The Housing Industry:
Perspective and Prospective

Working Paper Two
The Evolution of the Housing Production Process, 1946–86

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and Scanada Consultants

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INTRODUCTION

The process of technological change in new residential construction over the postwar period is the topic of this working paper.

FOCUS OF THE PAPER

Developments in single-family housing are given most attention because of the importance of this sector and the more complete information base concerning its considerable changes over the postwar years.[1] The changes are examined through descriptions of the housing end product and the production process at three successive times: the mid-1940s, the mid-1960s, and the mid-1980s. The apartment product and its production processes are traced over the same period. Descriptions of the renovation sector, the labor inputs to the whole and the basic matter of land development are presented in an overview.

The industry has followed two fairly distinct streams in its movement toward production volume, economy and control. The great majority of builders always have remained in the mainstream approach: on-site construction characterized by considerable adoption or emulation of factory-like processes. The whole of materials and equipment manufacturers, distributors, labour, lenders, and legislators and building authorities at all levels—including on-site inspectors—have evolved naturally to support or at least fit to that mainstream process. In contrast, a minor number of builders, materials suppliers or entrepreneurs from outside the industry have followed a second stream, seeking better production volume, economy and control by moving most or essentially all of the production of a house into the factory proper. While these changes are given first attention, much of the factory-based housing stream is traced also through the period. This latter stream has contributed substantially to the factory-like improvements in the on-site mainstream, and its history helps to demonstrate the effects of various constraints.

STRUCTURE OF THE PAPER

This paper is divided into the following six chapters.

- Chapter One describes the product of the builders of single-family homes and the basic production process in the mid-1940s, the mid-1960s and the mid-1980s. Both the mainstream evolution and the factory-based production stream are traced to delineate the changes;
- Chapter Two describes the apartment developer's product and production process and changes thereof in much the same manner as for the single-family home;
- Chapter Three deals with residential renovation: how the industry has responded technologically, insofar as is known, to changing needs and opportunities;
- Chapter Four provides insight into the labour component of the residential construction market: the sources of on-site labour; levels of education and training; and other characteristics of this important input;
- Chapter Five outlines some key aspects of land development: how serviced land is produced and how the process has changed; and
- Chapter Six summarizes the main conclusions in this Working Paper.

CHAPTER ONE
SINGLE-FAMILY HOUSING: THE HOMEBUILDER'S PRODUCT AND PROCESS

No other large consumer product has changed so little in appearance, structure and functional performance over the past several decades as the single-family house. Many Canadian houses built in 1946 or 1906, and some indeed from the mid-1800s or even the late 1700s, still fit satisfactorily and indeed proudly among their modern successors. These houses now shelter their third or fourth generation within the old chassis, reasonably maintained, fitted with new kitchen, bath, wiring and fixtures and dressed with new claddings that imitate the old. However, there have been evolutionary changes in the product, as well as changes in the production process.

The changes in the housing product are described first; those in the production process next. Only those component changes affecting the final form or function of the house are considered under product changes; those mainly affecting production are discussed under process. Several component changes affect both.

BACKGROUND

The roots of change were becoming established in the years leading up to the Second World War, and certainly through the war years. Tracing some of the roots may be helpful in appreciating the technological advances already incorporated into the house of the mid-1940s, the starting point of this paper.

The introduction of modern stud framing, from the mid- to late 1800s, was brought about by a combination of two advances: the mass production of inexpensive nails, replacing hand-wrought nails, and of power-sawn lumber. Beginning in the Chicago area, the "balloon" stud framing approach (connoting its lightness and efficient use of sawn lumber) superseded heavy timber "eastern braced frame". This hand-crafted construction used hewn timbers in a post-and-beam-configuration, with a mortised-and-tenoned main frame, heavy knees or cross bracing, slightly lighter infill frames (much of which did nothing structurally) and few nails. Eastern braced frame takes the wood frame tradition back to the mid-1700s in much of Atlantic Canada and New England. Typical housing in Canada was, and is, wood frame housing.

Other construction forms have been popular in some areas, three of them persisting into recent decades: Quebec's plank frame construction, Ontario's solid masonry and the log houses of hand-hewn or machined-log types. The first two constructions were used in great numbers in urban housing, while log constructions are still favoured by a good number of owner-builders in rural areas. Plank frame construction, known as piece-sur-piece, spread through much of Quebec and then into the west (Red River Frame) in the early French settlements in Manitoba. Typically, it used full 75 mm thick (three inch) pine planks stacked horizontally on edge as infill between vertical planks dove-tailed to form a surrounding framework. The so-called solid masonry houses in Ontario had exterior walls of brick outer wythes and brick, block or tile inner wythes, with the interior finish applied to wood strapping nailed to the masonry. Floors, roofs and partitions were of wood frame construction in both cases. Interestingly, each of these types of construction was particularly dominant in the urban core of Montreal and Toronto, respectively, each for reasons of fire resistance/fire containment in such densely built centres; each died out in the 1960s. Both are labour-intensive and would require considerable additional framing or space to accommodate today's levels of thermal insulation.

Pre-war and wartime changes were notable in regard to the form of houses: The builders and designers began to focus on house design-for-production (that is, simplicity of form to favour cost-efficient producibility). The Cape Cod and salt-box forms or styles were brought back into some of the urban scene in the 1930s, and further simplified for the remarkably successful defence housing production programs through the war years. Gingerbread, dormers, valleys, verandas, internal jogs and corners were eliminated; producible and livable small house design received great attention.[1]

The homebuilding industry adopted and developed simple, highly producible and livable forms of small houses, as well as appropriate production approaches and technologies, through the period when great numbers of good, small houses clearly were needed. In later years (mid-1960s to mid-1980s), when the market opportunities opened again for large, much-adorned and complicated forms of houses, the homebuilders met these demands with equal ease.

THE SINGLE-FAMILY HOUSE OF THE MID-1940s: THE BENCHMARK PRODUCT OF THE MODERN HOMEBUILDING INDUSTRY

The benchmark description that follows is intended to represent typical houses built by homebuilders in the mid- to late 1940s period. The product of the do-it-yourself owner-builder is not addressed as part of the industry's output: While it probably constituted a substantial part of the total production, it was often indistinguishable (then and now) from the house built by the homebuilder.

Form and Size The small bungalow remained the most popular form, reflecting the trend of the depression years and of wartime housing production. The one-and-one-half storey dwelling gained considerable favour, continuing from the same roots, and two-storey forms also returned to the scene. CMHC's Integrated Housing Program, while constituting a small fraction of the total output, was extremely influential in the continuing builder-designer concentration on all three forms of small, basic houses; the Corporation's Small House Designs books and plan services were used widely and, unarguably, effectively: the evidence is everywhere.[2]

The designer's ingenuity was fully challenged over how much livability could be packed into, for example, a 7.3 m by 9.8 m (24 foot by 32 foot) bungalow, nicely dimensioned to fit lumber and sheet material sizes, or into its one-and-one-half storey counterpart, which simply made better use of the attic. Livable floor space was typically 71 to 93 m^2 (770 to 1,000 square feet) for these two forms and 111 m^2 (1,200 square feet) for the two-storey units. These and other products of the 1940s are still very much a part of the Canadian housing stock, but usually have been expanded and renovated, often beyond recognition.

Basement The dirt-floor cellar, with its dampness and low clearances, had given way almost entirely to the concrete-floored full basement by the mid-1940s.

The mass use of crawl spaces under the well-built temporary housing of Wartime Housing Limited proved to be a short-lived practice.[3] By the late 1940s, the WHL units were being purchased by their tenants and retrofitted with full basements and warm air furnaces. Housing renovation activity was enjoying something of a boost at the same time that the modern homebuilding industry was being born.[4]

Framing By the mid-1940s, the typical house structure was being erected rather efficiently in platform frame construction, replacing the balloon frame approach that used full-height wall studs even for two-storey houses.[5] Floor construction used wood joists, typically on 400 mm (16 inch) centres, the first floor centrally supported on a nailed-together wood main beam and the upper floor and ceiling joists on load-bearing stud partitions. The subfloor usually was formed of 20 mm (one inch nominal) boards laid diagonally across the joists, so that the hardwood strip finish flooring was supported equally in whichever direction it was placed. The joists were laboriously cross-braced when subfloored and dry.

The typical pitched roof was framed with rafters notched and toe-nailed into the top plate of the exterior walls, butted against a ridge board at the peak and connected with collar tie board. It was weak in resisting downward loading (snow loads) and wind uplift—but it generally performed well during previous decades, and still does.

Sheathing and Cladding The exterior wall and roof framing generally was closed-in with 25 mm (one inch nominal) board sheathing, but fibreboard sheet was not uncommon where brick or stucco was used. The wall was then wind-proofed with asphalted sheathing paper designed to retard wind penetration and shed incidental water that might get through the cladding and trim details. Sheathings and papers had already been used in this manner for several decades.

Generally, roofing was made of asphalt shingles, mineral-surfaced. Both wood and asbestos cement shingles were used rarely by now. Wood wall cladding was typically of clapboard or shiplap sidings in smaller eastern centres, painted on site. Brick veneer was dominant in much of urban Ontario and Quebec, and stucco in some Western regions.[6]

Windows and Doors Windows were still vertically sliding wood sashed and framed, with separate storm windows. The glass area generally constituted about 10 percent of the livable floor area. Doors were solid wood panelled, and the entry door often featured a window.

Insulation Insulation was not in use everywhere, but it was a feature in the typical builder's house of the mid-1940s, at least in those built under the National Housing Act. A minimum RSI value of 1.17 (R 6.67) was required in walls and ceilings of NHA houses. Usually, the attic had 50 to 75 mm (two or three inches) of vermiculite, wood shavings treated with lime, or loose mineral wool, or just 50 mm (two inches) of mineral wool batts. The latter were used also to insulate the exterior walls. A kraft-asphalt vapour barrier paper formed the inner face of the wall batts, and rolls of the same paper were placed with edges overlapped to form a vapour barrier under the ceiling joists.

Interior Finishes Walls and ceilings were finished with plaster on gypsum lath or fibreboard insulating lath, the latter two replacing wood lathing rapidly. Finish flooring was usually hardwood strip, with linoleum or asphalt tile in the kitchen and bathroom. Interior trim and millwork was wood, painted or varnished.

