof framing requires some experience especially when gables and changes of direction are involved. Few, if any, of the workmen had ever handled a truss before. Productivity varied according to the relative complexity of the roof design and the number of closely spaced repetitions of a particular roof. The graph below is an average for all house types. The poorer experience in April and May can be attributed to building the model homes where each one was new and different.



Notes:

1. As expected from the building sequence, production of roofs closely parallels the production of walls and follows the production of floors.

2. All of the structural assembly of the houses as represented by activities 23-25 and 26 was completed at the end of November and 75 per cent was done after July 1.

All three of these operations had large numbers of units (m²) involved, i.e. a total of 57,885 m² of surfaced structure was erected at close to Canadian estimates.

EXPERIENCE — SECONDARY TIMBER-FRAME ACTIVITIES

A basic concept of the timber-frame house is the cavity wall within which various amounts of insulation, vapour barrier, electrical, plumbing and heating conduits can be hidden and to which a wide variety of exterior and interior finishes can be applied. This is an important reason for its easy adaptability to the widest range of climatic environments and owner requirements for livability and sophistication.

Once the structural frame is erected many choices for finishing are available both in terms of need and desirability. The houses at Igny are completed at a high level of perfection and are well above minimum requirements.

Canadian timber-frame construction provides for a very high degree of insulation against extremes of heat and cold. In Canada, interior temperature conditions are, in practice, economically maintained at about 21°C (70°F) while the outside temperature varies from —45°C (—50°F) to 38°C (100°F).

The main reasons for this capability are:

(*a*) The timber frame itself —

i. Wood is a relative non-conductor of heat and cold so that thermal transfers are at a minimum.

ii. Wood is thermally dimensionally stable and does not expand or contract appreciably when subjected to fast and/or substantial temperature changes. No expansion joints are required and the numerous semi-rigid joints in the frame maintain their structural integrity.

iii. Dead air is an efficient insulator. There are numerous thin, contained air spaces built into the walls, notably between the exterior sheathing and wall insulation in the stud spaces.

iv. Air infiltration is carefully restricted by the use of panel sheathing inside and out and the installation of building paper gusseting around wall openings.

(*b*) The inclusion of insulating materials and techniques —

i. Fibreglass wool in batt form is normally inserted in all exterior walls, over ceilings and under floors where these surfaces separate the interior from atmospheric temperatures.

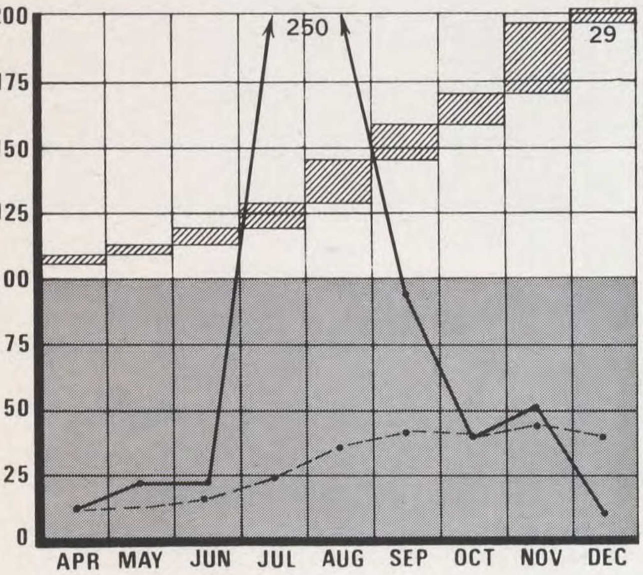
ii. The efficiency of insulating materials is maintained by keeping them dry through the incorporation of vapour barriers on the warm side of the insulation.

iii. Ventilators, installed in soffits, promote and control air circulation in the roof cavity and eliminate any risk of condensation induced by temperature gradients.

(*c*) The installation of ducted warm-air heating and/or air conditioning systems with automatic controls.

The installation of insulation in appropriate places and thicknesses together with integrated or separate vapour barriers is a secondary but essential activity in timber-frame construction. It is not a difficult operation but it has to be done carefully to be effective and close quality control is necessary.

29 Insulation of Walls 11,131 m²



The variation in productivity occurred because it was assumed that this was a simple operation and workmen would require little training. However, the speed and quality of the work done in the early stage required remedial action. In some instances insulation had to be reinstalled. Canadian supervisors took control in June and achieved a marked improvement in productivity which lasted for two months until new untrained men were added to the crew in November.

In November, the benefit of experience gained by the new workers in October could be observed. Productivity in this area declined in December when small intermittent amounts of work were done and supervision was reduced because Canadian instructors had returned to Canada.

Productivity in the installation of fibreglass insulation would have been higher if Canadian-style insulation batts, which are precut and packaged to fit between studs and joists, had been available. The material used on the site had to be cut and handled much more than anticipated.

The graph shows that, in spite of difficulties, productivity did exceed estimates for two months and that efficiency was achieved by training and supervision.

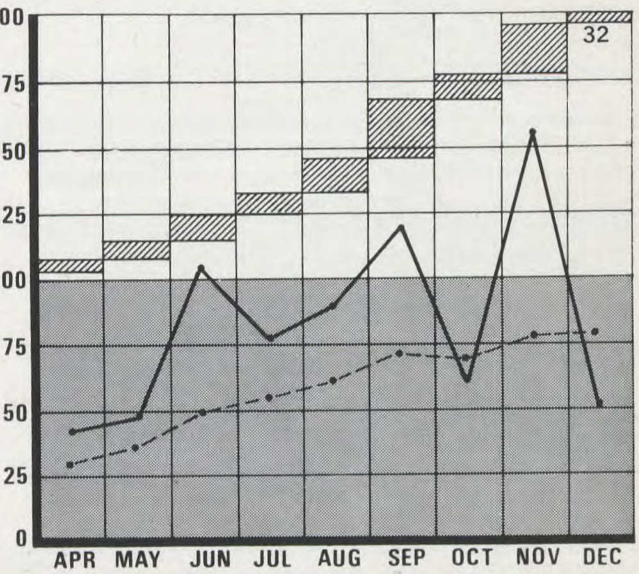
30 Insulation of Ceilings 12,062 m²

Most of the comments made on activity No. 29 also apply to this activity but difficulties here resulted from the form and packaging of the material which had not been designed for this use. The backing paper was too weak to allow the planned installation with staple guns; there was no integrated vapour barrier so an extra plastic sheet was applied. Productivity levels in this activity were one-third of estimates.

The display home phase up till mid-June was done with Canadian supervisors working with and training local labour. When this job control was withdrawn the experience reversed and productivity dropped. In October supervision and training were restored and new application techniques instituted. Much better productivity was achieved in November when the last 28 per cent of the work was done.

