THE USE AND PRODUCTION OF CONSTRUCTION – GRADE PLYWOOD IN CANADA

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THE USE AND PRODUCTION OF CONSTRUCTION-GRADE PLYWOOD IN CANADA

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ABSTRACT

Investment in the construction of new structures, and conversions, alterations and repair to existing structures, has represented a dynamic element in the growth of the Canadian economy over the post-war years. This paper appraises the utilization and production of construction-grade plywood, one of the more recent innovations in building products, against a background of rising levels of construction activity in Canada.

Construction-grade plywood, some 92 per cent of which is made from softwoods, has a number of competitive advantages in the building industry in Canada. Its major market gains in earlier years were at the expense of sawn wood, despite the fact that sawn wood was less expensive. The speed of erection of the four by eight-foot plywood panels cuts production costs both in the factory and on construction sites. This has become increasingly important as levels of wages increase in Canada. Plywood's strength/weight ratio is one of the best of any structural material and has enabled it to penetrate end-uses previously dominated by steel, particularly when relative prices are considered. Composite woodboard, such as particle board and fibreboard, has made few inroads into the major Canadian markets for construction-grade plywood, despite the advantage of lower cost of production for the former. This is due principally to the dimensional stability of plywoods and their ability to resist weathering. The totally waterproof glueline (phenolic resin) in Canadian construction-grade plywood, coupled with quality veneers, is a major reason for its success in competition with lumber and composite boards as well as with non-waterproof plywoods.

Six major end-use markets are recognized for construction-grade plywood in Canada; (1) residential construction (23%), (2) non-contract home and second-home use (25%), (3) non-residential construction excluding farm construction (13%), (4) farm construction (11%), (5) government (less than 1%) and (6) industrial uses. The first five markets together account for about 73 per cent of the total market for construction-grade plywood in Canada. The sixth, the non-construction market, absorbs some 27 per cent of construction-grade plywood. Plywood has a wide variety of uses within these major markets. This paper describes these uses in detail and briefly examines the qualities of plywood that have adapted it to these markets.

In 1966, production of construction-grade plywood totalled 1.7 million cubic metres (1.9 billion sq. ft., 3/8-inch-

thickness basis, unsanded). Output of softwood plywood - which consists of Douglas-fir, balsam fir, pine and spruce - amounted to almost 1.6 million cubic metres (1.8 billion sq. ft.), and hardwood plywood processed from poplars totalled 145 thousand cubic metres (164 million sq. ft.) in 1966. In terms of geographic location, the production of construction-grade plywood is largely concentrated in British Columbia where 1.4 million cubic metres (1.6 billion sq. ft.) was processed in 1966. Over the 20-year period 1946 to 1966 output of construction-grade plywood increased at an average annual rate of more than 11 per cent, compounded. Indicative of the degree of penetration that plywood has made in building construction and other industries, this rate of growth is double the annual rate of increase in total construction outlays during the corresponding 20-year period. Current annual rates of increase, which have averaged 10 per cent over the past six years, stem from both the export and domestic markets. Apparent domestic consumption per 1,000 population has been rising at an average annual rate of more than 7 per cent, compounded. Since 1960 exports of construction-grade plywood for sheathing have tripled. Initially, the United Kingdom was by far the largest purchaser but, while it has remained the leading market in recent years, a more diversified export market is being achieved.

Productivity in the plywood industry increased by an average annual rate of 6 per cent, compounded, during the six-year period 1960 to 1966. While much of this increase was supported by a skilled labor force whose hourly earnings moved up by an average annual rate of almost 5 per cent, compounded, a very important part of the increase was stimulated by high levels of investment in new equipment with technological improvements. Many fully automated and semi-automated control systems were introduced in log preparation, in veneer production - particularly in lathe processing - in veneer drying and processing, and in press operations and panel finishing. One of the outstanding developments was the installation of double-concentric spindle units that permit blocks to be peeled to a core diameter of four inches without reducing lathe speed. This innovation was among the primary technological changes that enabled the supply base to be extended to large commercial forests of small-diameter trees.

EXTRAIT

La croissance rapide de l'économie canadienne depuis la guerre résulte en partie des investissements favorisant la construction, modification et réparation de bâtiments. Une évaluation de la production et utilisation du contreplaqué, matériau de construction employé depuis relativement peu de temps, est présentée ici à la lumière de l'activité toujours croissante de la construction au Canada.

Le bois contreplaqué, tout en étant plus coûteux que le bois scié, a remplacé celui-ci dans une certaine mesure comme matériau de construction; les contreplaqués (dont 92 p. 100 proviennent de bois résineux) en effet présentent plusieurs avantages sur leurs concurrents. Par exemple, des panneaux (4 X 8) de contreplaqué s'installent très rapidement, ce qui diminue les frais de construction non seulement à l'usine, mais aussi sur le chantier. D'ailleurs, le rapport <<résistance aux forces de compression, etc./poids>> très élevé du contreplaqué comparé à celui des autres matériaux de construction le fait préférer parfois à l'acier surtout si l'on tient compte des frais relatifs. Enfin, en raison principalement de sa résistance aux intempéries ainsi que de la stabilité de ses dimensions, le contreplaqué s'emploie de plus en plus au Canada, et de préférence aux panneaux composites de bois comme le panneau aggloméré et le panneau de fibre, malgré les frais plus élevés.

Les joints imperméables (de résine phénolique) et le placage de qualité permettent au bois contreplaqué canadien de l'emporter non seulement sur le bois de construction et les panneaux composites de bois mais aussi sur le contreplaqué qui n'est pas imperméable à l'eau.

En général, le contreplaqué canadien, en tant que matériau de construction, s'emploie dans les six domaines suivants: (1) construction de maisons d'habitation (23 p. 100); (2) construction sans contrat et de résidences secondaires (25 p. 100); (3) autre construction sauf celle de fermes (13 p. 100); (4) construction de fermes (11 p. 100); (5) utilisation par le gouvernement (<1 p. 100) et (6) par l'industrie à des fins autres que la construction (environ 27 p. 100). Les usages divers du contreplaqué dans ces domaines seront précisés dans l'article, et les qualités qui permettent ces multiples emplois seront examinées brièvement.

En 1966 la production de contreplaqué en tant que matériau de construction s'est montée à 1.7 million de m^3

(soit 1.9 milliard de pieds carrés; épaisseur de base: 3/8 de pouce; bois non poncé); celle de contreplaqué de bois résineux (Sapin de Douglas, Sapin baumier, Pin et Épinette) s'est chiffrée presqu'à 1.6 million de m^3 (soit l'équivalent de 1.8 milliard de pieds carrés) et celle de bois dur fait de Peuplier à 145,000 m^3 (soit l'équivalent de 164 millions de pieds carrés). Or, toujours en 1966, la Colombie-Britannique produit la plupart des contreplaqués, en tant que matériaux de construction, à savoir 1.4 million de m^3. Entre 1946 et 1966, sa production a augmenté de plus de 11 p. 100, en moyenne, *chaque année*; ce taux d'accroissement annuel est 2 fois celui de tous les autres matériaux de construction pendant la même période.

Deux facteurs contribuent à maintenir le taux qui a été de 10 p. 100 (en moyenne) ces six dernières années: les exportations de contreplaqué de revêtement, ayant triplé depuis 1960, et la consommation locale, qui, pour mille personnes, augmente d'au moins 7 p. 100 (en moyenne) par an. La Grande-Bretagne constituait la principale acheteuse mais depuis quelques années le marché a été diversifié.

Entre 1960 et 1966 la productivité de bois contreplaqué de toutes sortes a augmenté de 6 p. 100 en moyenne chaque année. Cette augmentation a été favorisée non seulement par la main-d'oeuvre spécialisée (dont le salaire horaire a augmenté de presque 5 p. 100 (en moyenne) chaque année) mais aussi par les investissements permettant à l'industrie de bénéficier pleinement des progrès technologiques. Plusieurs systèmes de vérification et de commande, complètement ou partiellement automatisés, ont été introduits dans la préparation des billes, la fabrication (surtout par le tour) et le séchage des placages, le pressage et la finition des panneaux. L'une des innovations les plus importantes a été l'installation de doubles têtes de tour concentriques permettant le déroulage des blocs jusqu'à un diamètre d'âme de 4 pouces sans pour cela réduire la vitesse du tour. A l'aide de ce changement, et d'autres progrès technologiques importants, nous pouvons exploiter de grandes forêts composées d'arbres de petit diamètre, source de bois jusqu'à récemment inexploitée pour le contreplaqué.

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THE USE AND PRODUCTION OF CONSTRUCTION-GRADE PLYWOOD IN CANADA

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INTRODUCTION

Investment in the construction of new structures and conversions, alterations and repairs to existing structures has represented a dynamic element in the growth of the Canadian economy over the post-war years. From a level of $1.6 billion in 1946, expenditures on new construction and major repairs rose to an estimated $11.2 billion (in current dollars) in 1966. In the latter year, investment in new construction alone constituted 16 per cent of the gross national expenditure. Outlays on the construction of business capital in agricultural and non-agricultural industries amounted to 45 per cent of the total, and investment in the building and extension of housing and other social capital accounted for the remaining 55 per cent. Discounting the effect of rising price levels over the 20-year period, the volume of construction work put in place doubled and, averaged on a compound-interest basis, increased annually at a rate of 5.3 per cent.