Amenities The kitchen was often small, perhaps 4.7 m^2 (55 square feet). Cabinetry was typically solid pine or Douglas fir. Countertops were surfaced with linoleum but in some cases were of painted wood or tempered hardboard. The kitchen was fitted with perhaps 2.4 m (eight feet) of counter, including a single sink, with cabinets below and above. There was just one bathroom, three-piece, usually with a small medicine cabinet but rarely a sink cabinet.

Services The electrical supply was 30 or 50 A, sufficient for lighting, refrigerator, stove, clothes washer, small water heater and small tools and appliances. Water lines were typically copper, having replaced galvanized steel for the most part over the past several years. Waste and vent pipes were cast iron; galvanized steel remained in use for the smaller diameter runs.

Heating was now commonly forced warm air, largely replacing gravity furnaces and space heaters. However, until recently, hydronic heating remained popular in some parts of the Atlantic provinces. The furnace was still fueled with coal- or wood-fired in many cases, but oil had replaced these in much of the East and natural gas had moved through much of the West. In the forced warm air configuration, the supply registers were placed in the central partitions and blew outward toward the exterior walls; return air registers were placed at or near the outer walls, usually in the floor under windows.

Although the house tended to be too dry in winter (its airleakiness helped to keep the humidity down), the amenability of warm air heating to the use of humidifiers was not exploited widely.

THE SINGLE-FAMILY HOUSE OF THE MID-1960s: A LITTLE LARGER AND MORE MAINTENANCE-FREE

Form and Size While the 1950s bungalow, a larger version of its 1940s counterpart, remained dominant in new single-family house construction, the rather complicated split-level forms had arrived in considerable numbers as a hallmark of the 1960s. Buyers wanted a more elaborate style and expanded size, and the industry responded; but somewhat less attention was paid to producibility and spartan design. The bungalows began to feature L-plans, and two-storey houses vied with split-levels, particularly in western and central Canada. Most styles of houses incorporated open planning (that is, they failed to incorporate the privacy and usability of their predecessors, size for size). They were built bigger and more generously endowed with light, toil-saving finishes and amenities. Living space was typically 100 to 110 m^2 (1,100 to 1,300 square feet); few were smaller, some were much larger.

Basement The end product changed little from that built in the mid-1940s, except for the combination of crawl space and full basement underlying the split-level house. However, the production process changed remarkably in most regions, as is outlined in the later sections dealing with production.

Framing Studs were now smaller in cross section, and there were more appreciable changes as well. A steel main beam replaced the wood beam under the first floor in most cases. Diagonal bracing of walls had disappeared for the most part in Canada in recognition of the diaphragm (rack-resisting) value of sheet sheathings. Roof trusses were now supplanting traditional joists and rafters through much of the industry.[7]

Sheathing and Cladding Sheathing and cladding changed substantially from those used in the typical house of the mid-1940s. Board sheathing and subfloors had been replaced almost entirely (with the exception of some parts of the Atlantic region) by sheet materials: plywood or fibreboard wall sheathing; plywood subfloor and roof sheathing. Roofing remained unchanged (asphalt shingles). The change to prefinished, low-maintenance materials was now well under way in wall claddings. Prefinished aluminum and hardboard sidings had supplanted much of the market for site-painted wood sidings and apparently took some of the Ontario brick market as well, while stucco held its western markets.[8]

Windows and Doors Windows and doors also had changed. Separate storm windows had yielded to integrally double-glazed arrangements, sometimes including hermetically sealed double glazing on the one hand and horizontally sliding sashless windows on the other. The horizontal sliders, and to some extent the casement and awning forms of operable windows, generally had taken the place of vertically sliding arrangements. Aluminium made substantial inroads in the various forms of windows, competing with wood. Although the energy crisis was not yet on the horizon, weatherstripping had come into play in much of the new housing. Glass areas increased considerably in many cases; picture windows had become universal a decade earlier.

Insulation Insulation practices began to change appreciably in many houses, if not in the typical house. Recognizing the economics of heating with higher cost energy, the electric utilities were recommending a 2–4–6 approach: 50 mm (two inches) of insulation for basement walls, 100 mm (four inches) for the frame walls and 150 millimetres (six inches) for the ceiling. A few builders of gas- or oil-heated homes — considerably less costly than electric energy — also were beginning to emulate these higher insulation levels as selling points, long before any thought of oil crises and cost increases.

Mainly because of ease of handling, the fibreglass type of mineral wool had supplanted to a large degree the rock wool type, and batts were used in most new attics, and in essentially all walls. However, in Western Canada many builders adopted blown-in cellulose fibre for attic insulation and had found that large-roll polyethylene film lends itself nicely to the separate vapour barrier job. As well, in many of the electrically heated houses, polyethylene film was being installed in ceilings, and sometimes in walls, intended to offer more moisture protection to the structure in these houses characterized by reduced air change and commensurately higher humidity. However, in the typical house the batt paper face continued to serve as a vapour barrier, and the typically insulated shell of the mid-1960s—despite the harbingers of substantial change—was thermally barely distinguishable from that of the mid-1940s.

Interior Finishes Interior finishes and amenities underwent substantial change. Lath and plaster had yielded slowly to gypsum drywall. Finish flooring featured hardwood strip in some cases, but builders or buyers tended increasingly to cover it with broadloom; by the mid-1960s, builders were beginning to place the broadloom directly on the plywood subfloor. The plywood subfloors and underlays also encouraged the broad acceptance of plastics: vinyl asbestos floor tile, roll vinyl and cushion floor vinyl. Linoleum and asphalt materials, along with traditional hardwoods, were being edged out of new housing. Plastics also came into play in many other ways: Scrubbable oil paints had now become even more scrubbable oil-alkyds, and latex paints had made substantial inroads. However, wood trim was still used everywhere.

Amenities The kitchen had increased in size to some degree, typically offering about nine m^2 (100 square feet) and often including an eating area. Cabinetry was essentially all plywood or veneered particle board, looking much like the solid wood of the mid-1940s. Countertops were bright, cleanable, durable high-pressure paper-plastic laminates; already the square-edged applications were being supplanted by the seamless rolled edge versions, which outdo linoleum in all but quietness in use. Kitchen counter space had grown to 4.6 m (15 feet) or more, including sink and range, with full cabinetry under and over. By now, the typical new house offered the convenience of one-and-one-half or more bathrooms, and their sinks were set into convenient vanity cabinets.

Services Electrical service had grown to 50, 60 and 100 A. Water lines were still copper, as were the above-ground waste and vent pipes in the typical house. ABS and PVC plastics began to intrude into waste and vent plumbing, offering much faster assembly and the advantage of acceptability both above and below ground.

Heating Heating remained as forced warm air. The 1940s configuration had been reversed (to counter convection) in the early 1950s: The warm air register positions had been changed to the house perimeter, under the windows, and the return air registers were in the central halls. Electric baseboard heating had already begun incursions in areas with low-cost electricity (Ontario, Quebec and Manitoba). The typical house was considerably more airtight than its mid-1940s forerunner, probably because of better windows, sheet sheathings and plywood subfloors; the latter develops tighter floor-to-wall junctions than do board subfloors. Further, it was equipped for showering, not just bathing. With less air change and more moisture source, it tended to operate at a higher humidity than its predecessors. Nevertheless, the forced warm air system was always receptive to easy installation of humidifiers, and the house of the mid-1960s often came equipped with a powerful drum-type humidifier set parallel to the warm air stream.

THE SINGLE-FAMILY HOUSE OF THE MID-1980S

Through the 1970s and halfway through the 1980s, the industry has continued to respond and adapt to the market demands and opportunities. The move-up buyers and the two-income first-time households are served the large and well-appointed houses they clearly want, tied firmly to the location desired: The house is sized and the whole is priced according to the supply-in-hand of suitably located serviced land. The cost of producing the house itself—a critical factor in developing and marketing most large products—has become somewhat secondary. As one large, long-established builder phrased it, in contrast to his drive to attain higher productivity and lower costs in past decades: "Who cares now about a $500 or $5,000 saving in producing a house? The buyer wants an oversized house in a desirable location, and we have that location." In the mid-1980s market, the house is often twice the size and fitted with double the bathrooms and amenities; a single-family house now often has two storeys, four bedrooms, two-and-one-half bathrooms and over 186 m^2 (2,000 square feet) of living space.

However, in much of Atlantic and Western Canada and Quebec, and in small-town and outlying areas elsewhere, modest houses are still being built in addition to a smaller number of large and luxurious dwellings. Generally, the houses are still the L-bungalows and split-levels of the mid-1960s. The addition from the 1970s, in much of this regional market for modest houses, is the raised basement house, called the raised ranch, split-entry or bi-level style. This development retains the producibility and low costs of the bungalow, while using the raised basement as finished living area to provide the generous living space of a much larger house.

Basement The single notable change has been in insulation. The basement walls are now commonly insulated to R 12, from the first-floor level down to at least 600 mm (two feet) below grade.

Preserved Wood Foundations represented a greater innovation, although they were still far from being part of the typical building scene. This approach was first used experimentally in the Mark III and Mark IV research houses (1961 and 1963, respectively), under the aegis of the National House Builders' Association (now the Canadian Home Builders' Association). The idea of using pressure-treated preserved wood to produce full basements attracted considerable interest in the USA from the later 1960s to this day. Since its acceptance by CMHC in the early 1970s, it has been adopted in several western areas and in other outlying areas.

Framing One notable change has been the remarkably swift replacement of the traditional 38 by 89 mm (2 by 4 foot) stud frame with 38 by 140 mm (2 by 6 foot) framing. This has occurred in response to the desire for more insulation, requiring more space.[9]

Sheathing and Cladding One of the greatest Canadian successes in building materials has been the full development of the waferboard-type of structural particleboards. Using forest resources primarily in the waste-woods class, the waferboards have replaced plywoods in sheathing walls, roofs and subfloors. Building code changes accepted and even enhanced their applicability.

Insulating sheathings have also been remarkably swift and effective in their development and application. Expanded cellular polystyrene boards and semi-rigid mineral wool compete in this market.

After a false start or two, vinyl sidings have moved in strongly to compete with the prefinished aluminiums and hardboards that had begun to supplant painted wood two decades earlier. However, brick veneers and stuccos still remain popular in Ontario and the western regions, respectively.

Windows and Doors In this respect, the house of the mid-1980s differs little from its mid-1960s counterpart. The overall glass area has increased (countering the energy-conserving intent expressed, at considerable cost, in the remainder of the house shell). Wood, aluminium, vinyl-clad wood and now rigid vinyl extrusions are all competing in the window markets, but wood and aluminium windows remain dominant. Airtightness has increased to a consistently good level, thanks to the development of window industry standards; and other problem areas have been addressed. Insulated steel doors, also well equipped with durable weatherstripping, have become common.