32 Roof Shingles 18,732 m²

The application of asphalt shingles on plywood sheathing was a skill which had to be learned by local workmen who were more accustomed to laying tile on spaced boards. The interface with flashing at roof valleys, dormers and chimneys was a detail requiring some special instruction.



Productivity varied directly with production which, in turn, was influenced by weather conditions. Experience in June, September and November showed 50 per cent of the work done was at rates better than estimated.

35 Plasterboard — Walls and Partitions 35,118 m²

Note: Graph for activity No. 35 (Refer to page 21).

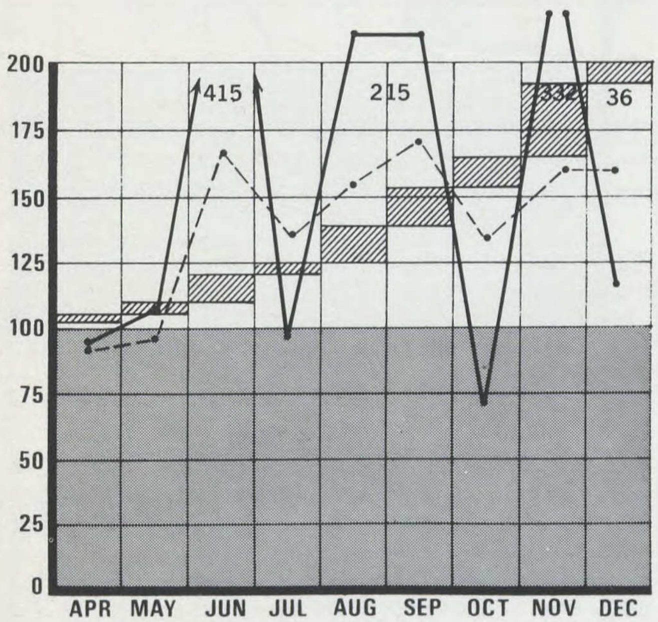
36 Plasterboard — Ceilings 16,440 m²

Plasterboard has become an essential part of timber-frame construction. It provides for rapid finishing of interior walls and, as a diaphragm, strengthens the structure. There are no delays in waiting for plaster to dry, no introduction of humidity to affect other operations and little handling and clean up. The smoothness of the surface is excellent and it resists hairline cracking.

It is important that handling such a labour saving material be efficient for there are many square metres used in every house.

Specialized mechanical equipment is available for the taping and finishing of joints and corners. Skilled operators can do perfect work with amazing speed. In Canada plasterboard installation and/or finishing is often a specialty subtrade.

Plasterboard available in France did not conform to interior wall sizes on this project, but techniques were developed quickly to use it efficiently. Over the entire project experience was satisfactory.



Notes:

1. After the initial training period in the display home phase, productivity levels were good.

2. Weather had no effect on this operation.

3. Lower productivity in October resulted from the temporary relaxation of supervision which was quickly reinstated with the desired improvement.

4. Productivity rates were below estimates for 75 per cent of wall work and 85 per cent of ceiling work, i.e. about 41,000 m² of surface.

EXTERIOR FINISH AND TRIM ACTIVITIES

37 Metal Lath — Exterior Finish 9,674 m²

Before this project, workmen were not experienced in the application of a stucco-type exterior finish over plywood exterior sheathing.

When proven methods were adopted as standard in September, productivity improved greatly. During August, September and October, 50 per cent of the work was done.

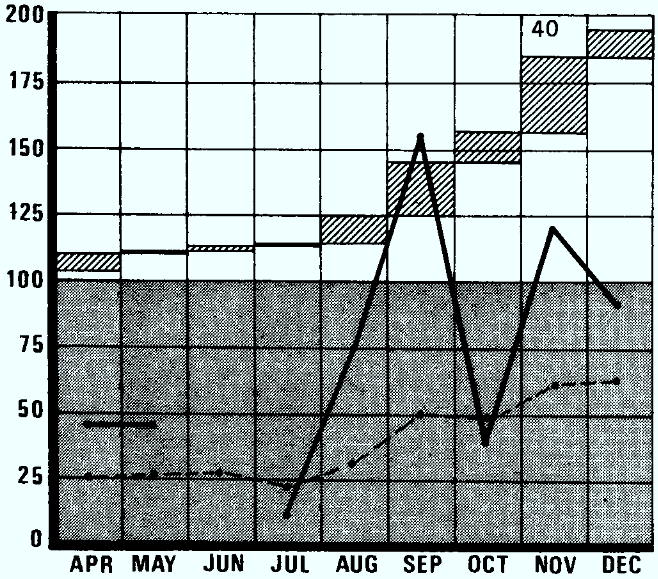
40 Aluminium Siding 4,587 m²

The application of aluminium siding as an exterior finish for timber-frame construction, common in Canada, was another innovation for France. It was used at Igny to demonstrate the variety of exterior finish compatible with the system. It appeared on only a few houses, most often on gable ends.

Productivity was low on the first 15 per cent of the job while training was in progress. Later in September (20 per cent) and November (30 per cent), productivity was better than estimated.

Timber frames can be faced with a wide variety of other materials or combinations of them. Clay or concrete brick, natural or artificial stone, wooden boards applied horizontally or vertically, provide variations in texture, colour and cost.

In well-designed projects, the contractor may restrict the choice in the interest of maintaining a particular appearance throughout in terms of model repetitions and exterior finishes. Parc des Érables was semi-restricted and used brick veneer and aluminium siding to provide variety with stucco.



42 Exterior Wood Trim — Windows and Doors
1,220 Units

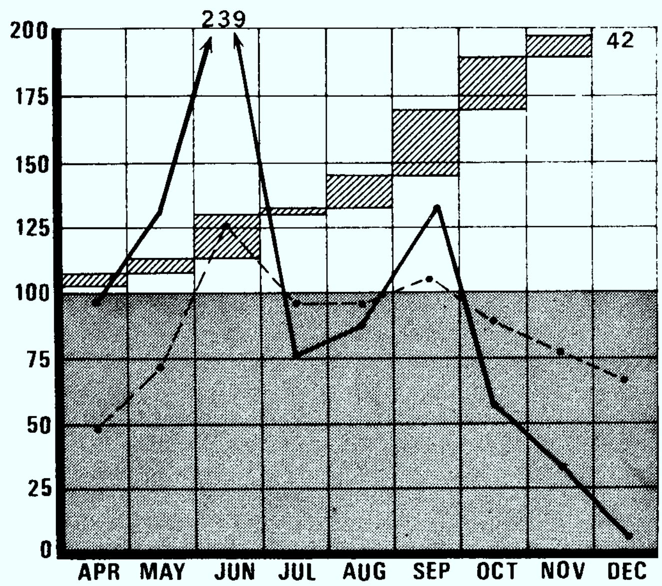
Windows were of French design due to building code and insurance regulations.