The use of construction-grade plywood has been a significant contributing factor in the achievement of annual expansions in the construction industry. This publication appraises the utilization and production of construction-grade plywood, one of the more recent innovations in building products, against the background of rising levels of construction activity.

Construction-grade plywood is defined as plywood used in areas where basic requirements are for physical properties rather than appearance. Construction-grade plywood consists almost entirely of softwood species in Canada. Some hardwood species, such as poplar, are used in construction areas, but the amount is still relatively small. Conversely, a very small percentage of softwood plywood is used in appearance grades.

HISTORY OF THE INDUSTRY

The production of construction-grade plywood in Canada has a relatively short history. The first Douglas-fir plywood mill was erected in 1913 at Fraser Mills near New Westminster, British Columbia, and the plywood produced was used mainly as panelling for interior doors. In the 1920s a small poplar plywood mill was started at Nelson, B.C., but it was not until 1935 that a modern mill was constructed at New Westminster to produce large-scale runs of Douglas-fir plywood for sheathing and other construction uses. Subsequently, prior to the outbreak of war in 1939, a mill was built at Port Alberni on Vancouver Island. By 1945, there were nine mills in operation and these were concentrated around the mouth of the Fraser River at Vancouver and New Westminster, and on Vancouver Island where existing log storages, already established by sawmills in coastal bays and rivers, facilitated the selection of peeler logs for veneer. In the 1950s production capacities were increased significantly in the original mills and new plants continued to locate around the estuary of the Fraser River. This location, apart from the natural advantages of access to a log supply adjacent to deep-sea harbour facilities, also enabled plywood mills to interchange logs according to the requirements of the market. An associated long-range implication was the broadening of the energy base, as oil refineries were put on stream in the area and natural gas began to flow to the B.C. Lower Mainland in 1956.

In 1951, the first large-scale plywood mill was constructed in the interior of British Columbia. This mill developed the methods and techniques necessary to economically produce plywood from small diameter logs. More recently, in the 1960s, a number of plywood mills have been constructed in the B.C. Interior and a significant proportion of current increases in production are stemming from these mills. The original mill built in 1951 is, however, the only mill in the interior of British Columbia currently exporting plywood to the United Kingdom and Europe.

CONSUMPTION OF CONSTRUCTION-GRADE PLYWOOD

Factors Affecting Market Development

Construction-grade plywood has enjoyed a number of advantages over competitive materials in the building industry in Canada. Its major market in earlier years was taken from sawn wood, despite the fact that sawn wood was less expensive. The speed of erection of 4' x 8' and 4' x 4' plywood panels has helped to hold down assembly costs at off-site wood-working plants and at on-site construction projects. This inherent labor-saving feature has become increasingly important as wage levels increase in Canada. Plywood's strength/weight ratio is one of the best of any of the construction materials available on the market and this, together with relative price considerations, has enabled it to penetrate some structural end-uses previously dominated by steel (1, 2). (See also Appendix A.)

Composite woodboard, such as particle board and fibreboard, has made few inroads into the major markets for construction-grade plywood despite the advantage of a lower cost of production for the former. This is mainly due to the dimensional stability of plywood and the reliability of its waterproof bonding. The totally waterproof glueline (phenolic resin) used in the manufacture of construction-grade plywood, coupled with quality veneers, has had a strong effect on its success in competition with composite boards as well as with other non-waterproof plywoods. Other advantages over composite boards are plywood's high strength, especially in bending, its resistance to warping and change in size, and its ability to hold fasteners such as screws and nails.

There is a wide range of grades to suit many end-uses and it is available in six sanded, two unsanded, and two overlay grades. Overlaid plywoods are available which have excellent paint-holding qualities. This has assisted in the competition for the house-cladding market, and further developments in this field will be described later.

There are, however, other reasons for the exceptionally strong position that Canadian construction-grade plywood occupies in the market. Manufacturers have gained the confidence of consumers by instituting a regular system of quality control at all producing mills to ensure that standards are consistently maintained. Each mill has an inspection department which checks the grade, size, strength and glue quality of plywood shipments. Standard grading rules were developed in 1951 for the entire industry, in order that the quality of material would be consistent.

For the past two decades, the federal government has conducted an active scientific-research program on the properties of, and bonding agents for, veneers and plywoods through its Forest Products Laboratories (3). In 1961, a research, development and testing laboratory was established by the softwood-plywood industry in British Columbia. The laboratory has proved invaluable in developing new uses for plywood. Among recent laboratory studies have been the photo-electric analysis of the strength of elements of plywood structures, a computer program to develop standard web-beam designs and the testing of a variety of structural components.

LABORATORY RESEARCH INSTALLATIONS,
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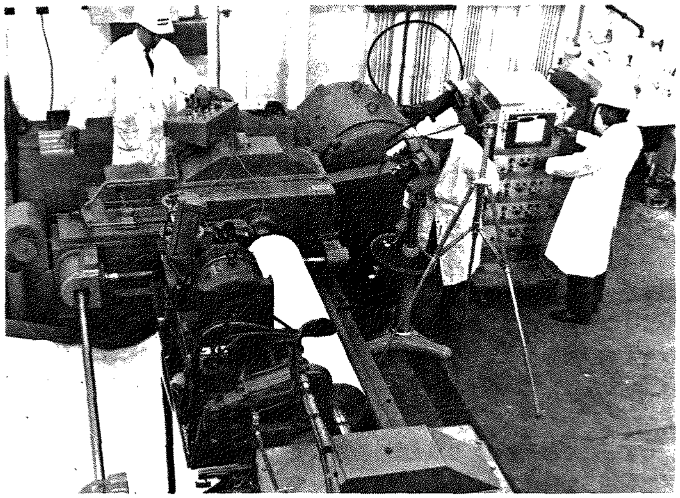
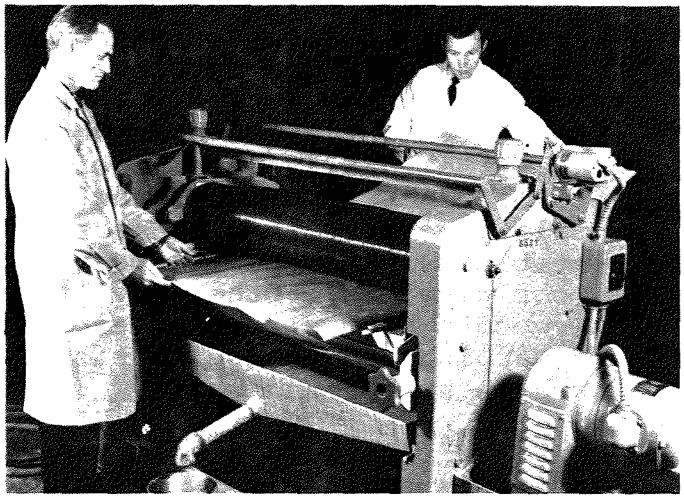
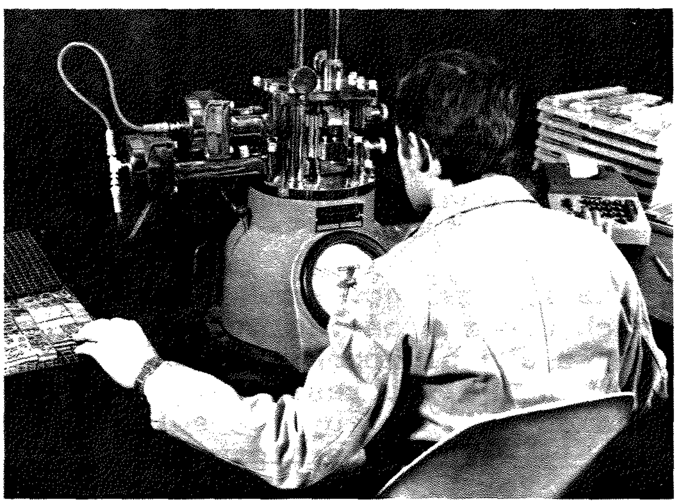


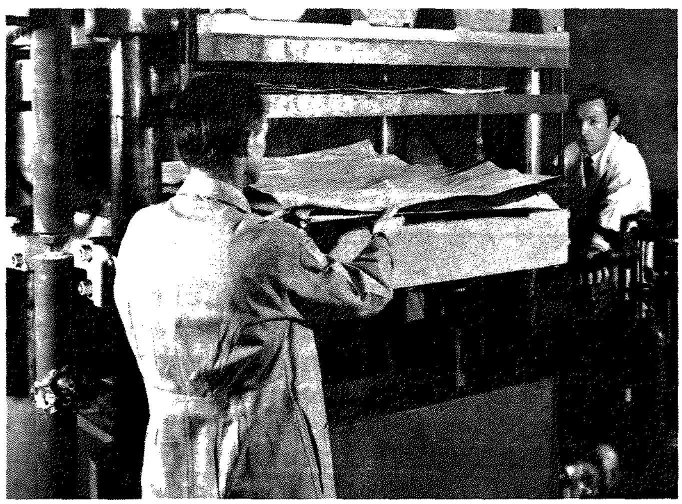
Testing rotary cutting of veneer.