Insulation and Airtightening The house of the mid-1980s incorporates two substantial responses to the oil price boosts of the 1970s and the longer-range concerns about energy supply and costs: increased thermal insulation and airtightness. The typical house now features wall and ceiling insulation levels of RSI 3.5 and 5.3 (R 20 and R 30), respectively, varying somewhat to suit the range of winter climates across the country. Glass fibre batts predominate in walls and compete with blown-in cellulose fibre or mineral wool in attics. The wall insulation is augmented more and more with insulating sheathings, to help attain or even exceed the typical values. Expanded polystyrene insulation is featured in some wall systems.

The overall airtightness of the house of the mid-1980s is perhaps about 25 to 35 percent tighter than its mid-1960s counterpart and more than twice as tight as the house of the mid-1940s, size for size.[10] The use of polyethylene film air/vapour barriers, tighter windows and doors and packed or gasketed sill details has become widespread. Exterior air barriers of spun-bonded fibres are being introduced.

Interior Finishes Interior finishes have changed little from the materials and practices established two decades earlier. Trims have become plastic-clad or rigid plastics in many cases, but site-painted wood is still commonly used. Wood trim usually is formed efficiently from finger-jointed stock. Wood panelled and mirror panelled walls are featured sometimes in one or two areas of the house.

Amenities The kitchen has continued to evolve in size, planning detail and factory-finished cabinetry, the latter often to a Scandinavian level of quality and convenience. Whole cabinet walls are sometimes featured, as well as extended counters and cabinetry surrounding much of the kitchen. Bathrooms have multiplied to two-and-one-half baths. Gleaming plastic integral bath-shower units are evident, but the ceramic tile tradition is not disappearing. Flush-mounted recirculating fireplaces are common; built-in vacuum systems, walk-in closets, dishwashers, microwave alcoves and even window seats, sun spaces and open entranceways have all arrived in—or come back to—the large new house of the mid-1980s.

Services Electrical service is typically 100 to 200 A. Water lines are usually copper, but plastic is now accepted in some regions. Drain, waste and vent piping is almost universally plastic.

Heating In the use of forced air distribution and in the predominant use of atmospheric (that is, no induced aspiration) natural gas furnaces, heating has remained unchanged from the mid-1960s. However, medium-high and high-efficiency gas furnaces are making inroads into new construction, offering significant savings in fuel consumption—and assurance of proper exhausting (draft) in the more airtight houses that characterize the mid-1980s — for a higher first cost. More efficient oil furnaces are being introduced, particularly in Atlantic Canada and other areas where gas is not available. Surprisingly, wood heating is also returning in those areas. Electric heating remains common in Quebec, Newfoundland and some parts of Ontario and Manitoba; the once-dominant baseboard installations—still the lowest in first cost of any heating system—have been supplanted to a small degree by electric furnaces, which provide the air-handling advantages of forced warm air systems in the larger houses of the mid-1980s. Heat pump heating and air-conditioning units are appearing in small numbers, and heat recovery ventilators are making their way into airtight new houses.

THE SINGLE-FAMILY HOMEBUILDERS' PRODUCTION PROCESS, MID-1940s TO MID-1980s

Over the first two decades of the post-war period, the focus in developing both housing forms and construction technology—the production process—was on cost rationalization, cost reduction and improved productivity in producing a livable house, more or less affordable and saleable to the great numbers needing a decent home. In the last two decades and especially after the mid-1970s, the emphasis in production shifted considerably to providing more space and amenities and then better performance, in the right locations, for the considerable numbers who want all of that and, apparently, can afford to buy it. This summation of production philosophy is oversimplified no doubt: Particularly in Atlantic Canada, Quebec and in small towns or outlying areas elsewhere, still many modest, good-quality houses are being produced with costs held down carefully. Conversely, large and prestigious houses were produced wherever desired in the 1960s, just as today. Oversimplified or not, the pattern can be seen in the foregoing product description and equally clearly in Exhibit 1, outlining the changing production processes in the single-family homebuilding industry. To summarize:

- Most process and product developments in the 1940s through to the 1960s were geared to reducing on-site construction time and labour and the need for skilled trades or extensive training. The goal was to reduce costs in order to compete in the mass housing markets.

- Most product developments from the late 1960s to the mid-1980s have been geared to enhancing performance, quality and appeal to the substantial numbers of higher-income buyers who want the right house in the right location. While overall speed, reliance on unskilled labour and on-site productivity may not have been allowed to slip much (per unit area of finished product), neither have they been pushed persistently ahead as they were in the earlier period.

FACTORY-BASED HOUSING: SOME ADVANCES ARE TRANSFERRED INTO THE HOMEBUILDING MAINSTREAM

The preceding discussion shows the increasing role of the factory in single-family housing production. Materials and components feature more and more factory content. Consequently, on-site fabrication decreases commensurately and quality generally rises because the factory affords controlled working conditions, machine-based production and inspections and testing, whether the component is a sheet of drywall or plywood, a roof truss, a pre-hung door or complete kitchen cabinetry. But the dream of the 1930s and the following decades—the "house in a day" springing more or less wholly from a pristine factory—has failed to become common. Even as homebuilders accept higher factory content in more of the house's parts and pieces, their mainstream industry is little interested in the more completely manufactured house, which has long been technically attainable.

A look at the history of factory-based housing—its evolution close beside, but usually outside, the mainstream industry of producing houses—allows further insight into the nature and adaptability of the mainstream industry.[11] While the acceptance of gradual changes has been listed in the preceding sections, the lack of acceptance of bolder innovations may be more revealing.

The Roots of Home Manufacturing

Factory-based house prefabrication enjoyed significant beginnings well before the Second World War. Indeed, ready-made wood houses of the small-panel knocked-down form were just one small part of the bustling north-south trade between the Maritimes and the Caribbean in the 1890s. The units were produced in Truro, Nova Scotia, and shipped to Jamaica. In the following decades, precutting and some pre-assembly was used to provide huts for isolated areas within Canada, and in 1932, the first house prefabrication venture started in earnest: The Halliday Company in Burlington began shipping house packages (and also farm buildings and summer cottages) to small towns and rural buyers, using a combination of wall panels and precut framing, along with practically all other materials. Halliday, and a sister company, Halliday Craftsmen in

Exhibit 1: Outline of Changes in the Mainstream Production Process

Mid-1940s	Mid-1960s	Mid-1980s
Excavation Wartime construction marked the almost-complete disappearance of of the horse-drawn scraper. The bulldozer took over.	The bulldozer yielded, in large part, to the back-hoe. Hand shovel final shaping and trenching for services essentially disappeared.	No change.
Basement Concrete blocks gave way (substantially) to poured concrete, site-mixed, with site-built board formwork. The boards were then reused as wall and roof sheathing. But the first transit-mix and the first oiled-plywood forms were already being used by a few leaders.	The concrete was transit-mixed and the formwork prefabricated (high-density overlaid) plywood. But concrete blocks still served in rural areas and board formwork sheathing was still used in Atlantic Canada, although was disappearing.	Broadly no change, but the preserved wood foundation begun in Canada in 1961 gains some acceptance.
Wall framing Typcal builders used platform frame; some in the west already used tilt-up, precutting and "stationary assembly line" processes; very few used much equipment or peice-work sub-trades.	Pre-cut studs, tilt-up, "stationary assembly line" with sequencing of piece-work paid subs, the "factory with no walls" was by now really producing. The basic advantages of *platform frame* construction came into full play: The floors provided the "assembly table" areas for the walls, partitions and roofs.	Little change – some reversion to less productive custom building because of scattered smaller projects and large complex, ornate houses.
The roof was still laid out and erected by skilled carpenters, with site-cut and fitted rafters.	Engineered, manufactured roof trusses have taken over the typical house production line.	Little change.
Plumbing and heating site-fitted and installed.	Little change, but plastic Drain-Waste-Vent (DWV) piping speeded up on-site plumbing process. Ductwork sub-assemblies were used effectively. Prefabricated chimmneys became common.	Little change, except in bathroom component noted below and in easier, faster fittings and all-plastic plumbing. Chimmneys and flues are typically prefabricated types.
Interiors wet finished (plaster), cured, then brush-painted.	Interiors were dry-finished (drywall) and roller-painted: Both raised productivity greatly.	Little change. Prefinished plastic trim enhances speed and quality.
Windows, cabinetry, stairs, millwork still fabricated on site.	Builders installed manufactured windows, cabinetry and countertops.	Little change, but pre-hung doors and prefabricated stairs are often used too.
Bathrooms Bathtub and tile (or linoleum) all installed separately.	Little change.	Typically, little change. But plastic tub-shower units gain a foothold in some areas, at least for the second bathroom.
Scheduling, job control, costing and cost control were generally all rudimentary; "builders don't know their own costs" — except for a few leaders.	Generally effective costing and control was established among larger builders, but "builders don't know their own costs" was still an industry refrain.	Little change. Some builders now using computer-based costing and job control with better knowledge of the whole process and costs.
Wall and roof sheathing used boarding (stripped from the basement forms).	Plywood sheets were widely used (fibreboard sheets retained their place in walls where final cladding was brick or stucco).	Waferboard sheets dominate.
Siding was often clapboard-applied, trimmed and painted on-site using scaffolding, but brick and stucco retained their dominant position in some areas.	Pre-coated aluminium and hardboard competed strongly with wood. (Brick and stucco remained dominant but often only on the first storey.)	Little change. Vinyl sidings compete with other claddings. On-site painting essentially disappears.

Nova Scotia, expanded into a large and remarkably effective mail-order service, with prefabrication and precutting inputs to varying degrees, that epitomized the open market type of house manufacturing. (Open market is applied to those ventures using a central plant to supply houses, or house packages, to any buyer with a lot, and to independent builders too, often as far as 100 or 200 km from the plant.)

The Second World War was the main springboard for another typical form of house manufacturing venture: the project-manufacturer (as the extension of or counterpart to the project-builder). Here, the project-builder simply sets up his own shop to prefabricate and marshal house components to service his own project building flow. The plant, manufacturing methods, assembly and final product may be essentially identical to that of the open-market house manufacturer, but the project-manufacturer has his own market, close at hand, and need not get into the extensive marketing, customizing, packaging and shipping—nor the costly hand-holding services—in which the open-market entrepreneurs must immerse themselves in dealing with scattered individual buyers.