The installation of windows and doors can be divided into four operations:

(*a*) Fixing into rough openings.
(*b*) Trimming with wood mouldings.
(*c*) Final adjustment for operation.
(*d*) Final painting.

Operation (a) proceeded well. The doors and windows were preassembled and frames only had to be inserted into openings and fixed in place with wedges to assure their permanent alignment. The trimming and adjustment operations were slower than anticipated due to the need for organized and co-operative timing with other activities and to the cabinet making approach of the workmen. This latter accounts for the reduced productivity levels in October and November when most of the final trimming and finishing were done.

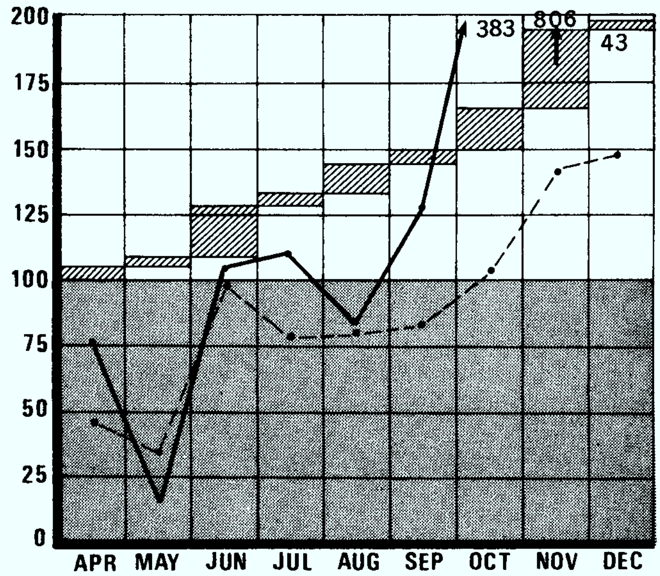
Painting was done by subcontractors.



43 Sliding Shutters — Installation 663 Units

Shutters on ground floor windows in France must operate to provide both weather and security protection. French shutters of various types with associated hardware are compatible with conventional French windows and wall construction. In Canada, shutters have become purely an architectural feature — they do not operate and have no purpose other than decoration. Thus at Igny the exterior elevations of the Canadian-style houses had to be adjusted to accommodate the relatively heavy appearance of shutters. It was also necessary to design and find a source for shutters to work with the timber-frame structural system.

The relatively thin timber-frame walls made it necessary for shutters to be mounted externally. Most took the form of sliding panels suspended on metal tracks. Only 47 roll-up type shutters were installed.



Notes:

1. When production techniques were developed on the display homes, productivity in installing shutters was high for 95 per cent of the work.

2. It appears likely that some man-hours were mixed between this activity and the previous one (No. 42) in the latter stages when the same workmen made final adjustments to the operation of windows and shutters at the same time. The November productivity changes should not have been as extreme for both activities and probably were not.

COMPONENT MANUFACTURING PLANT — MONTSAULT

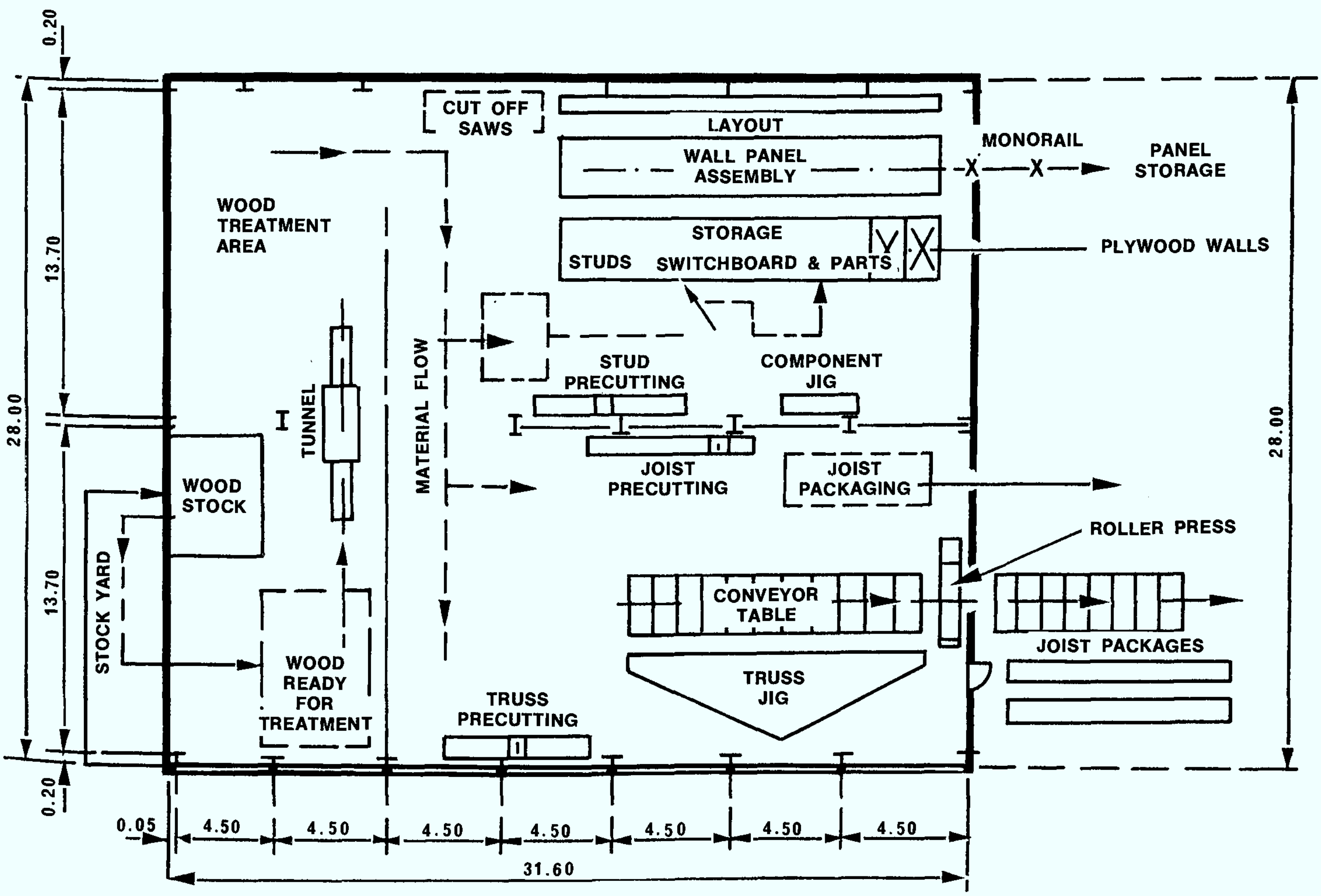
Timber-frame houses can be built using different degrees of factory production from the minimum, known as site or stick building where basic materials are cut to required size and assembled on site, to the maximum, where the house is built, decorated and even furnished in a factory and transported as one or two, three-dimensional units. Site construction does not provide all the proven advantages of mass production and control possible and is usually only employed for single buildings on remote sites. Complete factory construction requires a large continuing market and a sophisticated plant. In Canada an intermediate method of construction is common where most structural components are produced in a factory and economically transported to surrounding building sites. Campeau Corporation uses this method in Ottawa, Canada, and it was used successfully at Igny by Dumez-Campeau S.A. It provided many of the benefits of control without the substantial cost of a complete factory. It was considered the most advantageous system for demonstration to French builders.