Experimental glue spread on a selected wood species of veneer.



An automatic sheer test machine for high speed testing of glueline quality in plywood.



Loading selected species of veneers into a 4'x4' press for test samples of plywood.

End-Use Markets for Construction-Grade Plywood in Canada

Six major end-use markets are recognized for construction-grade plywood in Canada: (1) residential construction, (2) non-contract home and second-home use, (3) non-residential construction excluding farm construction, (4) farm construction, (5) government and (6) industrial consumption. The first five markets are those in which plywood is used in the erection, maintenance or alteration of structures. They account for almost 73 per cent of the market for construction-grade plywood in Canada. The remaining 27 per cent is absorbed in industry for purposes other than construction. (See Appendix A.)

Plywood has a wide variety of uses within these major markets. This section describes these uses in detail and briefly examines the qualities that have made plywood applicable to these various end-uses.

Residential Construction

The first major end-use is residential construction, which accounts for an estimated 23 per cent of the total volume of construction-grade plywoods used. This market is rapidly expanding each year and the trend is expected to continue. The large sheet sizes in which plywood are available have made it particularly desirable for sheathings of various types. The three areas in a home where plywood is used as sheathing are in the roof, flooring and walls, and these together account for an estimated 95 per cent of the plywood used in new home construction. Other qualities which make plywood so successful in sheathing are its racking strength and light weight.

Plywood has proved particularly acceptable as roof sheathing because of its ability to withstand extreme stresses from snow or wind. It also provides an excellent base to which shingles or tiles may be applied. Of all the plywood used in house building, about one half is used for roof sheathing and there are no indications that its popularity is dropping.

The second major sheathing use in home construction is flooring (4). Plywood, both softwood and poplar, is particularly applicable here, not only because of its resiliency and speed of application, but also because of sheet size which ties a floor together into one structural unit. There are three types of plywood flooring: (1) "Sub-flooring", which is the bottom or strength layer of a floor, represents more than half of the volume of plywood used in flooring. In this area, plywood's strength is its major advantage; thickness can be altered to comply with various support spacings. (2) "Underlayment", which is the layer of flooring before application of the tile or carpeting, requires a smooth, hard face, with no surface defects or open joints. (3) A recent development is the combination of underlayment and sub-flooring into one plywood panel. This combines both qualities of plywood in a single sheet and saves an estimated eight man-hours per home in application time. The panels usually have a tongue-and-groove or ship-lap joint on the eight-foot side, providing an exceptionally strong and tight joint. It is interesting to note that this method of joining plywood has spread to many other uses in the industry.

Plywood used in wall sheathing competes effectively with both lumber and composite-wood products because of its ease of installation and exceptional racking strength. This is a particularly competitive field, but plywood is maintaining its position.

Exterior cladding for houses provides an important market for construction-grade plywood. A significant development affecting the cladding market has been the combining of plywood wall sheathing and cladding into a single panel that is applied directly to the vertical framing members of a house. The product is usually patterned on the face, has a ship-lap or tongue-and-groove joint and is available as standard, prefinished or overlaid plywood. Appreciable savings have been made in labor costs by using this product, without sacrificing quality or strength.

A recent innovation in plywood cladding has been the introduction of new exterior facings. These have rough-textured surfaces that are processed to obtain brushed grain or striated or cross-sawn finishes, then impregnated with oil-based stains or maintenance-free paint at the factory. Earlier, in the 1950s, medium-density kraft paper overlays for plywood were developed. These increased the paint-life of plywood by two to three times and overlaid plywoods gained a significant portion of the house-siding market. Now, with the introduction of high quality factory-applied liquid finishes, plywood-based panels are being used as cladding for commercial buildings, and in more decorative styles in furniture, kitchen cupboards, wall partitions, doors, flooring and boats.

Other uses for construction-grade plywood in Canadian homes include closets, soffits, shelving, cupboards and partitioning. These are all small markets compared to house sheathings, but they represent sizeable end-uses when compared with other markets for construction-grade plywoods in Canada.

Non-Contract Home and Second-Home Use

More than 25 per cent of the construction-grade plywood used in Canada is purchased by individuals for non-contract home and second-home use. Do-it-yourself projects represent a well established market in Canada. A great deal of plywood is so utilized in homes, cottages, summer homes and ski chalets.

With the gradual increase in leisure time, a growing number of individuals are building second homes, or altering and maintaining their present homes. The trend to building second homes in the country has continued upward, a high percentage of them being erected by the individuals. Smaller quantities of plywood are used by individuals for building home fixtures, as well as garages. Plywood's attraction to individual users probably arises from the ease with which it can be formed into cupboards, walls and shelving. The variety of free plans provided by the industry on how to use plywood on do-it-yourself projects has aided this market greatly.

Non-Residential Construction, Excluding Farm Construction

A third major end-use for construction-grade plywood in Canada is "non-residential construction, excluding farm construction", accounting for an estimated 13 per cent of Canadian consumption. It is in this area that plywood has shown its greatest recent growth. The foremost end-use in this category is in the concrete-form market, which takes advantage of softwood plywood's strength and large sheet size as well as its smooth exterior. These features, combined with its competitive cost, have allowed plywood to take over the market from sawn wood whenever the forms are to be used a number of times. Its ability to bend to desired shapes is also an advantage, with the recent trend to free-form concrete buildings. Plywood for concrete forms is available from manufacturers with a factory-applied concrete-release agent.

There have been major changes in the methods of concrete forming in recent years in Canada, brought about by a strong increase in the construction of reinforced concrete multi-storey buildings. These buildings require a lightweight form that is durable enough to be used for many consecutive pourings, and can be easily cleaned between uses. High-density overlaid plywood with its extremely smooth and durable face has met these requirements. A major change in the market is the recent trend toward commercial buildings with "architecturally-finished concrete" on the face. Forms were required that would leave the concrete exceptionally clean and defect-free and which could still be used a reasonable number of times. A variety of factory-applied finishes and overlays have been developed for this market. Two of the most common of these are overlaid plywood which utilizes a chemical-release agent, and a urethane-coated formply which requires no release agent. Epoxy coatings have also been used for concrete forms. All of these products impart a clean surface to the concrete and usually have the added advantage of great durability and ease of cleaning.

A second major area of plywood usage in this category is in roof systems. Plywood's high strength/weight ratio and its versatility makes it easily adaptable to modern and unusual roof designs. The plywood industry has developed many new roof systems and expanded knowledge on the older ones. Plywood beams and stressed-skin panels have become common building components. Roofs of plywood folded plates and barrel vaults are used in all types of buildings throughout Canada (5).

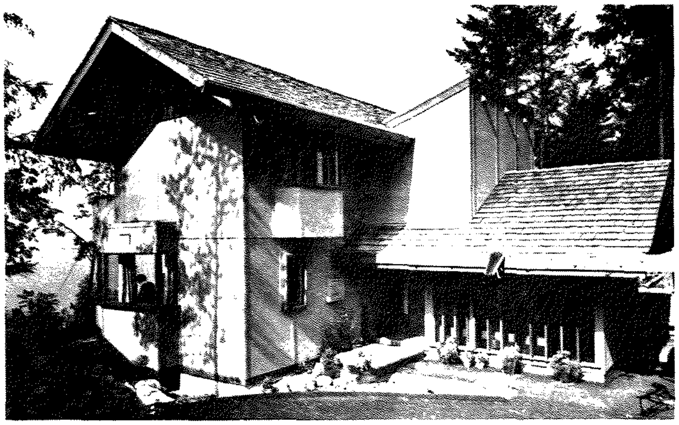
Farm Construction

The farm-construction market in Canada absorbs 11 per cent of the total construction-grade plywood consumed. Farmers require buildings that can be erected quickly and inexpensively, but which are durable and easily maintained. All of these properties are characteristics of construction-grade plywood and this end-use market is an increasing one. Two special types of buildings designed specifically for the farm market are the geodesic dome, or shell building, and the rigid-frame building. These buildings have proven exceptionally versatile and have found use in other industries as well. A third type of farm building using plywood is the pole-type building which has gained wide acceptance on Canadian farms. In the grain-producing areas of Canada, plywood is the most popular material for the construction of farm granaries where grain is stored prior to shipment to railroad-loading points. Smaller quantities of plywood are also used on farms for fencing and feed troughs.

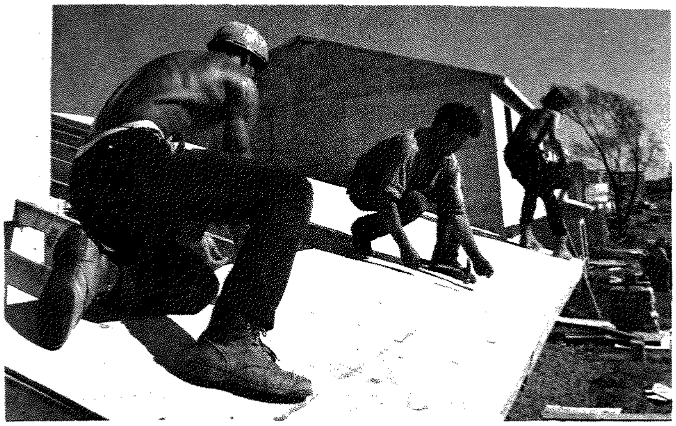
Industrial Consumption

The final major market for construction-grade plywood in Canada is the industrial market, which accounts for 27 per cent of Canada's consumption. Plywood sold for this end-use is re-manufactured into a variety of products which may or may not be associated with the building industry.