The quest for factory-manufactured housing, as a competitor and anticipated successor to on-site stick-built housing, was pushed equally by open-market and project-manufacturers in Canada. Both have been part of the changing homebuilding scene and have made their way into the mainstream of typical housing production in Canada.

The 1940s and 1950s

The war years of 1939 to 1945 provided strong impetus for the project-manufacturer approach, and much more. Both the National Housing Act administration's housing efforts and those of Wartime Housing Limited adopted shop prefabrication of wall panels and precutting or pre-assembly for the larger projects, with shops close by or on-site. Also, materials manufacturers and related research brought many materials developments into play in that period, most of them of equal advantage in rationalizing site-building, as well as factory-based housing:

- Waterproof plastic adhesives (phenol formaldehydes) and the broad-based availability of exterior grade plywoods;
- Improved larger-panel fibreboard sheathings and interior claddings;
- Pressed steel bathtubs (the singular spin-off from the gigantic Lustron steel-house manufacturing venture, U.S.A., 1940s);
- Pressed steel fireplaces (from the Acorn house venture, U.S.A., 1947);
- The first aluminium windows (Fleet Aircraft, Ontario, 1946);
- Aluminium siding (Alcan, and also the Fairchild Aircraft house venture, Montreal, 1946); and
- Other developments included the application of stressed-skin plywood laminated panels, successful in Canada's "GP" military huts that are still widely used, to housing production: Fairchild (Faircraft subsidiary); Eastern Woodworkers, Nova Scotia; Halliday Homes (trials of stressed-skin panel system); Canadian Forest Products, MacMillan Bloedel and Greenall in Vancouver and Glenwood in Calgary.[12] All of these made considerable progress in competing head-on against wood frame housing, with a little laminated panel system more amenable to more efficient use of materials and more complete factory production. Most or all of this was begun with wartime impetus or spin-off effects, and then abandoned between 1945 and 1955, a period that has much to teach about the constraints facing the housing industry.

The Attempts to Advance Quickly: The Bolder Innovators

It is helpful to outline some of the more innovative efforts from that fertile period, and then fall back to discuss the progress of wood-frame systems. The bolder innovators were faced with particular constraints: established building codes, jurisdictional responsibilities, materials distribution, market preferences, financing, labour and other factors that tended to protect the site-builder status quo, especially in the larger urban markets. Municipal codes and regulations were such that new systems either could not gain acceptance or only very slowly entered one municipality at a time.

Factories could not reach full production, thus potential cost savings could not be realized. At the same time, the potential cost advantages, even at full production, were usually small, scarcely providing much incentive to fight the system or change it.

The following history glimpses illustrate the effect of these types of constraints:

- Halliday's efforts to deploy stressed-skin systems were blocked outright by local codes ("Where are the studs?");

- Eastern Woodworkers gained regional (Atlantic) acceptance, partly by incorporating unneeded studs, in final effect, for their high-quality "MacGregor" line of stressed-skin houses. Eastern "gave in" to the codes and lost potential cost advantages;

- Halliday, Engineering Buildings Ltd., Colonial Homes and others pushed quickly into pre-wired closed panel systems (that is, wall panels factory-clad on both sides, as opposed to the rudimentary open panel approach where the interior finish is installed after all wiring and plumbing is done on-site), in their successful wood-frame type of prefabrication. All reported persistent difficulties in gaining entry into municipalities with any such pre-installed services because of local code, trade and inspection hurdles. All backed away, by the mid- or later 1950s, to the rudimentary, inspectable open-panel approaches.

- Canadian Comstock, Montreal, was perhaps the first in North America (1946) to produce "unitility" core units: eating/bath/kitchen core in one box unit. These and apparently others were aimed primarily at housing. "Unit-built bathrooms, to be moved in like wall panels, are a fact now but their cost is still high," wrote W.B. McCutcheon in 1947.[13] He predicted that the end of material shortages and the advent of real mass production would bring greatly reduced costs in these and some other areas of home manufacturing. But the attempts to enter housing construction or home manufacturing with such unit bathrooms or unit kitchens were not well pursued: Municipal codes and requirements for on-site piece-by-piece inspections, and installation by local trades, forestalled the innovators. Further, there was some feedback from the limited trials that handling difficulties, weather damage and breakage were costly nuisance factors in deploying both closed panel and the box-unit bath or kitchen core assemblies. Efforts made to revamp the transportation and on-site handling approaches are not recorded. Later examples suggested that the prefabrication ventures were sometimes just as mired in "working in the mud" site conditions as were the site builders they were attempting to supercede. The following box-system examples show that the handling of prefinished systems need not be a negative factor if the whole approach, factory-through-field, is geared to the system and not simply accommodated or patched-in to traditional site operations.

- In 1947, the earliest whole-house box modular system approach in Canada was established successfully by Kernohan Lumber under the name Nuway, in London, Ontario. Modular housing is the ultimate extension of the unit bathroom or kitchen concept: It is really a unit house, or rather a two-unit, three-unit or even a four-unit assembly depending on the size and configuration of the final house. Kernohan and its successors worked out the transport and site transfer methods and hardware ingeniously and effectively. Producing and selling well through to the late 1960s, Kernohan ran ahead of the demands in the surrounding small town and rural markets, where such completely pre-wired, pre-plumbed and prefinished units had been slowly allowed in. The pent-up demand for Nuway's high-quality houses, in the areas slowly opened to the company, was being satisfied, and the remaining needs were insufficient to keep the large plant operating efficiently. But Kernohan's efforts to gain municipal acceptance in other towns, within a radius up to 300 km were blocked. Even where allowed in, the local plumbers and electricians (required by municipal regulation to hook up these units) took their time, thus erasing many of the cost advantages.

- In British Columbia, West Coast Trailer developed rather advanced and low-cost two-unit modular houses in the late 1950s. It featured stressed-skin construction, all wiring, plumbing, kitchen, bath and finishing elements. But the firm said municipal codes and federal housing standards kept the units from gaining even a foothold.

The Perennial Fallback

Having followed some of the bolder attempts to advance quickly and logically in home manufacturing through the peak period of growth—the 1940s and 1950s—it is instructive to trace some of the wood-frame factory houses that fitted closer to the established regulatory system. The entrepreneurs of these houses did not fail, on the whole, enjoying two or three decades in leading positions in the mainstream. However, while conforming to the codes and standards, they could not wander far technologically, or accomplish much.

- By 1947, North American Buildings Ltd. in Winnipeg was producing 500 houses a year, expanding their plant from its 1941 beginnings and gearing their production primarily to the slowly increasing supply of plywood.[14] The Precision Built system used was, perhaps, the forerunner of all open-panel wood-frame approaches; from the U.S.A., it featured modular-dimensioned indexed jig tables, sheet sheathing (at first, room-sized Homasote fibreboard, then plywoods or other fibreboards), stud framing of walls and partitions and complete precutting of all other framing. North American's production of 200 houses of varied size and design at Terrace Bay in Northern Ontario, in the late 1940s, marked the real starting point of project-manufacturer activity, and of factory-based housing's dominant role in remote resource towns.

- Muttarts in Edmonton (and, of course, Halliday in Burlington) were already well started in somewhat similar system production. Engineered Buildings of Calgary began as a Muttarts enterprise in 1948, spun off completely in 1956 and became the most successful part of Canadian home manufacturing—very much in the mainstream of housing production—for two more decades. Also in the west, Quality Homes and Bird Construction began to advance with similarly factory-based housing projects.

Those entrepreneurs and perhaps one or two others involved in wood-frame production (as against Eastern Woodworkers' and others' stressed-skin ventures) were pushing ahead partly as project-manufacturers but largely as open-market manufacturers. With remarkable effectiveness, they all emphasized a complete package service out of the central plant: Even in the late 1940s, they apparently produced and sub-assembled doors, windows, stairs and some cabinetry. Only the shell itself remained as rudimentary open-panel and pre-cut components, open to installation and inspection of all services by local trades and authorities.

But in truth, despite these leaders in the period of 1940s to 1950s, not many large contractors were active as project developer-builders, and neither was there much home manufacturing, under whatever guise or name. This technological step beyond on-site stick building was involved in producing perhaps seven percent of the houses built in Canada in 1946.[15] That involvement rose very little through most of the 1950s and early 1960s.[16]

From the 1960s to the Mid-1980s

Moving into the 1960s and through to the mid-1980s, it is useful to keep in mind some of the motivations and technological dreams of the leaders in the 1940s and 1950s era of home manufacturing development. The leading student and exponent of prefabrication, Professor E.G. Faludi, University of Toronto, echoed the primary concern of many: the grave shortage of labour, and especially trained and skilled labour, in the face of the need for vastly increased housing production in the post-war years.[17]

G.E. Konantz, President of North American Buildings Limited, inferred that the use of conventional wood framing and building materials (with which he had gained NHA acceptance and a reputation for quality) could not allow prefabrication to do very much in reducing labour or overall costs. He said, "The future of prefabrication is not in using conventional materials in a better, more efficient way, as at present, but to develop new materials, new methods, that are peculiarly suited to prefabrication and will produce excellent homes for considerably less money."[18] Perhaps none of the researchers or entrepreneurs could then foresee that the developments of new materials, components and methods—in the setting of the prevailing regulatory, inspection and acceptance procedures—would favour on-site builders as much or more than home manufacturers. For both, the goal was to reduce person-hours, the need for training and skills and time and costs; the developments helped on the job site, as well as in the house factory.

The few significant examples of innovative efforts can best be followed through to the mid-1980s by further examples:

- In 1960-61, Aero Marine Industries of Oakville, Ontario, developed an integral FRP (fibreglass reinforced plastic) unit bathroom, producing a number for Bishop Homes. Concurrently, Polyfiber in Renfrew, Ontario, began developing an integral FRP bathroom-utility core back-to-back unit. What stopped Aero Marine has not been recorded, but Polyfiber stopped when its investigations suggested that local codes and trades would have to be overcome painfully, one by one, and some not at all. Hence, there was not an open market for real innovation.

  In the 1980s, FRP and other integral plastic bath-shower units have begun to move into new homes in significant numbers. Provincial assumption of building code jurisdiction (rather than municipal) and the continual updating of the relatively rational model code, the National Building Code of Canada, have made a difference.