The component plant is a light framed warehouse-type building with outside storage for bulk quantities of lumber and plywood. The yard was paved to facilitate the use of materials handling vehicles. Inside, the manufacturing equipment was arranged along the two long sides at ground level. Roller conveyors and an overhead crane moved the raw materials, components and finished panels.

The main operations in the plant were:

(*a*) Cutting of lumber and plywood with power saws;
(*b*) Laying out of component parts in adjustable table jigs;
(*c*) Nailing and/or stapling assembly of components with power nailers;
(*d*) Laying out and assembly of roof trusses using metal connectors with a Trans Canada Truss System roller press;
(*e*) Applying a wood preservative to lumber structural components with bath type equipment.

The plant and equipment — capital cost of approximately 500,000 francs — was scaled to produce



PLANT DIMENSIONS SHOWN IN METRES

components for two houses per day on a one eight-hour shift basis. It was efficient, though not sophisticated nor automated, and proved to be more than adequate to supply the Igny project. Visitors to the plant expressed some surprise that it was not a fully automated mass production operation. Such automation was not necessary; this simple operation was efficient because it was compatible with the size of Igny and other foreseeable projects. It was controllable without having to carry heavy overhead charges. The plant was operated at an efficient rate for two months in mid-summer and produced components at better than estimated costs. A factory of this size should be capable of producing the components for 500 or more houses annually within a radius of up to 200 kilometres.

The products of the plant were:

1. Exterior wall panels with plywood sheathing on the exterior face of lumber frames. Window and door openings were framed-in according to different house designs.
2. Interior partition sections framed for doors and corner connections but without cladding. Bearing partitions used studs at 16″ o.c. — non-bearing at 24″ o.c.
3. Dwarf walls for split-level house designs.
4. Gable ends with exterior plywood sheathing applied.
5. Gable end roof lookouts without roof sheathing.
6. Roof trusses of all required slopes and spans including graduated trusses for roof intersections and soffit overhangs as needed.
7. Basement and first floor stair assemblies.
8. Some types of window shutters.
9. Precut joists, door sills and incidental trim pieces.

Additional items which could easily be made in the plant are precast concrete products such as porches and steps, patio slabs and chimney caps and sheet metal components such as flashings or duct work and iron work, for example reinforcing rod fabrication and ornamental railings.

The products of the component plant were considered to be manufactured and are subject to TVA (taxes on value added) of up to a maximum of 23 per cent of the total selling price.

Control was the main benefit of the component fabrication plant. It facilitated material handling, fabrication, inventory, delivery and quality control in all kinds of weather and was independent of building site conditions. Control of labour in training was an important benefit to the Igny project. It was much more efficient to train the small plant staff of less than 10 men in production line assembly operations than to train erection carpenters on the site.

SUBTRADES

Subcontracting of elements of residential construction is well developed in both France and Canada but the system in each country is related to traditional methods and materials in use locally. French subcontractors were used as often as their skills were appropriate to the timber-frame system but contractors were not available for some of the activities normally so handled in Canada.

The main subcontracts were for the supply and installation of materials for services — electrical, plumbing, heating and painting. The contracts were of standard format including mandatory guarantees. Price variations were tied to national indices.

The experience with subcontractors at Igny was good. They co-operated sincerely in adhering to production schedules and in doing first-class work in somewhat unfamiliar circumstances.

Electrical installations in timber-frame construction are relatively easy because of the open structure and the ease of working wood. However, it was different from the usual French installation so that the contractor specified modified methods of installing the electrical system to satisfy codes and standards which referred to traditional concrete and masonry construction. Most of the differences were foreseen and resolved in the design and planning stage while the contractors studied plans and cross-sections of the houses in advance to visualize how to lay out circuits and install distribution panels. On-the-job installation went smoothly so that, early in the project, the work became routine.

The plumbing subcontractor had similar good experience. Early problems were soon taken care of with the aid and advice of Canadian supervisors. From the timber-frame point of view, the general contractor was able to accommodate the needs of services subcontractors easily.

Heating is an important factor in the livability of a home. In Canada, ducted warm air systems are most common and economical. They provide automatic controlled circulation of air from gas or oil fired furnaces through heat exchangers. Subcontractors usually handle sales, installation and maintenance. Subcontractors of the same type were not available in France where hydronic systems are prevalent. It was an objective of the Igny project for this system to be an essential part of demonstrating typical Canadian-style homes. However, delays in receiving official acceptance resulted in only the X-ray model home having a Canadian-type heating system.

It is expected that the Igny experience has helped introduce ducted forced warm air heating as a potential standard installation in future projects.

Information on the acceptability and installation of the Canadian system is available from the offices of Gaz de France; Comité Scientifique et Technique de l'Industrie des Chauffage et de la Ventilation; Ministère de l'Equipement et du Logement and from the Canadian Embassy — all in Paris.

Of the 114 homes at Parc des Érables, 113 have traditional hydronic heating systems. The subcontractor soon found, as did the electrical and plumbing men, that installation in timber-frame houses is fast and economical.

The prices for subcontract trades were relatively high which reflected the extra design time used to convert traditional methods and materials to timber-frame needs. Coverage of an element of risk from lack of experience was another factor. It can be reasonably predicted that future subcontract prices will reflect the experience gained and more competitive bids will be forthcoming on subsequent work.

In the subcontracted painting, there was no significant cost difference between decorating the Parc des Érables houses and traditional French houses. Methods and materials were similar except that Canadian practice is to make more use of powered spray application both for base coats and finishes of walls and ceilings.

Other construction activities which are normally subcontracted in Canada and which are expected to develop in France are:

(*a*) Excavation — site work including back filling
(*b*) Concreting — formwork and placing concrete
(*c*) Damp Proofing — spraying basement walls

(*d*) Masonry — concrete block and bricklaying
(*e*) Framing — the on-site erection of prebuilt components
(*f*) Roofing — the installation of shingles
(*g*) Drywall — the installation and finishing of plasterboard
(*h*) Flooring — finish floor materials and laying
(*i*) Stucco — application and finishing
(*j*) Aluminium — siding and trim including soffits
(*k*) Metal work — supply of sheet metal flashing and ornamental iron work.