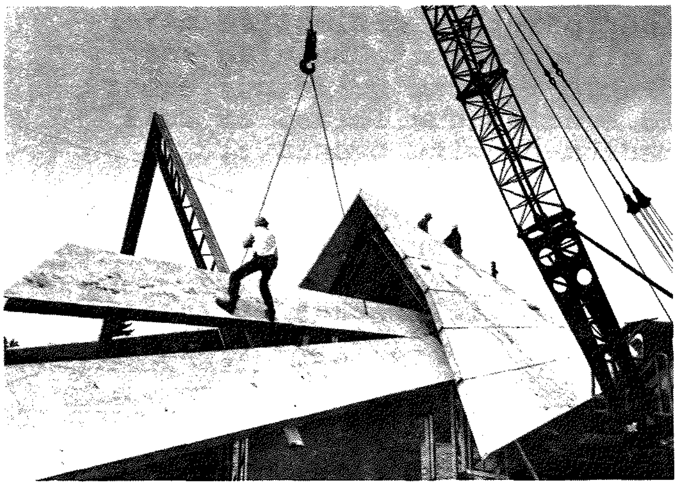
Construction-grade plywood used in the materials-handling industry accounts for almost one third of the industrial plywood market. The field of materials handling has offered some of the most interesting new markets for plywood over the past few years. Efficient and economical movement of goods, under present market conditions, requires that the goods be transported in reusable bulk containers, an application to which plywood readily lends itself. While containers made of plywood are not new in Canadian or international trade, the number of industries using them has been growing rapidly. The Plywood Manufacturers of B.C., and member companies have been providing technical assistance in the development of products for international container systems and are publishing a manual for packaging designers to be released in 1968. Construction-grade plywood in large sheets, when combined with reinforced fibreglass becomes an extremely competitive container material. Other examples of industrial uses may be found in the furniture-moving and storage industry, where there is a strong trend



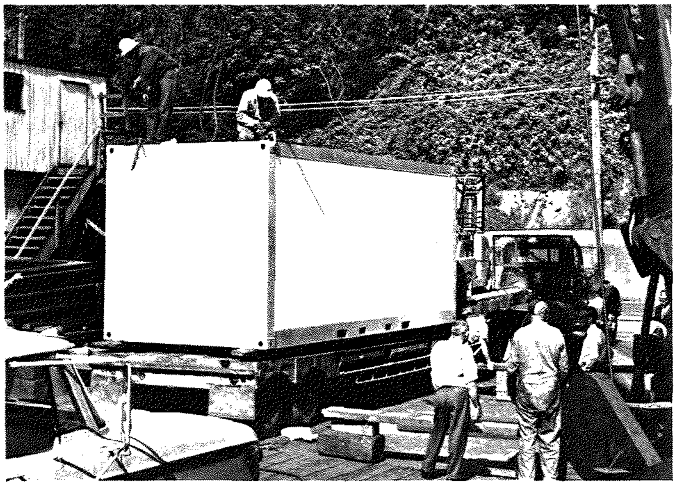
This architecturally designed home has medium density overlaid plywood cladding, and plywood roof sheathing.



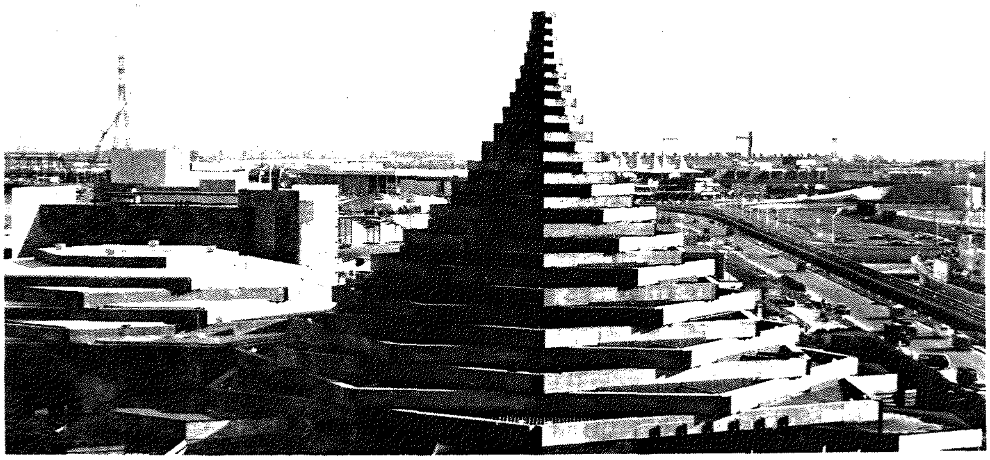
Large (8′ × 4′) plywood panels are used to quickly close-in the walls and roof of a typical Canadian home.



Plywood's versatility as a structural component is shown in this church which utilizes fir plywood stressed skin panels, consisting of plywood glued and nailed to lumber frames.



Fibreglass reinforced overlaid plywood shipping container undergoes testing procedures.



222 Fir plywood box beams, including the largest in the world (80′ long and 5′ square), were used to form this novel building at EXPO '67.

towards machine handling of furniture in large plywood containers. Plywood's durability, cleanliness and light weight have proved advantageous for pallets in certain industries. Other uses are in automobile-shipping containers and in the bins used by the Canadian tree-fruit industry for collection, storage and shipment of produce to packing houses.

The industrial market, however, has many other uses for plywood than materials handling. The more common and larger volume end-uses include cabinet and furniture manufacture, manufacturing of store fixtures and the construction of mobile homes. Plywood has proven extremely successful for re-manufacturing because of the large sheet sizes available and the ease with which it may be cut and shaped. Fairly large volumes are used in Canada for street and highway signs, usually with a medium or high-density overlay. The plywood overlay provides an extremely durable surface for either paint or reflective materials. The waterproof glueline in all grades of Canadian softwood plywood make it readily adaptable to boat building; other advantages are its sheet sizes and bending qualities, as well as the paint-holding ability of medium-density overlays.

The industrial market for softwood plywood is extremely diversified and it is impossible in this publication to give an account of all end-uses. Many manufacturers in Canada have taken advantage of the size of the industrial market by installing facilities to machine and cut plywood to size, as well as to prefinish plywood for industrial customers.

EXPORTS OF CONSTRUCTION-GRADE PLYWOOD

In 1960, 12 per cent of the construction-grade plywood produced in British Columbia, the only source of Douglas-fir plywood in Canada, was sold in export markets. During the following six years, exports absorbed about one half of the increase in production in B.C., and in 1966 accounted for some 21 per cent of that province's shipments.

Until recently, the export trade in construction-grade plywood was concentrated on the United Kingdom market (which took well over 90 per cent of exports) while other small markets regularly increased and decreased with no set pattern. By 1966, however, the percentage purchased by the United Kingdom had dropped to less than 75 per cent and a number of other markets, primarily the European Continent, Australia, and Japan, began to show consistent yearly increases. Generally, Canadian construction-grade plywood sales in Europe are in end-use areas not competitive with European plywood. It is expected, therefore, that sales to Europe will expand.

Canadian construction-grade plywood has enjoyed increasing acceptance in world markets due, in part, to the confidence that it has attained among building authorities. This was accomplished by intensive development of quality control methods and by the manufacture of only one type of glueline - the waterproof, phenolic resin type. Agencies of government and industry have also promoted Canadian plywood in these major markets through trained technical personnel. Assistance in the development and use of Canadian plywood is available to architects, builders and other authorities.

The rapid growth in sales of construction-grade plywood in Canada and in foreign markets has been due to its application to a wide variety of uses within and outside the construction industry. Through extensive product research and development, new uses have been found and new products have been developed for modern markets. These products are now being exported after years of success in the building-materials industry at home. The services and products provided have been given excellent reception in both markets, and the rapid growth of the industry is expected to continue.

Agencies specializing in the promotion and marketing of Canadian construction-grade plywood in foreign markets are listed in Appendix B.

PRODUCTION OF CONSTRUCTION-GRADE PLYWOOD

Until the outbreak of World War II, most of the softwood plywood produced in British Columbia had been bonded by cold-press adhesives. During the war the demand for plywood for exterior cladding, wooden aircraft and marine craft increased so rapidly that all equipment in B.C. mills was converted to hot-pressing using synthetic phenolic resins. These resins had the significant effect of preventing delamination under any type of exposure and increased the service life of plywood to that of wood itself. Since the advent of phenolic-resin bonds, production and utilization of plywood has increased continuously.