- In considering the further development of its Can Car division's venture into modular housing in 1962, A.V. Roe Ltd. (Avro) voiced two major fears never encountered in their development or production of aircraft, railway cars or transport trailers: Piecemeal, municipal code wrangles would defeat any hopes of volume marketing, even of their conventionally wood-framed modular units, and further efforts at real innovation would be similarly forestalled or defaulted.

  Despite considerable success in providing fine houses to the Bomarc missile base in La Macaza, Quebec, Avro withdrew from its home manufacturing venture.

In the 1970s to 1980s, the rationalization of codes and jurisdictions did clear a broader path for marketing modular housing. For a time, there was a regional boom, particularly in Quebec, the Atlantic provinces and in a few western areas.[19]

Over most of this same period, the modest fall-back approach of the project-manufacturers, using open-panel wood-frame structures in conventional form (easy to accept and site-inspect in the established routine) appeared modestly effective and secure.

- Between them, Engineered Buildings (Engineered Homes) of Calgary and Quality Construction (Qualico) of Winnipeg and Calgary dominated the larger builder business in the West. Engineered Homes operated to supply its own projects, as well as open markets, through widespread dealerships.

- Campeau Corporation and Minto Construction dominated the booming Ottawa market with similar closed-market project-manufacturer operations.

- Even Toronto had its Bramalea operations in this form for a time, Rockett Lumber in full production and others.

In the peak years of the 1960s to 1970s, the number of homes that could be considered manufactured housing (open-market and project-manufacturer totals) probably ran about 15 percent of the single-family house production.

Open-market and project-manufacturer producers, each serving market areas encompassing several municipalities, had to carry much of the brunt of getting roof trusses accepted. However, the public sector helped considerably. Practically all the materials and component advances encouraged or developed by the project-manufacturers were adopted as easily and as cost-effectively by all project builders with similar scales of operations: pre-cut studs, roof trusses, better windows and doors, kitchen cabinetry, stairs, better sheathings, insulations, fixtures, equipment and prefinished materials of all kinds.

Essentially, the only difference between the large project-manufacturer type of homebuilder and the equally large mainstream project builder was that the former used wall panels and partitions (offering faster close-in, of particular advantage in winter construction). The former also tended to have a larger investment in plant and warehouse: manufacturing windows and cabinetry, for example, where the mainstream counter-part bought such units from other manufacturers or wholesalers. Both were and are, finally, just wood-frame house builders. The overall cost and labour productivity factors have not been much different, but the extra risk of investing in the plant proved unattractive.

When interest rates soared the end of the 1970s, the operations of homebuilders were decimated; worst hurt were those with the greatest investment in plants, as well as large land banks. The market revival in the mid-1980s generally has been characterized by the demand for large, more costly homes, built usually in smaller projects, scarcely inviting prefabrication of any greater degree than that used by all builders with no plants of their own. Small builders have returned in great numbers (mirroring the late 1940s); house factories have remained generally closed, except in Quebec and some Atlantic and western areas where demand persists for modest, reasonably priced houses. The on-site homebuilders, with their array of sheet materials and prefinished materials and components (indeed, a "factory content" much beyond that of yesteryear's prefabricator) and powered equipment, are producing prolifically.

McCutcheon and Konantz were remarkably prescient in their 1947 comments on both the ease of regulatory "fit" and the commensurate limitations of home manufacturing using conventional materials and methods. Now the corollary has become clear: As better materials, components and methods have been developed, the on-site builder has adapted and adopted them effectively. With the exception of fulfilling the housing supply in remote areas and in year-round volume production or times of peak demand, factory-produced housing has not proven cost advantageous.

THE HOMEBUILDERS RESPOND TO AGENTS OF CHANGE OUTSIDE THEIR INDUSTRY

Notwithstanding the failure of bold innovations, the homebuilding industry has advanced markedly in producing houses the past four decades. The many small steps taken to improve on-site productivity is addressed later. But it is instructive to look more closely at the industry's response to technological changes, which have not been a feature of the industry for very long.

Product Quality: Responding to Deficiencies

Examples of troubleshooting cases reveal an industry not often expeditious in solving technical problems nor seldom led or driven by the final producer, the homebuilder, in the research and engineering required to solve these problems. If a clear pattern or thrust is not discernible, it may be because there is none.

Basements More than anyone else, anywhere, Canadians like to have a hole in the ground under their houses. Five decades ago the use of cellars for storing coal and turnips began to wane; four decades ago, concrete floors and drain tiles were almost universal in new construction. The result was a *basement*, not a cellar. Three decades ago, this space evolved further into finished recreational space; then it became insulated, raised a little further out of the ground, better windowed and became a lower living space. In all that time, cellars have been plagued by summer dampness and mould (as its cool temperatures are often below the dew point of the warm and humid outdoor air), by ground and surface water leaks in spring and fall and also by inadequate air change, mustiness and questionable air quality. As a cellar, it served its purpose; as a living space, it is sometimes less than ideal.

The industry has not solved these problems entirely; the ***incidence*** of basement deficiencies is still substantial. The Ontario Warranty Program has found that about 20 percent of new house construction has deficiencies built or apparent within one year, with the largest single group occurring in or relating to the basement.[20]

Corrections to this situation have been attempted: The association representing the concrete manufacturers, the Canadian Portland Cement Association, has developed rigorous specifications for basement construction, which, if followed, would help the homebuilders gain reasonable assurance of trouble-free performance over many decades. Alternate construction systems have been developed by the pressure-treated wood industry. Proprietary insulation systems help improve the basement, but may decrease the tolerance of moisture problems. The key point is that impetus for this research has come primarily from the materials manufacturers and public agencies, and only secondarily from the homebuilders.

Related to this is that the industry cannot define the basement problems by specific type, cause and solution because no feedback system is in place to do so. Warranty people, the inspectors representing various interests and the builders visit the callback cases and see to it that corrections are made but maintain little feedback, analysis or databanking. It may well be that the present level of product specification and quality control is economically correct (that is, more time and money into the hole in the ground would cost everyone more than the costs entailed by the incidence of callbacks). However, the industry does not know because it does not do, or control, its own research and development. The industry associations are recognizing the need for research, feedback and databanking, even though the needs were pointed out at least two decades earlier.[21]

Windows Two distinctly separate directions in window manufacture—horizontal slider windows and sealed double-glazed windows—have manifested separate problems over the past two decades or more.

The advent of ***sashless horizontal slider*** windows was welcomed in the 1960s by homebuilders because of their simplicity and low cost and by consumers because of their attractive clear appearance and relative ease of cleaning. However, some windows were plagued by rain leakage. Air leakiness was a more common concern in most regions. This problem prompted the development of air infiltration performance standards for all windows. Still more serious is the tendency of the slider types, with their horizontal tracks forming ruts that end at imperfect corners, to let water directly into the wall cavity and structure below the corners. The water may come from indoor condensation running down the glass, or from rain, or both. The phenomenon appears to be particularly troublesome in coastal areas.

Sheathing and studs beneath such corners are subject to decay, especially in some modern walls where rates of drying are slow owing to the effective vapour barrier on the inside and tight sheathings on the outside and where the coastal climates inhibit drying. Accurate feedback of information is lacking, and horizontal slider windows (now usually plastic-tracked but still not always well drained, corner-sealed or properly installed) are still common in new house construction. Where such problems are hidden within the structure, reliance on the marketplace for product-testing and feedback or correction has proven unsatisfactory. The housing industry neither test drives nor undertakes follow-up research on even a small sample of its end product. Again, the fragmented industry does not operate as a product manufacturer.

The post-war advent of ***sealed double-glazed insulating glass*** windows was of even more interest to the industry and consumer as they offered the promise of freedom from fogging between the panes and from the need for cleaning the inside surfaces. The two original U.S.A. manufacturers, Pittsburgh and Owens Corning, used two distinct but equally rigorous and costly manufacturing techniques that yielded products of dependable long-term performance in most housing applications. These sealed units did not move quickly through the markets because of high costs.

About 25 years ago, the availability of new elastomer-plastics began to facilitate the manufacture of sealed units in almost any shop, large or small, at lower initial costs. The markets opened up quickly. Buyers and builders (a few of the latter becoming sealed unit manufacturers) welcomed the cheaper units with confidence because of the successful performance of the costlier pioneer makes. However, in many of the new units, the elastomer seals failed quickly; the inner glass surfaces became slowly and permanently disfigured from fogging and leached salts. CMHC initiated a research project at NRC's Division of Building Research (now the Institute of Research in Construction or IRC) in co-operation with window manufacturers. Test methods and performance criteria that predict long-term performance were developed eventually.

In the 1960s, the window industry incorporated these criteria into its new standards. Improved sealing materials and manufacturing procedures were adopted to help ensure the effectiveness of the desiccants commonly added to the edge spacer to reduce the dew point of the air space. Usually, a five-year warranty was provided. The desiccants also help accept years of slow diffusion of water vapour through the sealant, if not through initial or eventual flaws or breaks. The homebuilders were not greatly involved in trouble-shooting, laboratory research or re-acceptance procedures. Information on the rate of failure of such units does not appear to be available, but reports of failure in the seven- to 12-year range still seem common.

Other Examples Complaints of floor springiness became frequent in the 1970s following changes requested by the lumber producers in lumber stiffness and span standards. The homebuilding industry's national association (then called HUDAC) worked effectively with CMHC, Forintek (formerly the Forest Research Laboratories) and lumber manufacturers in correcting the problem. Further, when problems of floor squeaking and "pop" disfigurement of interior finishes, usually caused by excessive shrinkage of drying wood that exposed the heads of nails and other fasteners, persisted, builders reported the problem to their suppliers, with fairly good results. The suppliers have developed new fasteners and adhesives that perform better despite the builders' tendency to use wetter lumber. Once again, the builders were faced with a problem that materials manufacturers more or less solved.

The use of wet wood may be a result of the push for faster handling and construction turnover on the one hand and the tendency on the other to leave much of the lumber lying in the rain and mud until it is used. Recently, it has become apparent that modern wall constructions can trap moisture for many months, which can in turn promote rotting. CMHC and other research groups are investigating the problem, and the builders are responding but not leading in such research.

The pattern of troubleshooting is not all one-sided in such a fragmented industry, but general conclusions can be drawn. The single-family homebuilding industry is becoming more product-oriented, but it is still not one that researches and knows its product well or where the end producer (the builder) generally controls the suppliers. The nature and quality of the end product—its evolution, in fact—are still as much in the hands of the materials and equipment manufacturers and government agencies as in the hands of the homebuilder.