Where this amount of subcontract work can be arranged, the general contractor is mainly concerned with organization and scheduling and has the benefit of specialist workmen and firm prices.

In France, subcontractors for these secondary trades specifically related to timber-frame construction will develop from Igny workmen who have been trained and have the necessary personal initiative.

ECONOMICS OF THE PROJECT

The costs and final selling prices of the houses at Parc des Érables were higher than originally anticipated. However, the owners of the homes got good value and have superior homes in an excellent location at competitive prices.

There are good reasons for some unusual costs on the project. Basically they stem from: the demonstration nature which had an escalating effect on the management overhead; the cost of the land was as much as 250 per cent more than other sites in the general area but was necessary to give the project all the advantages of location for public relations and advertising purposes; the decision to have an early opening and to provide the site with parking and reception areas and first class access roads at the same time made the project different from an ordinary commercial development.

It should be noted that the houses were sold by Dumez-Campeau S.A. to GEPRO at a contract price established by estimates produced late in 1969. This price only varied by the amount allowed by the referenced indexes. Thus any other cost increases were borne by the contractors and were not passed on to GEPRO or to the final purchasers. The selling prices per square metre both to GEPRO and to final owners is a matter of record and were controlled by Crédit Foncier limits. The actual costs are the contractor's private business.

The graphs which have been included in this report refer to the cost estimate mentioned above as the datum so that the number and amount of variations for numerous construction activities can be seen. Some of these extras had been anticipated, e.g. those due to on-the-job training, and the provision of Canadian supervisors.

The complete project of 114 houses consisted of the following models with the number of each one constructed:

MODEL		NO. CONSTRUCTED
Vaudreuil	crawl space	15
Vaudreuil	crawl space — double	10
Vaudreuil	full basement	22
Champlain	crawl space	5
Champlain	full basement	5
Champlain	crawl space — double	16
St. Laurent	full basement	20
Boischatel	crawl space	11
Beauport	full basement	10
		114

Using this breakdown as a base, three facts emerged from the project:

1. Total usable floor space 19,936.2 m²
2. The average cost per finished house, exclusive of land and services 659 frs, per m²
3. The average number of man hours per house 1,800

CONCLUSION

The Parc des Érables project was a successful demonstration of the building of Canadian-style timber-frame houses in France. Valuable experience was gained which will be advantageous to house builders and material suppliers in both France and Canada.

The project drew the co-operation of building authorities and financial groups and resulted in widespread acceptance of a new "traditional" method. Approval by housing authorities of the timber-frame construction system makes all-weather factory production of transportable houses available in France to assist in the solution of housing problems. The public as well as design, construction, materials supply and trade groups have been introduced to the system which will ease starting operations in future developments.

As a result of the project at Igny:

- A number of subtrade contractors have designed and carried out timber-frame installations for the first time. The differences they encountered from their usual procedures have been identified and their experience recorded.
- A nucleus of trained workmen has been developed.
- The production norms for profitable timber-frame construction activities have been determined and the influence of conditions affecting them measured.
- The amount of training and supervision likely required for workmen to learn and apply new skills has been determined.
- The project has demonstrated the efficiency and flexibility of prebuilding structural wood-frame components in a modest plant and advantages with respect to the transportability, ease of handling and speed of erection of timber-frame components compared with components of other materials such as concrete.
- Building materials manufacturers have seen what product modifications are most required in supplying the timber-frame housing market.

Visitors' comments, supported by the sales record, showed that Canadian-style timber-frame houses are attractive to French home buyers. The most popular models had the most Canadian features, often those associated with habitable basements. There was a strong preference for designs with family rooms, large kitchens, mud rooms and built-in garages, especially when these features were available at reasonable cost per square metre. This demand resulted in a mid-project change in style emphasis and the building of more full basement models.

Acceptance of warm air heating systems should be more easily obtained in future projects because of the development work done and approvals received based on the Igny experience. In addition to reasonable costs of installation and operation, this feature of modern Canadian homes adds substantially to their comfort.

One of the main advantages of timber-frame construction is the speed of erection using either on-site or factory-built components. This aspect was demonstrated at Igny where 114 houses (10 different styles) were started in December, 1969, and completed, except for some interior finishing, by the end of December, 1970. The major part of the construction took place between June and November, 1970, when 75 per cent of the houses were completed (15 houses per month).

The speed of completion is further accelerated by the use of a dry form of construction complemented by drywall interior finishes as opposed to the "wet" or masonry type construction using plaster. Paintwork can be finished immediately after completion of the interior dry-wall application. In addition to being advantageous to the builder, dry construction also imparts a sense of comfort and warmth (dryness) to the home buyer. This is an extremely important sales point.

Timber-frame construction offers the advantages of system building, lower labour costs through use of semi-skilled labour and allows for tight control of material costs. In addition, large capital outlay for factory building and equipment is not necessary as a simple building and relatively inexpensive machines can be used.

Timber-frame construction requires a minimum of training to develop the necessary skills to erect the unit and site supervisory requirements are no greater than normal to maintain productivity and quality standards in traditional building methods.

The Igny project showed that French home buyers are receptive to innovation and the qualities offered by timber-frame. The system demonstrated flexibility of design at reasonable cost. Variety in exterior appearance, internal room arrangements and installed equipment as required by buyers were accommodated without affecting the basic construction techniques and materials. Parc des Érables provided ample evidence that wood-frame is a desirable form of residential construction readily applicable to conditions in Western Europe and one which can be carried out with a high degree of factory pre-building and a corresponding reduction in labour costs and weather dependency.

Copy of the CSTB (French Government) approval given to the Canadian timber-frame method of house construction as built by Société Dumez-Campeau in France.

CSTB
Paris, France
1969

Société Dumez-Campeau
345, av. Georges-Clemenceau
92 - Nanterre

DECISION No. 3272

IDENTIFICATION AS TRADITIONAL METHOD

The Approval Committee for Wood-Frame Housing, consisting of representatives of the following organizations:

- Directorate of Construction of the Ministry of Equipment and Housing,
- National Centre of Technical Studies for Low Rent Housing (HLM),
- Central Building Society of the National Savings Bank (Caisse des Dépôts),
- Order of Architects,
- Bureaux de Contrôle Securitas and Veritas (independent inspection agency),
- French Association of Civil Engineering Consulting Engineers,
- Interprofessional Technical Union for Building and Public Works,
- National Association for Individual Housing,
- National Union (of local Chambers) for Framing, Joinery and Flooring,
- National Federation of Manufacturers of Joinery, Framing and Prefabricated Units,
- National Association of Builders of Joinery, Curtain-Walls and Metal Partitions,
- National Association of Manufacturers of Infill Panels,
- National Federation of Associations for Thermal Insulation and Sound Insulation,
- Associations of Manufacturers of Specialized Materials,
- Technical Centres, Laboratories and Specialists,

has examined the methods for the prefabrication and erection of light timber houses developed by the DUMEZ-CAMPEAU company in Nanterre (92).