In 1966, production of construction-grade plywood in Canada totalled 1.7 million cubic metres (1.9 billion sq. ft., 3/8 inch thickness basis, unsanded, Table 1). Softwood plywood consisting of Douglas-fir, balsam fir, pine and spruce, is by far the most important component of construction-grade plywood, and in 1966 output amounted to 1.6 million cubic metres (1.8 billion sq. ft.) or 92 per cent of the total. Hardwood plywood processed from low-density woods, such as species of poplar, accounted for the remaining 8 per cent. In terms of geographic

TABLE 1: PRODUCTION, EXPORTS, IMPORTS AND DOMESTIC CONSUMPTION OF CONSTRUCTION-GRADE PLYWOOD[1], CANADA, 1940-1966

Year	Production[2]			Exports[3]	Imports[3]	Apparent Domestic Consumption[4]	
	Softwood	Poplar	Total			Total	Per 1,000 Population
	*thousands of cubic metres**						*(cu. metres)*
1940	113						
1941	134						
1942	142						
1943	150						
1944	168						
1945	192						
1946	181						
1947	204						
1948	262						
1949	239						
1950	258						
1951	320						
1952	334						
1953	448						
1954	497						
1955	616						
1956	718						
1957	724						
1958	786	103	889				
1959	774	119	893				
1960	894	112	1,006	109		880	49
1961	1,006	134	1,140	120		1,027	56
1962	1,091	108	1,199	180		1,013	55
1963	1,264	122	1,386	186		1,181	63
1964	1,439	141	1,580	303	3	1,278	66
1965	1,481	130	1,611	296	1	1,282	66
1966	1,563	145	1,708	338	2	1,347	67

[1]Converted initially to a 3/8" thickness, unsanded.
[2]Compiled by the Forest Economics Research Institute from the following sources: 1940-1944, Annual Report, 1962, B.C. Lumber Manufacturers Association, Table 9; 1945-1951, Veneer and Plywood Mills, Dominion Bureau of Statistics, Ottawa, Cat. No. 35-206; 1952-1966, Peeler Logs, Veneers and Plywood Mills, Dominion Bureau of Statistics, Cat. No. 35-001.
[3]Data on exports prior to 1960 not available on a standard thickness; nor on imports prior to 1964.
[4]Data are net of changes in year-end stocks.

*Conversion factor: 1 cu. metre = 1,130 sq. ft. (3/8", unsanded).

location, the production of softwood plywood is highly concentrated in British Columbia. In 1966, mills in that province produced 93 per cent of all softwood plywood in Canada.

The production figures in 1966 represent the culmination of 20 years of accelerated growth in the industry, as plywood penetrated the building-construction industry and many markets outside the building industry. Over the period 1946 to 1966, output of construction-grade plywood increased eightfold, representing an average annual rate of increase of 11.4 per cent, compounded. While the major thrust to this high level of increase occurred in the latter part of the 1940s and during the 1950s, when there was a great demand for all building materials, current rates of increase in production remain well above annual increases in Canadian investment in construction. Over the six-year period 1960-1966, production of construction-grade plywood increased at an average annual rate of 9.8 per cent, compounded, the increase taking place in both export and domestic sectors. In the Canadian home market, apparent domestic consumption per thousand population of all construction-grade plywood, rose from 49 cubic metres (55,000 sq. ft.) in 1960 to 67 cubic metres (76,000 sq. ft.) in 1966, representing an average annual rate of increase of 7.3 per cent, compounded. These figures compare with an apparent consumption per thousand population in Europe of 6.3 cubic metres (7,100 sq. ft.), based on a three-year average for all plywoods for the years 1959-1961 inclusive (6).

In British Columbia, the sustained upward demand has brought the industry to the forefront as a major purchaser of better quality logs. Increased demand also led to the opening of previously untapped reserves of peelable logs (in the B.C. Interior) of a smaller diameter than those customarily used on the coastal slopes of British Columbia. The manufacture of construction-grade plywood from smaller logs was made possible by the development of specially designed equipment. This combination of circumstances, the broadening of the supply base and new equipment, has attracted mills into the interior of British Columbia and into northern Alberta. The gradual use of other species of logs by the plywood industry has been a natural outcome of the intense utilization of mature Douglas-fir stands during World War II, when select "peelers" for clear-quality veneers were a high-priority item in the war effort.

Some measure of the importance of the plywood industry as a user of wood is indicated by comparison of the available data. During the 10-year period 1954-1964, consumption of Douglas-fir peeler logs doubled to about 2.3 million cubic metres (one-half million board feet) and remained at that level over the following two years. In 1965, 22 per cent of total B.C. fir log production was channeled into plywood mills as against 11 per cent in 1954 (7, 8). In addition to the upward trend in utilization of Douglas-fir peeler logs, consumption of spruce and lodgepole pine peeler logs in plywood and veneer plants increased 15-fold during the 12-year period 1954-1966, and in the latter year equaled 20 per cent of Douglas-fir veneer-log inputs. Currently, spruce and lodgepole pine peeler logs account for only 4 per cent of the total annual cut of these softwoods in B.C. These species are indigenous mainly to the interior of the province, which contains commercial forests seven times larger than those on the coast. Continued expansion of the plywood and veneer industry, therefore, seems assured over the long term.

TRENDS WITHIN THE PLYWOOD AND VENEER INDUSTRY

The buoyant upward trend in production of construction-grade plywood in the post-war years was accompanied by changes in end-use markets, factory prices, productivity, wages and employment within the plywood and veneer industry. It is the purpose of this section to briefly examine the nature of these changes against the background of production increase, which, when observed in isolation, showed all the evidence of economic stability and growth. Since a very large proportion of construction-grade plywood output is concentrated in British Columbia, and supporting data have been compiled or estimated on the industry in this province, attention is focused on developments there.

Until the mid-fifties, the housing market, as represented by single dwellings, duplexes and doubles, consumed the major share of plywood output; and plywood itself, because of the ease of handling at on-site and off-site locations, contributed to gains in productivity in the house-building industry. But urban spread, prodigal use of land, high cost of servicing land, and rising land prices influenced builders to construct more and more apartments in urban centres to fulfill housing needs. The rate of increase in completions of single detached dwellings began to level off in the mid-fifties and, during this transitional phase, the plywood industry opened new markets, such as home "do-it-yourself" projects, industrial and institutional buildings, concrete forms and agricultural buildings. Concurrently, the family of panel boards in the form of insulating board, hardboard, fibreboard, particle board and gypsum board, competed in varying degrees with plywood. Prices of softwood plywood declined. With prices in 1956 equaling 100, the industry selling price index of Douglas-fir plywood moved down to an average level of 78 in 1961 and then started to recover until in 1966 the index stood at 95 (Table 2).

TABLE 2: INDUSTRY SELLING-PRICE INDEXES OF DOUGLAS-FIR PLYWOOD; OUTPUT PER MAN-HOUR PAID; AVERAGE HOURLY EARNINGS; AND WAGES PAID PRODUCTION AND RELATED WORKERS, BRITISH COLUMBIA, 1957-1966

Year	Industry Selling-price Index of Douglas-fir Plywood[1] (1956 = 100)	Output per 100 Man-hours Paid[2] (cu. metres)*	Average Hourly Earnings[3] $	Wages Paid Production and Related Workers[4] ($000's)
1957	94	6.7	1.82	19,390
1958	86	8.1	1.88	20,512
1959	93	7.8	1.95	21,099
1960	81	8.6	2.09	22,670
1961	78	10.0	2.11	23,668
1962	82	10.7	2.20	24,843
1963	90	10.5	2.25	27,371
1964	91	11.1	2.47	30,678
1965	93	10.8	2.64	34,728
1966	95	N.A.	2.78	N.A.

[1] Sources: 1956-1959, Industry Selling Price Indexes, Dominion Bureau of Statistics, Cat. No. 62-515; 1960-1966, Annual Supplement to Prices and Price Indexes, Dominion Bureau of Statistics, Cat. No. 62-002.

[2] Source: Based on production data on plywood in B.C. prepared by the Council of Forest Industries of B.C., and recorded in Annual Report, B.C. Lumber Manufacturers Association, 1966, Table 8. Data on production include 3 per cent or less of hardwood plywood. Number of man-hours paid from Veneer and Plywood Mills, Dominion Bureau of Statistics, Cat. No. 35-206, Annual.

[3] Sources: 1957-1960, Special compilation prepared in Labour Division, Dominion Bureau of Statistics; 1961-1964, Employment Indexes, Average Weekly Wages and Salaries, Average Weekly Hours and Hourly Earnings, Monthly and Annual Statistics, Historical Series, January, 1961-May, 1965, Dominion Bureau of Statistics, Cat. No. 72-504; 1965-1966, Labour Division, Dominion Bureau of Statistics.

[4] Based on Revised Standard Industrial Classification and New Establishment Concept, Dominion Bureau of Statistics.

*Conversion factor: 1 cu. metre = 1,130 sq. ft. (3/8", unsanded).