Industry Response to Outside Agents Affecting the Costs of its Product

Once again, the single-family homebuilding industry has not presented itself as a powerful producer that controls its product evolution to retain or increase its share of the consumer's dollar. Although examples are not clear-cut, a pattern has been more or less apparent:

- The homebuilders' national association (now the Canadian Home Builders' Association) does rise above the shorter-term interests of its diverse members in recognizing and leading along paths of longer term progress. Where municipal codes and regulations differed arbitrarily, tending to favour local small builders and keeping costs high, the association became a vocal advocate of the adoption of the National Building Code—even though some members protested that such adoption would remove the rather protected status of small local builders and open the doors to larger regional builders. The materials manufacturers and design professionals also helped to initiate and support the changeover during the period of code/jurisdictional rationalization (the 1950s to the 1970s).

- However, even after general rationalization and broader unification of construction standards (where most provinces promulgated province-wide codes based on the National Building Code), homebuilders continued to be rather passive or unorganized in the face of cost-raising municipal zoning changes, imposts and service requirements. Where street width and general servicing standards were increased greatly, the industry appears to have acquiesced with little struggle. Likewise, in many smaller matters of components or end-product standards, builders have not participated commensurately with what should be in their vested interest. For example, where improved sheathings are still required to be covered with redundant building paper or where some insulation levels have been raised to uneconomic levels, builders have put up little fight. Whether real quality were raised or not, builders have not acted powerfully to control or forestall the many manipulations of their end product as long as the requirements were applied equally to the next builder too. Their associations realize the long-range impacts of cost rises, but individual homebuilders slowly realize that houses are sold not only in competition against other builders and properties but in competition against automobiles, boats, vacations, travel and many other items bidding for the consumer's dollar.

A few basic facts must be recognized. There are no very large homebuilders and never have been: no General Motors of housing, not even an American Motors. In terms of purchasing power or clout with the materials manufacturers and lobbying power, even the largest individual builders have carried little weight.

Neither are there any large buyers of housing, no continuing co-operatives or resource industries or others (such as in Scandinavia) who maintain longer-term commitments of reasonably predictable volume, type and quality of housing. Such buyers can help foster large, efficient, highly competitive builders or manufacturers of luxurious housing or simply great numbers of good-quality houses. The defence plant housing programs during the war years, and the veteran's housing programs after the war, constituted the large buyers who enticed the modern homebuilding and home manufacturing industry into existence. Today, in the mid-1980s, the Canadian scene is characterized by a complete absence of large buyers and, not entirely coincidentally, a diminished role for large builders of any type.

Responding to Market Demand and Opportunity: The Homebuilders' Drive for Production and Productivity

While homebuilders do not present themselves as a powerful producer, their industry has done well in striving for improved production efficiency. The years from 1946 to the early or mid-1970s were particularly fruitful in this regard. In Exhibit 2, some of the main changes are listed to allow for comparative acknowledgment of their apparent roots, nourishments, constraints and general chronology. In the exhibit, the first column identifies the change and indicates the approximate date of widespread acceptance. The next section, comprising four columns, identifies the main performers of research and development work leading to or nourishing that change. The next section, with three columns, identifies the apparent strength of the key incentives for builders to adopt such change. The final section in the exhibit, again with three columns, indicates the strength and direction (positive or negative) of three key industry elements on the adoption and implementation of the change.

The symbols used in the exhibit carry two different weights: An upper-case letter connotes a substantial role; and a lower-case letter connotes some significant role. A blank space connotes no known or consistent role, either for or against.

As an example, if one looks at Plywood Sub-floors and Sheathing, the seventh change named in the exhibit, a substantial R&D role was performed by the material manufacturers, with lesser R&D roles by the builders and their associations, public-sector agencies and universities. The incentive to builders to adopt this change was primarily because of opportunity for faster and lower-cost construction. The influence of building codes ranged from somewhat negative to somewhat positive, whereas the strongest incentive for using a new product was the acceptance by CMHC for its use in NHA-financed housing.

By reviewing the exhibit, it can be seen that the following apply:

- The great majority of changes originated outside the homebuilding industry, that is, from the research and development (R&D) sector of the materials or equipment manufacturers, or component manufacturers. Much of the activity occurred in the United States. In the earlier years, the component entrepreneurs and homebuilders were aided by current university research activities, with much of that help from the University of Illinois Small Homes Council and Purdue University.

- Public agencies became significantly involved in helping R&D, especially in the late 1950s (for example, the truss movement) and through the 1960s and early 1970s. However, the public sector was more involved in the technology transfer aspects than against R&D as such, as is next touched upon.

- Much of the *applications engineering/technology transfer* function was in the hands of the builders (these terms are inferred in the Builders or Associations column, in the R&D section of the table). Recollecting the period of ferment, it is fair to say that technology transfer was pushed strongly by four parties:

  — the materials and equipment marketing and sales people and building supply dealers:

  — the homebuilders themselves, perhaps especially in their travels to builders' conventions in the U.S.A. through the 1950s and 1960s, picking up ideas and transferring them in their association's conventions in Canada (and vice versa):

Exhibit 2: Apparent Origins And Causes of Technological Changes in Housebuilding Mainstream

Change in Product and/or Process (with approx. date of widespread acceptance)	Research and Development by: Mfctrs. of materials, equipment, components	Research and Development by: Builders & their associations	Research and Development by: Public sector (NRC, etc.)	Research and Development by: Universities	Builder's Incentive To Adopt: Speed with less skills and less costs	Builder's Incentive To Adopt: Enhance quality	Builder's Incentive To Adopt: Exploit public-sector incentives	Helped or Inhibited by: Bldg. codes	Helped or Inhibited by: Acceptance (CMHC)
Platform frame; some tilt-up, some pre-cutting (1946)	y	y	y	y	y	y	y		
Insulation (1950)	Y		Y	Y		Y	y	y	Y
Warm air heating counter-convection (1950)	Y		y	y		y			
Manufactured windows with frames (1950)	Y				Y	y			
Transit-mix concrete basements (mid-to-late 1950s)	Y				Y	y			
Manufactured cabinetry (mid-1950s)	Y								y
Plywood sub-floors and sheathing (mid-1950s)	Y	y	y	y	Y	y		n-y	Y
Drywall interior finish (late 1950s)	Y				Y			n-Y	
Prefab formwork basements (late 1950s)	Y	y			Y	y			
"Stationary assembly line" (late 1950s)	y	Y		y	Y		y		
Roof trusses (mid-1960s)	Y		Y	Y	Y	y		n-Y	Y
Fork lifts, truck-mounted hydraulic cranes, palletizing ... (mid-1960s)	Y				Y				
Winter construction (mid-1960s)	Y	Y	Y	y	y		y	n-y	Y
Prefinished, low-maintenance claddings (mid-1960s)	Y				Y				Y
More reliable sealed double windows (mid-1960s)	y		Y			Y			Y
Plastic vapour barrier (1970s)	Y		y			Y		Y	Y
Plastic dwv piping (early to mid-1960s)	Y				Y			n-y	Y
Plastic weeper tile (early 1970s)	Y	y			Y				Y
Waferboard sheathing, sub-floor (mld-1970s)	Y		y		y			n-Y	Y
Higher levels of insulation and airtightness (mid-1970s)	y	y	y	y		y	y		
Presently making inroads:									
All-plastic plumbing	Y				Y			n-y	y
Plastic bath/shower units	Y				Y			n-y	y
Computerized cost control	Y	y			Y	y			
Mechanical air-handling and heat recovery	Y	y	y	y		y	y	y	y
Exhaust air heat pump heat recovery	Y	y	y	y		y	y		

Source: Scanada Consultants Limited 1967.

Legend:
Y: "yes" — a substantial positive role or influence
y: some positive role or influence
blank space: no known or consistent role for or against the particular change
n: "no" — an inhibiting or delaying influence, at least in the initial years

— the CMHC engineers and inspectors; the latter especially did much more than mandated: training, informing and helping direct the post-war army of small builders, including those who became large ones and relied partly on the inspectors to help police the subcontractors: and

— the research programs at NRC's Division of Building Research (now IRC), the Forest Research Laboratories (now Forintek), often instigated by CMHC's engineers and acceptance people. The most direct technology transfer vehicles, the National Building Code and Residential Standards, were influenced by those efforts as well. The drive for energy conservation has been accompanied or led by the further wave of public-sector involvement in housing technology, in the promulgation of energy measures and in the further search for further improved thermal performance and the air-handling performance that is entailed.

Examining Exhibit 2 further, other observations and recollections may help illustrate the factors at work:

- Codes and standards, largely a creature of the public sector, have an inhibiting effect in the earlier years or even decades of a technological innovation, but then tend to be helpful in technology transfer and implementation. When a change is finally in the code, it becomes firmly entrenched. In some cases, cost-saving changes were introduced to the building industry through this route. Exhibit 2 tends to give a positive slant to the effects of codes as it deals only with typical or mainstream changes (that is, those that have been accepted). Further, the table does not reveal the time frame (for example, the 20 years and longer that unit bathroom proponents and plastic pressure pipe producers shied away from municipal code and installation jurisdictional messes, and perhaps even from sustained efforts at product development and standards definition). They are now able to push into most regions because code unification has opened the door more invitingly to innovation, just as predicted and called for in the 1940s.

- While the builders tended to be slow to adopt innovations, the incentive that moved them most effectively was the drive for increased production and labour productivity using less skilled labour (the column cryptically entitled "speed with less skills" in the exhibit), which contributed to controlling and reducing costs and increasing profits (the first column).

- Public-sector involvements have extended beyond the R&D and technology transfer functions already mentioned. The wartime and early post-war housing programs and financing mechanisms created a secure opportunity inviting larger contractors to bring to bear improvements in production and productivity techniques, such as platform frame, tilt-up construction, prefab shops, larger scale and the stationary assembly line approach. CMHC (and its immediate forerunners) can indeed be thought of as the "Godfather" of the modern homebuilding industry.

- A final column, "market preference", was deleted from the table because of the small role it appears to have played. Market preferences and attitudes (as distinct from market needs, size and fluctuations) apparently have had little to do with encouraging or discouraging the hidden technological and production changes, at least in recent decades. Earlier, the long period (20 years or more) in changing over from plaster to drywall may have been due as much to consumer ideas of plaster's solidity and soundproofing and a dislike of the first patchy, ridged drywall applications as to stubbornness by the municipalities and trades. In the Atlantic provinces, some owner-builders were still plastering their new houses in the mid-1970s. Maintenance-free sidings were welcomed by consumers who were voting more against the chore and cost involved in repainting every two or three years rather than voting for the new, unproven sidings. But the market has accepted product and process changes—if not cosmetic changes—with little more scrutiny in the last decades than accorded to those manufacturing automobiles or appliances. The buyer did not usually know or care, for example, that the new home from Engineered Homes or Campeau Corporation was indeed a direct and worthy descendant of the wartime prefabricated house.