On the request of the above-mentioned firm and in view of its observations, the method, as defined in technical extract No. 3272, is hereby considered a traditional method, subject to the following conditions:

Installation Conditions:

The vapour-barrier must not contain any gaps. Work employing traditional methods (roofing etc.) or approved procedures (partition walls) must be erected in conformance with DTU or other applicable regulations.

Kitchen and bathroom walls must be protected with impervious paint or a watertight facing.

If asphalt roof shingles are used in roofing, the standard requirements of standard ASTM 225.62 T shall be observed as well as the rules applicable to spacing of houses whose roofs consist of easily inflammable materials.

Conditions of Use:

The use of this method is limited to the construction of individual two-level houses on a masonry foundation.

Houses erected in Summer E 111 zones must be equipped with a heavy floor (i.e. concrete).

Paris, July 21, 1969
The Director of the CSTB
G. BLACHERE

TECHNICAL EXTRACT

I. METHOD

Construction method based on a supporting frame of timber permitting the construction of two-level houses on masonry foundation.

II. MATERIALS

Resinous North American wood (hemlock, Douglas fir etc.) for framing elements and roof structures.

Phenolic-glued plywood or Douglas fir or spruce:
- 8 mm thickness for the exterior load bearing wall panels,
- 12.7 mm thickness for the roof sheathing and floors.

10 mm thick gypsum board for ceiling linings; 13 mm thick gypsum board for the inner sides of walls.

Semi-rigid mineral wool batts of 45 mm thickness on vapour barrier for thermal wall insulation, and 45 mm thick mineral wool batts on a vapour barrier for ceiling and floor insulation.

Bituminized felt 18 I and 27 S.

Polyethylene sheet, 150 μ thickness.

Brick veneer (11.5 cm thick) and quarry-stone (10 cm thick) for the exterior siding of the structure.

Light partition walls of approved type.

III. PREFABRICATED ELEMENTS

1. Wall Elements

These panels are 2.53 m high, 5 m max. wide and 10 cm thick.

They consist of 40 x 90 mm studs placed at 0.60 m intervals, and upper and lower plates of similar dimensions. Additional studs are placed at each angle and at each partition wall connection. All elements are assembled by nailing.

The external wall consists of 8 mm thick Douglas fir or spruce plywood, nailed and stapled to the frame.

2. Wall Elements containing openings

These use the same system, the studs being doubled on both sides of the bays. The lintels consist of two 40 x 190 mm joists separated by plywood of 50 x 190 mm, 10 mm thick.

3. Exterior Millwork

The external joinery, of tropical hardwood, is placed in a bay frame of the same type in the factory. Shuttering is also installed here. This forms a unit that can be installed in wall panels on the building site.

4. Partition Walls

The partitions are identical to the wall panels. Light partition walls of an officially approved type may also be used.

5. Roof Framing

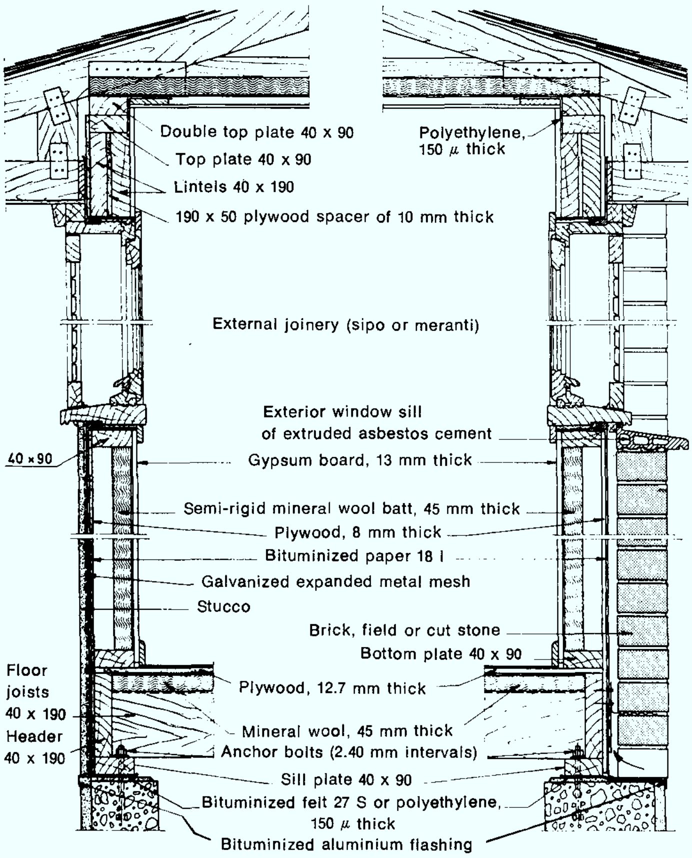
The roof framing (light trusses composed of 40 x 90 mm dimensional lumber assembled with pressed galvanized steel plates, or glued and nailed gussets) is traditional.

The gable trusses, sheathed with 8 mm plywood, are lower, in order to support the ladders constituting the frame of the gabled roof projections.

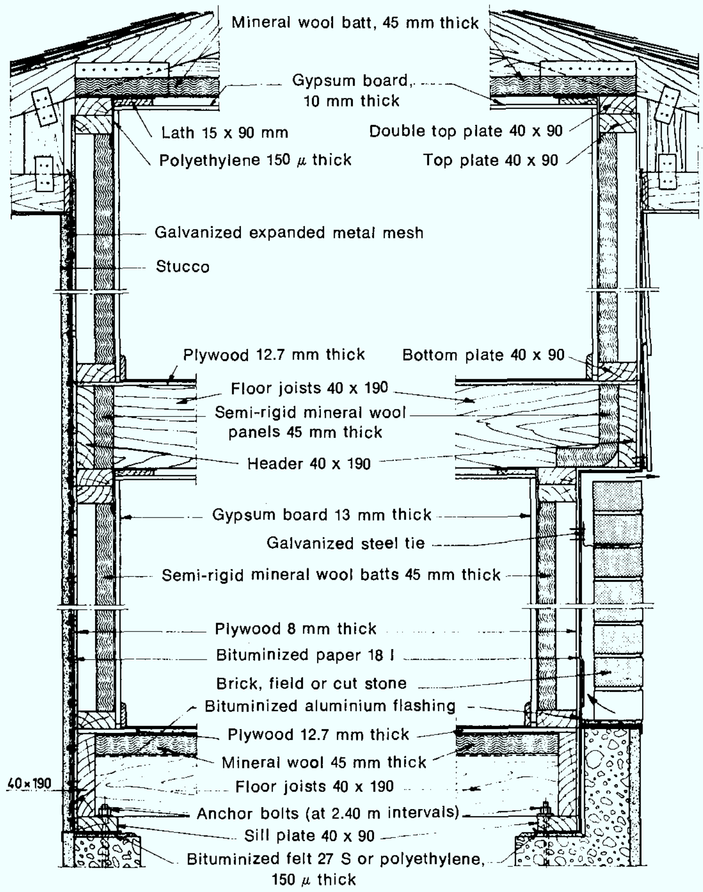
IV. ERECTION

The house is erected on a masonry base forming a basement or crawl space.