In view of the drop in prices, the industry in British Columbia was forced to adjust employment to sustain increases in output per man-hour and support annual increments in average hourly earnings. Employment dropped slightly during the three-year interval 1960-1962, to the level reached in 1958 after a brief rise in 1959, then moved up from the trough of the cycle in 1962 to new and higher levels in the following years. At the same time the industry sought to extend and broaden the market which, combined with a lowering of the employment level, generated rises in output per man-hour paid which went up from an estimated 6.7 cubic metres (7,600 sq. ft.) of plywood (3/8" thickness) per 100 man-hours paid in 1957 to 10.8 cubic metres (12,200 sq. ft.) in 1965. This represented an average annual increase of 6.1 per cent, compounded. Meanwhile, average hourly earnings moved up from $1.82 in 1957 to $2.64 in 1965, for an annual average increase of 4.8 per cent, compounded.

In turn, the salaries and wages bill followed a progressive upward trend and, in the face of the weak price structure during the period under review, formed a significant proportion of "value added by manufacture". This latter measure, which evaluates the contribution of management, labor and fixed capital assets to the transformation of raw wood materials to finished products, followed a downward path to 1961 because of the decline in factory selling-prices, then turned up in subsequent years. The consequence was that the salaries and wages bill reached 77 per cent of "value added by manufacture" in 1961, then settled to a more customary level of 64 per cent by 1965 (Table 3). A comparison of 77 per cent in 1961 with 65 per cent for "wood industries" (mainly sawmills) in Canada as a whole, indicates that the plywood and veneer industry in British Columbia was labour intensive. When the price structure weakened, only a marginal percentage of funds was available for capital-depletion allowances, operating expenses and capital accumulation.

Investment in new capital and repair in the plywood and veneer industry in British Columbia followed a cycle that was similar in timing to the upturn in prices, but the amplitude of the cycle was greater and the duration shorter than in the case of prices (Table 4). From a low of $3.7 million in 1961, expenditures on new capital and major repair rose to a peak of $19.3 million in 1965 and at that level represented 23 per cent of capital investment in the "wood industries" in British Columbia, which had been rising also. The major thrust in the investment program of plywood and veneer mills was in addition to new plant and equipment. Sizeable expenditures also were made on modernization of machinery as a result of technological improvements.

TABLE 3: SALARIES AND WAGES AS A PER CENT OF VALUE ADDED BY MANUFACTURE, PLYWOOD AND VENEER INDUSTRY,[1] BRITISH COLUMBIA, 1958-1965

Year	Salaries and Wages	Value Added by Manufacture	Salaries and Wages Paid As a Per Cent of Value Added by Manufacture
	(thousands	*of dollars)*	*(per cent)*
1958	24,255	38,783	63
1959	25,292	40,273	63
1960	26,968	36,149	75
1961	27,379	35,485	77
1962	28,871	43,844	66
1963	31,497	51,793	61
1964	35,246	55,631	63
1965	39,962	62,058	64

[1]Based on Revised Standard Industrial Classification and New Establishment Concept.

Sources: 1958-1961, Manufacturing Industries of Canada, Section F, Dominion Bureau of Statistics, Cat. No. 31-208, 1961, Table 3, p. 17.
1962-1965, Veneer and Plywood Mills, Dominion Bureau of Statistics, Cat. No. 35-206, Annual.

TECHNOLOGICAL INNOVATIONS

Annual increases in productivity over the period 1958 to 1965 were accompanied by the maintenance of higher levels of output of softwood and poplar plywood per unit of log input. This section reviews some of the technological innovations that have been introduced over the past decade to make it possible to increase output per man-hour on the one hand, and, on the other hand, to maintain a high rate of wood utilization in the manufacture of plywood from logs.

Small-Diameter Peeler Logs

One of the most noteworthy developments in the softwood plywood industry has been the production of increasing quantities of construction-grade plywood from relatively small-diameter logs. High quality, very large-diameter, peeler logs

TABLE 4: ESTIMATES[1] OF CAPITAL AND REPAIR EXPENDITURES IN PLYWOOD AND VENEER MILLS AND IN WOOD INDUSTRIES, BRITISH COLUMBIA, 1960-1967

Year	Plywood and Veneer Mills					Wood Industries Total Capital and Repair	Plywood and Veneer Total As a Per Cent of Wood Industries Total
	Capital		Repair		Total		
	Construction	Machinery and Equipment	Construction	Machinery and Equipment			
	millions of dollars						
1960	0.5	1.9	0.3	2.0	4.7	45.8	10
1961	0.1	1.1	0.4	2.1	3.7	46.1	8
1962	0.2	1.6	0.4	2.2	4.4	50.4	9
1963	1.4	6.6	0.6	3.8	12.4	59.3	21
1964	1.0	6.4	0.6	4.0	12.0	66.4	18
1965	2.7	10.7	0.7	5.2	19.3	83.9	23
1966	1.5	4.0	0.6	3.8	9.9	67.3	15
1967	0.4	3.3	0.6	3.5	7.8	63.9	12

[1]Estimates based on unpublished data, Dominion Bureau of Statistics, Ottawa, Canada. For the period 1960-1965 data represent estimates of actual expenditures. Data for 1966 are preliminary and for 1967 are intentions.

are no longer considered essential for the manufacture of veneers and plywood panels. The problem of economic transportation of logs which contained a relatively small percentage of peelable material, together with sharp decreases in average diameter, inhibited the development of many timber stands until technological improvements in veneer production were realized. Once these occurred, veneer and plywood mills could be established away from the major centres on the coast of B.C. The economics of deriving maximum utility values from logs, cut in undifferentiated fashion in the woods, emphasizes the necessity not only to use the whole tree but also the assignment of portions of trees to alternative end-use processes and products. The original, and still producing coastal mills are, for the most part, units of large companies which operate pulp mills, sawmills, particle board and hardboard plants. Being located on tidewater, the interchange of logs and waste products within a company, and with other operations, is not too difficult. These plywood plants, with access by water transport to typical mature Douglas-fir peeler stands, are the primary source of the higher grades of sanded plywood. Expansion in these mills has been significant during the past three years, permitting larger annual production by adding facilities for the efficient handling of smaller logs.

The newest British Columbia mills are being located away from the coastal region to utilize the inland timber resource by selecting peelable blocks from full tree-length logging operations. While it is common practice in the coastal region to select and mark peeler logs prior to felling, the selection of a peeler log in the inland region normally is made after delivery to a mill site. Logs or portions of logs not suitable for veneer manufacture are sorted out and transferred to sawmills. This system of selection at mills holds true for softwood and poplar mills across Canada, with one or two exceptions.

Automated sorting systems are installed in some mills on the coast. Tree-length logs are elevated from the water on powered conveyers, then passed through a cut-off saw where an individual block (8'6" approx.) is graded and allocated to a specific diameter sorting pocket in the water. This provides a storage of blocks cut to length and sorted by species, grade, and diameter. Proper mixing of the blocks, preparatory to transfer to the lathe, permits efficient production control in veneer requirements according to scheduled orders, which are prepared in advance of log sortings.

Log Preparation

Mills located on the Pacific Coast do not require heating-and-thawing installations, since logs are towed and stored in tidewater until the time of cutting. However, only a short distance inland the severity of winter weather requires that logs must be thawed. Spruce logs require a heating period for proper cutting in any case, so that all interior mills are equipped with heating units. These are generally concrete block structures, heated by steam coils, into which fork-lift trucks can drive to load or unload the 8'6" blocks. Generally a period of 12 to 24 hours is required for heating the average range of log diameters.

Scraper-type debarkers, in which the blocks rotate on chucks, are used in mills cutting mature Douglas-fir, which has very thick bark. Ring-type debarkers are commonly used for smaller logs of all species, which are passed through the machines in log lengths. These debarkers are typical of interior mills.

Veneer Production

The development of high-speed lathes, with fully synchronized, automatic block chargers and veneer-delivery systems for the heavy, large-diameter logs common to Western Canada, is an important technological advance. This equipment is installed in all new mills and in the reconversion of older units. Veneer thicknesses most commonly used are 1/10" and 1/8", cut from logs which may contain numerous knots and a high percentage of dense summerwood. Precision of cut, maximum yield and the greatest reasonable delivery speed are obtained through the use of double-concentric spindle units permitting peeling to a core diameter of 4 inches without reducing the lathe speed. Vibration of blocks at smaller diameters is minimized by the use of controlled-feed back-up rollers. A lathe now manufactured in British Columbia[1] is equipped with a reciprocating-knife carrier that oscillates laterally at 120 cycles per minute. This provides a smoother cut, reduces pressure on the lathe knife and reduces the main drive-motor power demand.

At least one mill in the B.C. Interior has installed an expansion-type bit clamp instead of the usual chuck. The clamp fits into the soft cores of blocks which are then revolved on a lathe. In this way, clear veneers, usually from western hemlock, can be peeled from logs with soft cores.

Double powered roller bars are commonly installed. Powered quick-change gears are available to permit change of veneer thickness without stopping a lathe. Lathe speeds vary up to 300 r.p.m., while veneer delivery ranges up to 1,000 feet per minute.