The Changes do the Job in Increasing Productivity

If the single-family homebuilding industry's goal was indeed to control and cut costs yet produce more and at a faster pace by reducing the use of site labour and especially skilled labour, the implemented changes clearly worked. Exhibit 3 lists some major changes and their effects.

At the same time as the distinct changes listed in Exhibit 3 were affording reductions in labour and time, other operational changes improved efficiency and control throughout. The "stationary assembly line" approach to sequencing the subtrades house by house, the mechanical handling by fork lifts and truck-mounted cranes and the use of power tools and fasteners have all contributed greatly to improving even those component operations where the materials and installations may appear to be virtually the same, such as in electrical wiring, plumbing, heating and even clean-up.

Overall Reductions in Site Person-hours and Time

The on-site labour entailed "then and now" can be traced in a rough way and compared usefully if allowances for changes in product size and amenities are calculated. Taking a rather typical mid-1960s two-storey house with 110 m^2 (1,200 square feet) living space, one-and-one-half bathrooms, generous kitchen and cabinetry and good landscaping as a benchmark, its

Exhibit 3: Changing Production Methods Reduce On-Site Labour

Changing This Operation	To This Operation	Fractioned Site Person-hours to: [a]
Framing piece by piece, in balloon construction (still practised here and there in the mid-1940s)	Platform framing with tilt-up, and using power tools	About a third or less
Constructing windows on site	Installing manufactured windows	A quarter or less
Sheathing walls and floors with boards	With sheet plywoods	A third or less
Forming basements with board formwork and site-mixed concrete	With prefabricated plywood forms and transit-mixed concrete	A third or less
Constructing cabinetry on site	Installing manfactured cabinetry	A quarter or less
Finishing interiors with wet plaster	Drywalling interiors	A third or less
Framing roofs piece by piece, ceiling joists/rafters/collar ties	Framing roofs/ceilings with trusses	A half or less
Brush painting interior, two or three coats	Roller painting, one or two coat paints	A third or less
Constructing chimneys with brick and flue tile	Installing manufactured flues	A quarter or less
DWV (drain-waste-vent) plumbing in cast iron and galvanized steel	Plastic DWV pipe	About half

[a] *Estimates by Scanada Consultants Limited.*

mid-1940s counterpart can be adjusted to similar standards. The total person-hours on site reflect all the production changes listed. Considering project-built houses and including site supervision and contingencies, the following points can be made:

- Site person-hours numbered roughly 2,400 in the mid-1940s.[22] These were reduced to about 950 in the mid-1960s.[23] Little if any improvement has been made since. All-plastic plumbing and unit baths allow appreciable reduction, but these were not yet commonly used in the mid-1980s; and

- Construction time was about seven months at best in the mid-1940s, with delays in material supply being common.[24] This had been reduced to about eight weeks at best in the mid-1960s.[25] Again, there has been little or no further change in evidence.

The apparent dearth of productivity improvements since the mid-1960s is not completely true: The end product now is better. The house of the mid-1980s has improved markedly in its windows, insulation, airtightness and heating efficiency compared to its mid-1960s forerunner. Despite problems with quality assurance, today's house often offers better finishes and freedom from maintenance as well.

SUMMARY

While the single-family home has changed little in appearance, structure or basic performance, its production process has taken many small steps that together have achieved a marked advance from the house of the mid-1940s through the 1960s. Bolder innovations in the same period, especially those directed to producing the house in a factory and of something other than wood frame, failed to establish a strong foothold. Regulatory and jurisdictional restrictions, as well as the apparent lack of clear cost or proprietary advantages to justify investment risks and struggles for local acceptances, discouraged such innovative ventures. However, these bolder efforts did help to bring forward and apply factory-produced components and prefinished materials to all homebuilding. The project homebuilders also learned to apply factory-like "stationary assembly line" flow to their on-site operations. Where a house typically required seven months and 2,400 person-hours to construct in the mid-1940s, producing a similar unit took approximately eight weeks and 950 person-hours on-site in the mid-1960s.

Little further progress along these lines has been made following that remarkable period of change in production approaches. The single-family homebuilding industry continues now, as then, to adapt and apply the results of research and development (R&D) done by others, primarily those involved with materials and component manufacturers and public bodies. It does that very well, in conjunction with its own efforts to make everything come together efficiently on the job site.

Unlike a true product industry, this industry tends to play a secondary or responsive role in specifying material or product performance, anticipating or correcting deficiencies, removing arbitrary constraints, controlling suppliers or controlling or leading much of its R&D. Nevertheless, the industry certainly produces houses in the volume and type demanded in the marketplace, and it advances new methods where needs and opportunities suggest and constraints can be avoided.

CHAPTER TWO
LOW-RISE TO HIGH-RISE: THE APARTMENT BUILDING PROCESS

Unlike the single-family house, today's typical apartment building cannot be said to look the same, have a similar structure or be produced in the same way as its counterparts of the 1940s. Beginning modestly in Canada in the 1920s, typical apartment construction changed little until the late 1950s; then in about one decade, by growing vertically, it changed in production process and end product perhaps more than the single-family house has in an entire century. The term "breakthrough" is appropriate in describing one or two points in medium- to high-rise apartment evolution. The demands and economic incentives appeared clear. The constraints were largely physical rather than artificial or involving arbitrary codes or jurisdictional constraints, as those that faced housing production evolution over the same period. The industry's technological response was a matter largely of construction and production engineering to meet the challenge of building vertically.

In this chapter, some of the main technological changes in the apartment product and process are traced and cause/effect relationships are touched upon. The review is less detailed than for single-family housing, partly because fewer, bigger changes happened faster in apartment construction, and somewhat less is known about the details. For these reasons, the discussion is done for periods, not points in time, and the product and process descriptions are provided together.[1]

THE LATE 1940s AND THE 1950s: THE PRODUCT AND PROCESS EVOLVES SLOWLY

The construction of apartments has been part of the Canadian housing scene for several decades. Apartment starts have been recorded in CMHC's *Canadian Housing Statistics* from their earliest records in 1949, when over 11,000 apartment units were started in Canada that year. Apartment living has been a normal form of city life in Quebec cities for a long time, even perhaps back to the 1700s, and especially in the walk-up flats in Montreal and in adjacent cities, such as Verdun. Following the war, in the late 1940s and 1950s, the construction of this type of dwelling continued unabated in Quebec.

In other parts of the country, the major surge in apartment construction after the Second World War began in the late 1950s; the trends in Canada-wide starts has been traced in Working Paper One. Much of the early activity outside Quebec was centred in Toronto. The apartment units constructed in the late 1940s and through much of the 1950s were predominantly of the low-rise walk-up type and usually with two-and-one-half to three-and-one-half storeys above ground level, with either three or four floors for accommodation, the first being one metre or so (three to four feet) below ground level. The units were called walk-ups simply because they were not equipped with elevators. This type of construction varied from place to place across the country, similar to the types of construction used in single-family housebuilding in that region. The production technology was not significantly different. The main difference in detail was in providing fire and sound separation between apartment units, something not necessary for single-detached houses.

In Quebec, and especially in and around Montreal, the predominant type of construction was plank frame, a construction of thick (generally 76 mm, or three inches) pine planks used to form the walls, with brick veneer or other cladding material on the exterior and lath and plaster on furring strips on the interior. The structure was moderately insulated (natural insulation of the wood) and fire-resistant. Many of the early walk-ups in the Quebec market were "cold" flats, with no built-in provision for any form of space heating. A flue outlet was provided for tenants to connect the stack pipe from their own space heater (what later became commonly referred to as a "Quebec heater"). That practice persisted into the late 1950s.

In the Toronto area, the predominant form of construction was solid masonry, where the structural walls were made from masonry block or brick, with brick facing. The early post-war units were low-rise walk-ups and incorporated a system for central heating based on coal or oil fuel, using steam or hot water with radiators for heat distribution. Such construction was used for walk-up apartments in a few other Ontario cities as well.

Elsewhere throughout the country, the type of construction for the walk-ups was wood platform frame, similar in most respects to the methods and materials applied for single-family housing. Concrete block fire walls were incorporated.

The materials and techniques basically were adopted from the single-family housebuilding process, and the changes that occurred in that process were, in due course, incorporated into apartment buildings. The structures and construction processes were basically the same, but the form of tenancy was different. Amenities and interior finishes, especially in the luxury or upper quality level of apartments, also began to parallel those used in single-family house construction. By the late 1950s, apartments began to feature broadloom or parquet flooring in living room, dining room and bedroom areas, vinyl-asbestos tile in kitchens and bathrooms, hollow-core wood doors, bi-fold or accordion doors for closets, ample kitchen cupboards, full lighting, bathroom vanities and so on.

THE SIXTIES AND SEVENTIES: TECHNOLOGY RESPONDS TO THE DEMAND TO BUILD HIGH

Apartment developers began to build up rather than out in response to several influences: cost of land and services, new demands to have open space around structures, sharply increased demand for rental apartments in or near the city and increasing complexities, costs and delays in getting a piece of land approved for building. By the mid-1950s, Toronto was beginning to move to medium-rise structures of seven to 10 storeys. Through the sixties, the high-rise structure of 15 and more storeys became not only the typical form in that area but also in many centres across Canada.

Medium-rise Apartment Construction

The construction of medium-rise apartment structures required the application of materials, designs and building techniques substantially different from those used for walk-ups. Building codes limited the heights to which timber frame or masonry load-bearing walls and structures could be built. The available alternatives were either to use structural steel framing with cast-in-place concrete floors, various materials (including masonry) for in-fill walls and partitions and some form of exterior cladding; or to use cast-in-place concrete to form the structural shell and floors and again select from various materials for in-fill walls, claddings and finishes.

Because there was no need to provide clear open-span (that is, column-free or bearing-wall-free) spaces in apartment construction, and partly because of familiarity with materials and processes, reinforced concrete construction emerged as the predominant construction type in the medium-rise, and later in the high-rise, segment of the apartment construction industry. Span lengths could be kept to normal room sizes, and design floor loadings were not high This meant that concrete floor slabs could be maintained at reasonable thicknesses. From experience with other forms of buildings and engineered structures, apartment developers were familiar with the installation and support of formwork and placing of concrete. Union jurisdictions were perhaps additional factors in maintaining the dominance of concrete over steel systems in apartment construction.