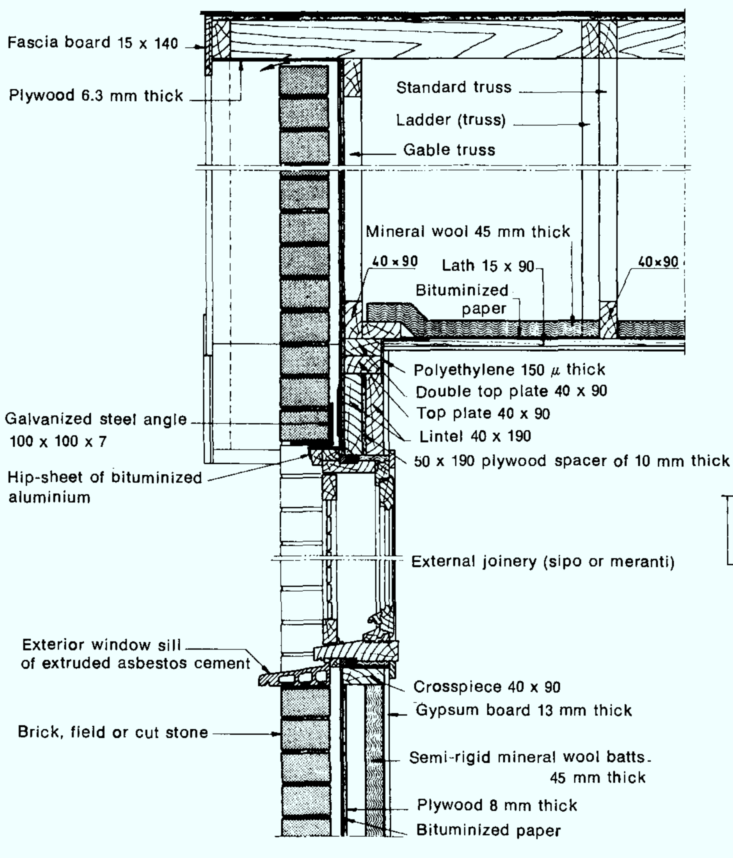
FACADE BAY VERTICAL SECTION



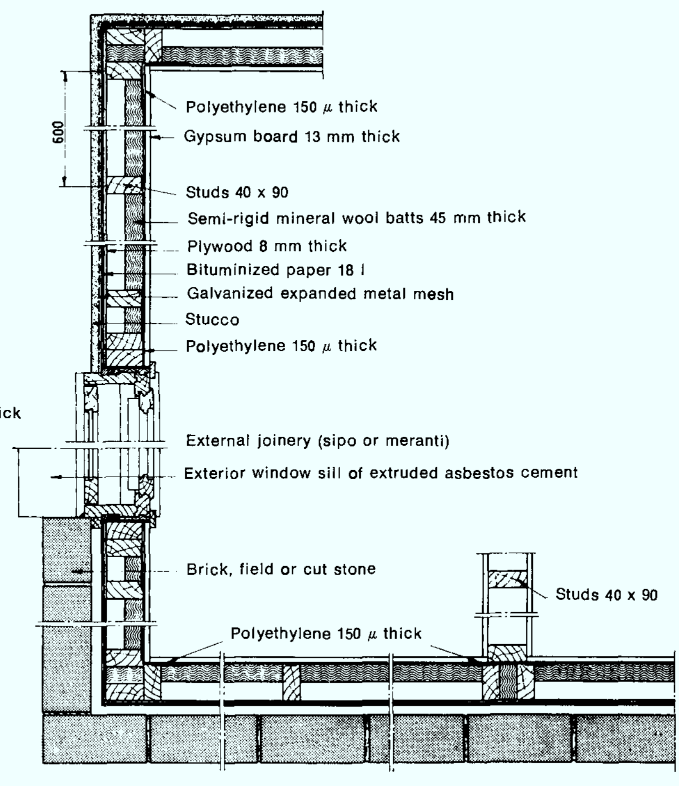
VERTICAL SECTION R + 1



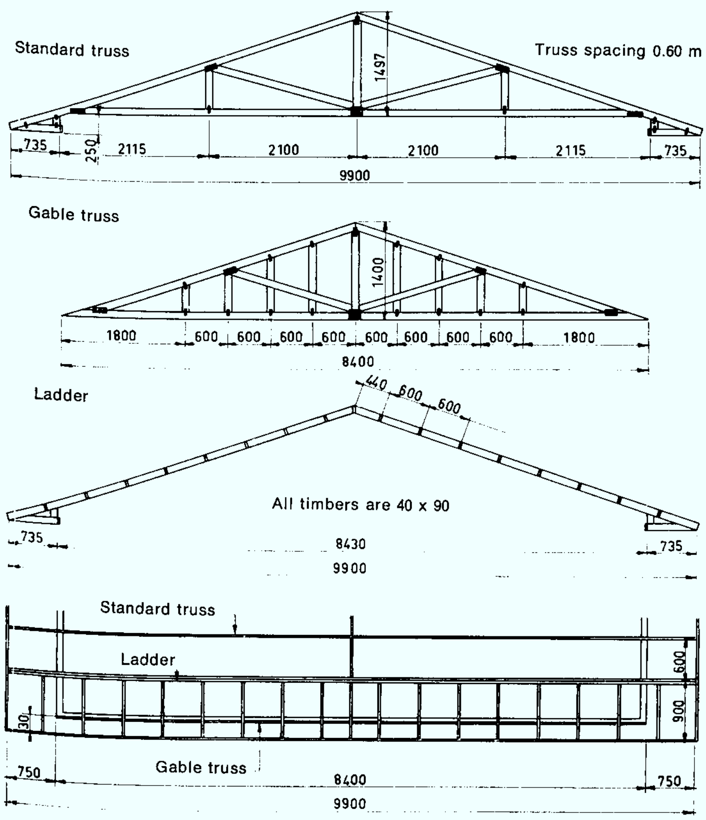
GABLE VERTICAL SECTION



HORIZONTAL SECTION



Framing (roof)



1. Floor

The wooden floor is constructed in the following manner:

A 40 x 90 mm sill, placed in a mortar bed (for adjustment) is fixed on the perimeter concrete foundation and a central beam, with the aid of embedded anchor bolts placed at intervals of 2.40 m, after the laying of a bituminized felt or a 150 μ thick polyethylene sheet.