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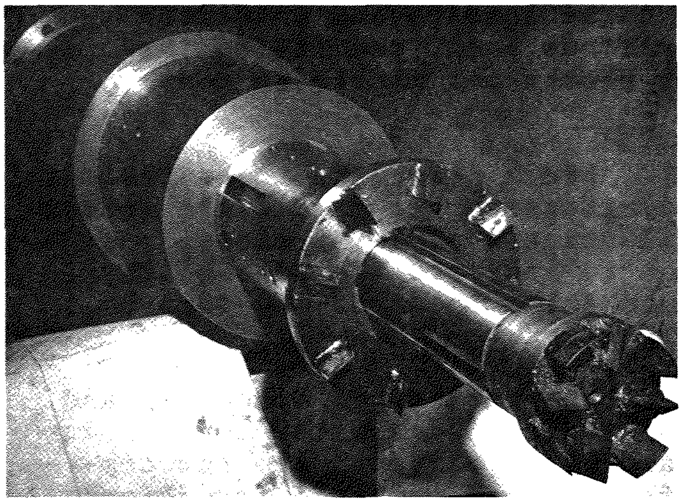
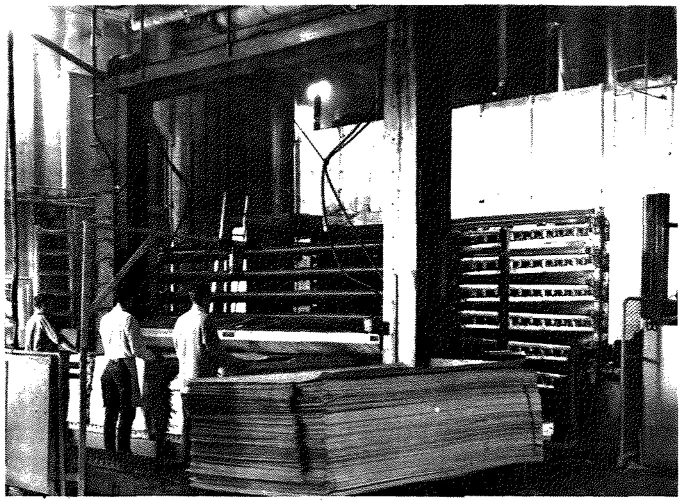
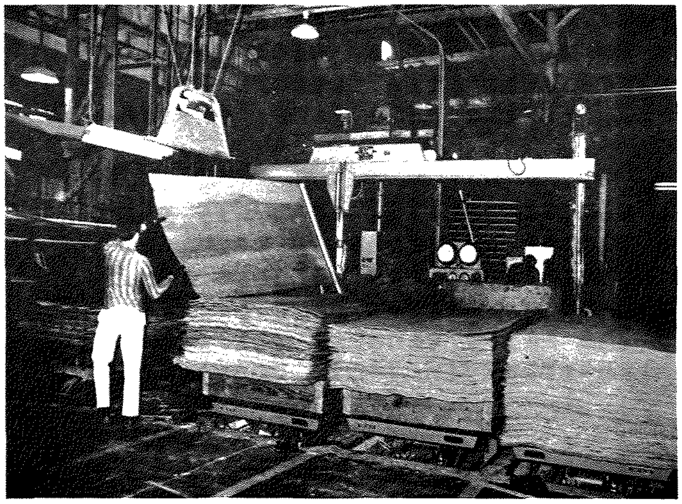
[1]Manufactured by Lamb-Cargate Limited, New Westminster, B.C.



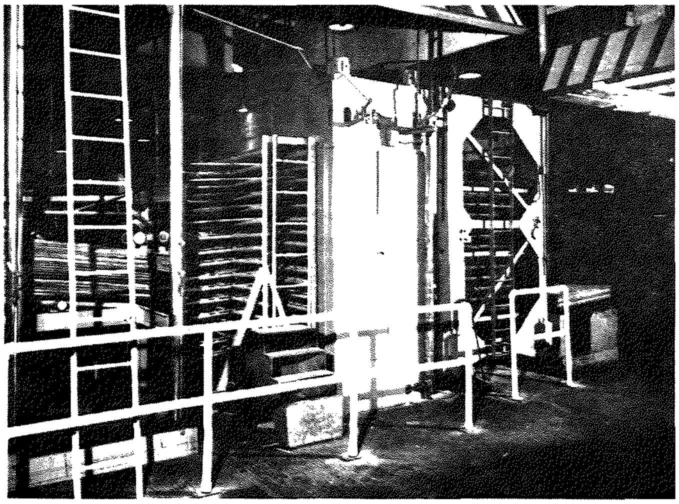
A double spindle chucking unit that permits peeling of logs to small core diameters.



Infeed of veneer sheets to standard veneer dryer.



A veneer sheet carrier (arm) which automatically places sheets on glued core, and which replaces one operator of normal crew.



Typical hot press unit showing automatic loader, unloader and stacking device.

These systems are operated by one man at a lathe who controls the entire cycle. By combining the charger and fast-acting core-removal systems, the lathe loading and unloading cycles can be as fast as 3 to 4 seconds each, permitting the peeling of about 4 small diameter blocks per minute in many cases.

Depending on the range of block diameters to be peeled, some mills have installed multiple-transfer trays to store veneer before delivery to a clipper, while others employ a close-coupled clipper. Recent developments indicate the possibility that direct transfer of veneer from lathe to dryer may soon be common in the softwood plywood industry.

Clipping is accomplished by a variety of automatic and semi-automatic clippers. Air-operated clippers with photo-electric cell controls for standard-width clipping are now common. These are equipped with a fast manual override for defect clipping. In certain grades and species of peeler blocks defects are common, necessitating a fast acting clipper. In all Canadian softwood veneer mills a separation of sapwood and heartwood is necessary for efficiency in the dryers.

Veneer Drying

Modern dryers are of both the jet-tube and longitudinal-circulation types. The dryers may range up to 100 feet long by 15 feet wide and have six to eight decks, with temperatures ranging to 400°F. Synchronized automatic feeders are installed to reduce labor costs and, at the same time, ensure efficient dryer coverage.

Moisture detectors that electronically scan dry veneer and colour mark wet stock are almost universally used, as the use of phenolic glue and the generally thick veneers restrict permissable moisture content to a maximum of 5 per cent. This is particularly critical for the heavy veneers cut from sapwood which may be used for centre stock in 7-ply construction.

Veneer Processing

Rather extensive reclipping, edge-gluing and patching departments are established in those mills producing the higher grades of plywood. For mills producing basically a sheathing grade, there is less need for patching equipment, but still a requirement for extensive edge gluing due to the defect clipping necessary to maintain grade standards. Plug-type patches of various shapes and sizes are used in patching operations.

Modern "crowder"-type edge-gluing systems are employed in which veneer components are fed crosswise to the jointer and then to the crowder-gluer and emerge as a continuous sheet which is then reclipped to width. The edge-gluers are designed to cure gluelines by radio-frequency heating.

Press Operations

All construction-grade plywood produced in Canada is hot-pressed, using phenol-formaldehyde glue to ensure a fully waterproof glueline. The main presses, of which the larger mills may have up to six, are generally 20 to 30 opening units heated by hot water or steam. Presses must provide temperatures of the order of 300°F to cure glue, spread at 55 pounds per thousand square feet of double glueline. Generally, two powered-roll glue spreaders service each press, which may change panel thickness several times daily according to the order file.

Several mills have installed pre-presses to improve glue-bond quality, reduce press time and also to reduce veneer slippage during the loading operation. Automatic loaders and unloaders are installed to minimize press-open time and reduce the crew. Plywood is always given a short hot-stack period of 4 to 8 hours before further finishing is begun.

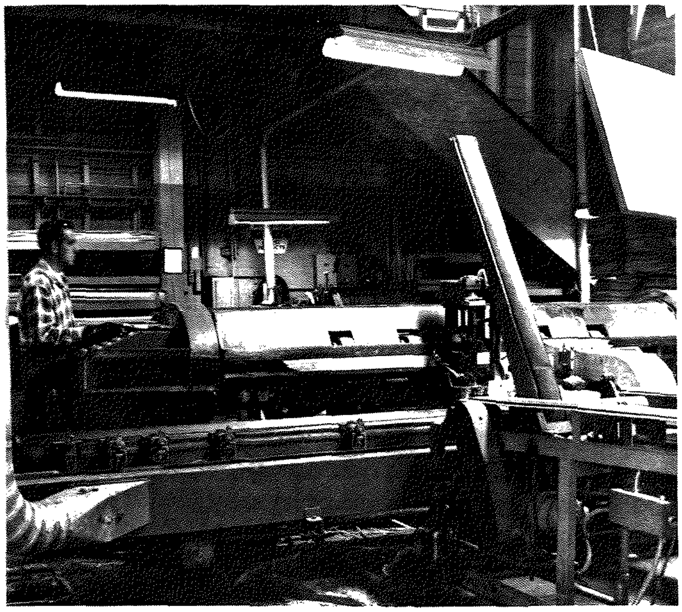
Panel Finishing

Automated conveyor systems equipped with powered unstackers are employed to pass the rough-edged panels through the paired panel saws. One-man grading stations equipped with panel turners are used to inspect freshly-cut panels. One-man-operated grade-sorting lines, using electronic memory-controlled drop-sorting bins, are frequently installed. Provision is made in these lines to bypass panels to a powered-conveyor line on which minor repairs can be carried out or, alternatively, deliver panels to automated stacking and packaging units.

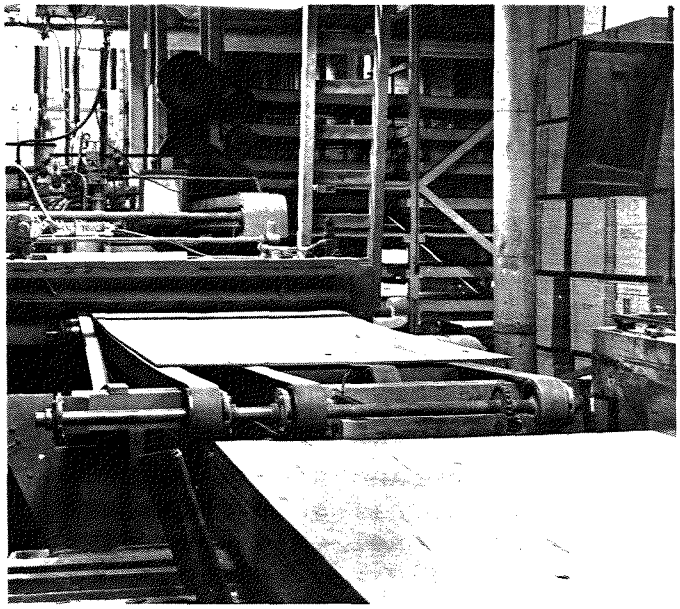
Depending on the product mix, either multi-drum or wide-belt sanders may be installed. Due to dense summerwood found in the annual rings of softwood trees, these sanders generally take a rather heavy cut off the face and back of the panels. The use of wide-belt machines is increasing and excellent finishes are being obtained.

By-Product Disposal

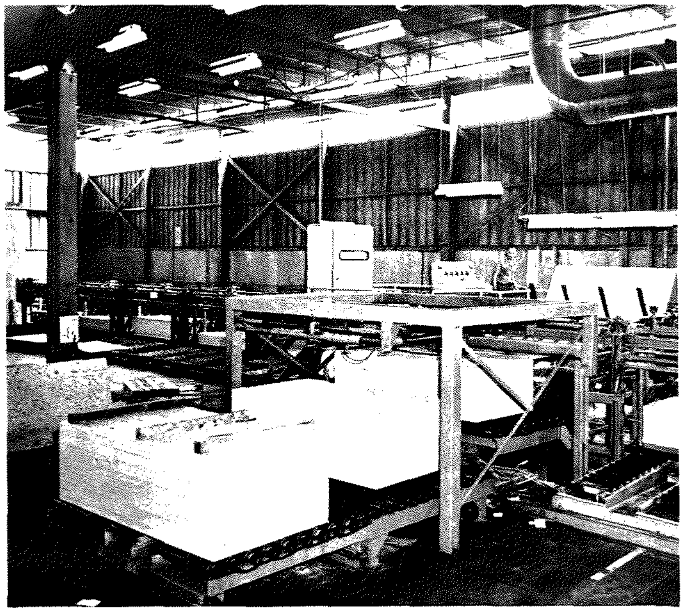
For the average softwood-plywood mill, about 50 per cent of the cubic volume only of logs is converted to plywood. The balance which is waste from the main operation is classified as chip material, boiler fuel and miscellaneous by-products. The corresponding volume of waste in poplar is about 60 per cent.



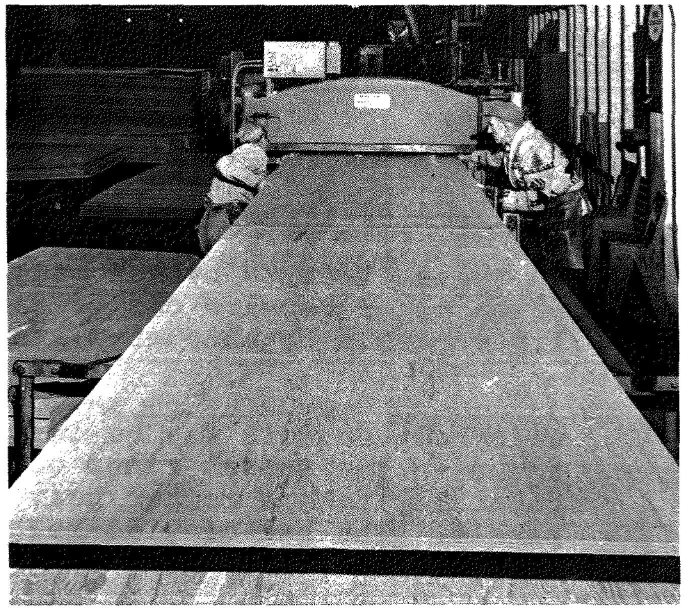
Veneer jointer for machining edges and applying glue to veneer strips prior to edge-gluing into standard width sheets.



Sheathing grade plywood is edge trimmed by the sizing saws.



An automatic panel sorting unit in which operator activates a memory device to direct and drop panels into pre-selected grade stacks.



Plywood panels are scarf-joined to form long 16′ lengths.

Bark is utilized in steam plants, when the mills are so equipped, together with dry-veneer waste and glued-panel trim from sawing operations. Green-veneer waste and some cores may be used for pulp-mill or hardboard-mill chips. The 8'6" cores from lathes are frequently recut into 2" x 3" and 2" x 4" studs or recut for in-plant use as dunnage or crating. Sander dust is fed to the boilers, generally in semi-compacted form to avoid explosion.

The upsurge in pulp-mill production in British Columbia has greatly increased the utilization of clean, green waste for chips, and therefore improved the effective use of wood residues from plywood manufacturing.

Quality Control

Quality control in Canadian mills is a well organized, regularly scheduled portion of the production process. Douglas-fir plywood, western softwood construction-grade plywood and poplar plywood are fabricated in conformance with specifications (9) approved by the Canadian Standards Association. Criteria to test the appropriate type of plywood for various structural uses are contained in specifications entitled "Performance of Construction Plywood" (10). The governing specifications are rigid and specific. Regular in-plant measurements of veneer thickness are made at the lathes so that variations can be corrected quickly. Dryer conditions are closely watched so that adjustments may be made to maintain moisture content levels. These are followed by portable moisture-meter checks of veneers before delivery to the presses, particularly for core stock.

Dry veneer thickness is regularly sampled to control mixes of improper thickness in panel lay-up and to maintain adequate allowances for shrinkage from the green veneer condition. Glue mixes are closely controlled from the time the ingredients are delivered by resin suppliers through storage in bulk tanks to the actual batches which are mixed every two hours or so. During panel lay-up, sample veneers are passed through glue spreaders to check the weight of glue spread, and samples are also taken from pressed plywood for boiling, soaking and shear testing. It should be noted that technical-service supervisors from resin supply companies regularly visit the mills to check the application of their products and to advise on problems which may develop in the gluing operations.

Final inspection of completed panels include dimensional checks, glue-bond-quality checks and checks on grading accuracy. All the functions are directed by mill quality control supervisors who are directly responsible to senior management.

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APPENDIX A

END-USE MARKETS FOR CONSTRUCTION-GRADE PLYWOOD IN CANADA

End-Use Market	Estimated Percentages[1]	Specific Use
Construction, alteration and repair		
I Residential construction	23	A) Roof sheathing B) Flooring (a) underlayment (b) sub-flooring C) Wall sheathing (a) interior (b) exterior cladding D) Miscellaneous (a) closets (b) soffits (c) cupboards (d) partitions (e) shelving
II Non-contract home and second-home use	25	A) Alterations and repairs to first homes B) New cottages, summer homes and ski chalets C) Tool sheds, fences, etc.
III Non-residential construction, excluding farm construction	13	A) Roof systems B) Forms for poured concrete C) Miscellaneous
IV Farm construction	11	A) Geodesic domes B) Rigid-frame buildings C) Pole-type buildings D) Fencing, troughs, etc.
V Government	less than 1 per cent	(Both construction and non-construction uses)
Non-construction		
VI Industrial	27	A) Materials Handling (a) containers (b) pallets (c) truck & van bodies B) Miscellaneous manufacturing (a) cupboards and furniture (b) mobile homes (c) signs (d) boats (e) doors, etc.

[1]Percentages represent approximations of end-uses of construction-grade plywood sold in Canada.

APPENDIX B

AGENCIES SPECIALIZING IN PROMOTION AND MARKETING OF CANADIAN CONSTRUCTION-GRADE PLYWOOD IN FOREIGN MARKETS

Category	Agency	Represented in Foreign Markets by:
Promotion and General Information		
I Canadian Trade Associations	Plywood Associations (Plywood Manufacturers of British Columbia)	(a) Plywood technical representatives at home and abroad (b) General wood-products representative (promoting all wood-products from a specific producing region of Canada)
II Canadian Federal Government	Department of Trade and Commerce, Forest Products Division	(a) Trade Commissioners specializing in wood-products (U.K., U.S.A.) (b) General Trade Commissioners at 70 posts in 49 countries
III Provincial Governments of Canada	Department of Industry or Forestry, in each Province	Trade offices in a few major markets
Marketing and General Information		
IV Industry (other than associations)	Shippers or manufacturers	Agents and importers of Canadian plywood

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