This sill supports the floor joists and the 40 x 190 mm joist header.

The joists are placed at a distance of 0.305 m o.c. Continuous header and joists are fixed together, and to the sill, by nailing.

Floor insulation is achieved by a 45 mm thick mineral wool batting with vapour-barrier, stapled between the joists and supported by a nylon net previously unrolled across the latter. (Note: in practice, insulation was applied without use of nylon net.)

Tongued and grooved 12.7 mm thick plywood sheets are nailed to these joists.

2. Assembly of walls and partitions

Wall panels and partitions are fixed at the base by nailing through the bottom plate, laterally by nailing to the studs of adjoining panels, and at the top by nailing a 40 x 90 mm top plate to the upper panel crosspiece.

Thermal insulation of wall panels is achieved by 45 mm semi-rigid mineral wool batts with vapour-barrier, stapled to the panel studs.

A moisture barrier is obtained by stapling bituminized paper 18 l to the outer sides of the walls. This paper is laid down horizontally with wide overlaps and turned back into the bay openings.

The window and door units are inserted from outside and attached to the frame by screws. Peripheral joints are caulked with a butyl lining after application of a base of bituminized plastic foam.

Polyethylene strips are stapled to the insides of the studs, in the wall corners and in the angle formed by the ceiling and the external walls.

3. Second Floor

Joists and joist header, of 40 x 190 mm, are nailed to the top plate of the wall and the partition wall panels. The inner sides of the joist header are lined with 45 mm thick semi-rigid mineral wool panels.

Tongued and grooved 12.7 mm thick plywood sheets are nailed to the joists.

The upper floor walls and partitions are erected in the same manner as those of the lower floor.

4. Roof assembly

The trusses, spaced at 0.60 m, are kept at this distance by 40 x 90 mm blocking pieces, nailed at the peak.

The trusses are nailed to the top plates of the walls.

Roof sheathing consists of 12.7 mm thick Douglas fir plywood nailed to the trusses.

The roofing is traditional.

5. Interior finishing

(a) Ceiling

10 mm thick gypsum wall board is nailed to 90 x 15 mm lath nailed to the ceiling joists at intervals of 0.40 mm.

A 45 mm thick mineral wool batting with vapour-barrier is unrolled between the ceiling joists to provide ceiling insulation.

(b) Walls and partitions

13 mm thick gypsum wall board is nailed to the panel framing.

(c) Floor covering

— 8 mm thick oak flooring
— Glued plastic lining (vinyl tile, etc.)
— Textile floor covering

In the bathrooms, a 40 mm reinforced concrete resurfacing is poured over the plywood sub-floor and moisture proofing is provided by a polyethylene sheet raised at the baseboard.

6. Exterior Siding

Bituminized aluminium flashing is first stapled to the lower part of the outside of the wall.

Wall finishing

The base consists of galvanized, ribbed sheets of expanded metal, stapled to the framing. The covering is applied in three coats with a total thickness of 25 to 30 mm (stucco).

Masonry facing

This consists of brick, field-stone or cut stone. The wall is built at a distance of 25 mm from the outer side of the wall panels and attached by galvanized steel clips fixed to the studs.

Perpendicular to the door or window openings, the lintels are supported by 100 x 100 x 7 mm galvanized angle iron. An exterior window sill of extruded asbestos cement (Eternit) is imbedded in the masonry.

The joint between the window or door frame and the masonry is lined with mastic.

The vertical joints of the first course are not sealed so as to permit air circulation.

Siding

This is either Douglas fir or redwood nailed to 25 x 50 mm battens which are nailed vertically to the studs, or "Masonite" nailed directly to the outer side of the walls across the moisture barrier. Connections are made by parts supplied by the manufacturer.

V. PROTECTION

All timber is treated with an insecticide and fungicide product under label CTB-F.

VI. FEATURES

Average thermal conductivity coefficient K:
— walls: 0.5 kcal/m^2.h °C
— lower floor: 0.7 kcal/m^2.h °C
— ceiling: 0.7 kcal/m^2.h °C

VII. REFERENCES

This method is used by the CAMPEAU CORPORATION Ltd. in Ottawa (Canada) for the construction of 800 to 1,000 houses per year.

EXTRACT OF APPROVAL COMMITTEE REPORT

The Approval Committee makes the following main observations:

1. This building method employs the technique of timber-frame construction, widespread in North America and used by the CAMPEAU company in Canada.

2. Stability is provided by the wood frame which is assembled and braced, for the walls and the roof, with phenolic-glued plywood sheets.

3. The use of gypsum board lining throughout (walls, partition walls, ceiling) satisfies fire safety requirements.

4. The application, on the building site and in finishing operations, of a continuous cladding (masonry wall, reinforced coating, or siding) solves the problem of rainproofing in a traditional manner. Certain precautions must be observed in the use of these linings:

- when building the masonry wall, avoid sealing the air space between the masonry and wall panel;
- with respect to the coating:
  - a satisfactory coat can only be obtained on a well-secured base, sufficiently separated from the support,
  - in order to prevent cracking, it is necessary to use a proper stucco mix,
  - the three coats should be applied at adequate intervals;

For this purpose, we refer to the National Building Code of Canada, supplement No. 5;

- with respect to wood claddings, visible fixing elements should be of anti-rust metals for external finishing, use stains or paints permitting relatively easy upkeep without varnishes.

5. American building technique does not employ a ventilating air space on the inner side of the wall (support section); the wall is a "breathing" wall and the external moisture barrier consists of a paper permitting the passage of water-vapour. In this type of wall, it is important for the internal vapour-barrier to be continuous and special attention should be directed to this point during assembly.

6. In the bathroom, the pouring of a reinforced concrete floor slab on a waterproof sheet is an interesting technique that satisfactorily solves the problem of floor conservation. However, in order to avoid differences in the floor level, it is recommended to reduce the size, and consequently the span, of the floor joists.

7. Although this type of construction is intended for single-family homes, it is advisable to improve the sound insulation of the floors.

8. The lightness of the interior walls and the resulting low thermal inertia call for special arrangements to ensure the comfort of occupants in summer and winter. In this respect, follow the recommendations applicable to the various climatic zones enumerated in the European Technical Approved Union's (UEAtc) "Approval requirements for light houses." The builder is particularly requested to consider the installation of a heavy floor in the Summer III climatic zone (Mediterranean area).

9. Since this building method exclusively employs traditional techniques of joinery, framework and masonry, it is recommended that it be declared traditional.

The General Reporter
P. ROGER
Department head of the CSTB

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