The methods and materials used in the 1950s and early 1960s were those of traditional concrete construction: the use of timber and plywood to make the forms, the installation of reinforcing steel according to the engineer's design and the placement of concrete. Formwork for floor slabs was fabricated from plywood and timber and supported by a system of adjustable steel posts called vertical shores. The concrete was hoisted and deposited at the working level by either a construction crane (the early ones used were the standard "crawler" cranes) or a material hoist equipped with a concrete bucket and hopper. To move concrete to those locations the crane could not service, wheelbarrows on runways were used. The tasks of setting up and then later dismantling and moving the forms and vertical shores to a higher level for re-use were difficult and time-consuming. With good concrete curing conditions, three storeys of shoring were required to maintain progress at the rate of one storey per week.

With greatly increased building activity and use of concrete, new products were developed and introduced to the market through the 1950s and 1960s to help speed the job. Horizontal shoring systems were developed to replace the use of vertical shores in certain situations. The horizontal shore is basically a re-usable extendable joist of steel or aluminium, supported on the scaffolding.[2] Panel-forming systems were developed, patented and pressed into use; heavy duty shoring frame systems replaced the vertical shores; improvements in hoist towers and hoisting equipment were introduced; motorized concrete buggies replaced wheelbarrows; and, later, concrete conveyor-belt systems and concrete pumping systems radically improved the construction process.

The singular awkwardness that remained unsolved was in the movement of workmen: While materials were hoisted, pumped or buggied with increasing speed and ease, the crew themselves had to climb through the building or through elaborate scaffolding. The consumption of time and energy became increasingly onerous as the building height increased.

High-rise Apartment Construction

The "need versus opportunity" relationship concerning building height and construction tools is not quite clear: Were the designers wanting to build higher and the equipment manufacturers accordingly devising tools to make it feasible, or did the designers see the remarkable new tools and then decide to take the opportunity of building higher? Probably both forces were in play simultaneously. High-rise apartment production quickly became an example of construction engineering/production engineering skills without parallel in residential history: The real needs, the physical constraints and the physics were rather clear-cut, while the arbitrary or artificial constraints were minimal.[3]

The production engineering for medium-rise, as well as high-rise apartment construction, focused first on vertical transport of materials and then, in the remarkable growth of advances in the mid-1960s, on the vertical transport of crew and large section formwork of the building. Beginning with medium-rise construction in the 1950s, material hoist towers gained widespread acceptance and use. The earlier versions generally were limited in height to about 28 m (90 feet) and were capable of hoisting a 550 kg (1,200 pound) payload at a maximum speed of 30 m (100 feet) per minute. Well suited for the medium-rise structure, this unit simplified to a considerable degree the process of moving materials to the various levels. Materials included everything: concrete (using wheelbarrows loaded with concrete and placed on the hoist platform, hence the name the "two barrow tower"), masonry products, windows and doors, and multitudes of finishing materials, as well as various pieces of equipment. Then, in the early 1960s, a heavy duty tower was developed, which had a maximum height of 80 m (260 feet) and could carry a payload of 1,800 kg (4,000 pounds) at a speed up to 80 m (260 feet) per minute. Again, this tower was only suitable for the movement of materials; the workmen still had to climb ladders or temporary stairways to gain access to the work levels.

New Tools Help Create the Leading System of High-rise Apartment "Production"

Three major product lines were introduced or developed in Canada in the 1960s that were, together, to have a major impact on high-rise apartment construction throughout North America.

The first important move was the introduction of tower-type building construction cranes, types that had been developed and widely used in Europe. The early models were either the stationary tower, guyed or attached to the side of the building, or the traveller, which could be moved along a track bed installed adjacent to the building. In many cases, these units were self-telescoping, so they could extend in height as the building grew. Their other big advantage, in addition to being able to serve higher elevations of building construction, was their ability to distribute material over a broad horizontal area at the working level. Campeau Corporation in Ottawa is credited with introducing such equipment to Canada and North America. Even by 1962, Campeau could show savings of about 35 percent in overall concrete costs compared to the earlier method it used of hoisting concrete by means of a hoist tower and distributing it horizontally using wheelbarrows.[4]

Such tower cranes were limited in working height, to about 20 storeys at best. Another type of construction crane—the climbing crane—literally removed the lid on building height. This crane uses the building structure as its support base and is jacked up to higher support levels as the building grows. Eliminating the need for a structural tower as part of the crane meant this type of crane was significantly less expensive than the others; yet it still offered equal or better operating characteristics. The location of the climbing crane within the confines of the building shell, usually in the elevator shaft, also provided better coverage of the work area than cranes at the side of the structure did.

As apartment developers became more familiar with the use of the cranes, further time and cost savings were realized. In the case of concrete placement, the ability to distribute materials on the working level close to the final destination eliminated the need for other forms of hoisting or distribution equipment, such as wheelbarrows and buggies, and for elaborate runways or conveyer belts.

The operating characteristics of the climbing crane and its strategic location on the site, more or less in the centre of the work, offered another unique opportunity for the apartment developer to realize substantial time and cost savings in the fundamental process of forming and shoring for floor slabs — the development of the flying formwork concept. In this, the contractor moves large sections of shoring and forming as whole units, eliminating the need to dismantle, move and re-erect the formwork and support system.

The flying form became the second product line, after climbing cranes, in the radical streamlining of high-rise construction. Early problems were encountered in trying to apply the process for some building designs because of deep spandrel beams around the floor perimeter and the need to collapse the shoring a significant amount to provide adequate clearance under this spandrel for form system removal. The need to eliminate this obstruction was recognized, and in the mid-1960s the flat slab design was developed and applied extensively in apartment construction. With this design, the floor slab is of uniform thickness throughout. The Toronto flat slab/climbing crane/flying formwork system for apartment construction quickly became recognized throughout North America, apartment developers coming from far and wide to observe and adopt the system.

A third product line came into play about the same time as flying forms and quickly took its place in improving the new, rapidly-spreading high-rise system. Also developed in Canada, the "Hi-Rise" hoist tower was safety-designed and licensed to operate as a workmen's hoist. It could be erected to heights up to 244 m (800 feet) and carry 20 men or 1,588 kg (3,500 pounds) at lift speeds up to 76 m (250 feet) per minute, in comfort and safety. If the tower was not to be used for transporting workmen, it could be equipped with a different hoisting mechanism and material platform, which could carry payloads up to 2,722 kg (6,000 pounds) at speeds up to 183 m (600 feet) per minute.

The entire combination of equipment available to the apartment developer now afforded the opportunity to apply essentially production-line operating and control techniques. The various stages of work, from initial construction through to final finishing, could be planned and scheduled floor by floor, with the trades and materials moving reasonably easily from one work site to the next rather than the product moving to the work station, as in a factory or assembly plant. Project house- building applies the same concept: crews moving horizontally down the row of houses in a scheduled and controlled fashion. In high-rise apartment production, the same concept of the stationary assembly line comes into full play, but the line is vertical. In both cases, the contribution of such organization and control, and the tools and materials that allow it to happen, is remarkably effective in saving time and money. As an indication, the on-site labour hours consumed in constructing walk-up apartments in 1946–47 were about 2,000 personhours, or a little less, per apartment unit.[5] The better finished and serviced high-rise apartment units were being produced in about 1,000 site person-hours each, or less, in the peak period of high-rise production in Canada, the mid- and late 1960s.[6]

EFFORTS TO INTRODUCE EUROPEAN SYSTEMS WITH HIGHER FACTORY CONTENT

Canadian apartment developers were twice enticed by the possibilities of technologically advanced European systems for apartment construction, once in the mid-1950s and early 1960s and more strongly at the end of the 1960s. In the first instance, in the mid-1950s, the Silver Heights Development Corporation in Winnipeg used the Lift Slab System to construct apartments in the six- to eight-storey range.

In this approach, the concrete floor slabs are individually cast on the ground, one on the other, with a releasing agent or separator (such as polyethylene) between each slab. After all have been cast and cured, they are jacked up one at a time, using hydraulic jacks on the permanent columns, to their final locations. The final column connections, walls, cross bracing and other components are secured. Partitions, plumbing, wiring and even finishing and furnishing materials and units may be added to each floor before it is raised to its final position.

Graham Lount of Winnipeg's Shelter Corporation developed the Lift Slab system further, incorporating post-tensioning by hydraulic jacks to stretch and anchor steel reinforcing cables placed in conduits through the slab. Such post-tensioning allows thinner slabs to do the job, reducing material weight, footings and so on. Shelter Corporation constructed six- to 12-storey apartments in this enhanced Lift Slab manner in the 1960s. Perhaps the anticipated cost savings never materialized (perhaps, indeed, the extra engineering costs in low-volume usage negated any possible savings), or perhaps the question of Lift Slab reaching to high-rise heights and high volume production posed a problem. In any case, by the late 1960s, the low-cost Toronto flat-slab system was taking over in the west and indeed through most of Canada and much of the United States.

Even as the Toronto flat-slab system matured quickly, details and interest in several advanced precast systems used in Europe circulated through North America. It proved enticing to several entrepreneurs, including the leading developers and users of the flat-slab system. The northern European leaders in pre-cast apartment building systems certainly were achieving high quality, with much better detailing for cold-country performance and durability than the details offered in the Canadian systems.

It appeared that they could do this at lower overall costs as well, at least in steady high-volume production of reasonably standardized apartments. In such production, the reduction in on-site person-hours (and skilled person-hours) and the financing period could more than offset the extra fixed costs of the plant. Under such ideal conditions, it was projected in 1970 that a 12 percent saving could be gained compared to the best traditional jobs.[7] Independent cost projections by Toronto apartment developers, concurrently working with European system sponsors, suggested about a 10 percent savings potential.[8]

Two main examples of system transplanting are briefly described to illustrate a large part of the remarkably intensive burst of activity in the Toronto area from 1968 to 1973. Throughout this period, the transplants were said to have faced a minimum of arbitrary restriction or constraint from architects, building or code authorities, financiers or organized labour.[9]

System builders, such as Denmark's Larsen and Nielsen, as well as Jespersen and Skarne in Sweden and Wates in England, were courted by apartment developers and other entrepreneurs in Canada and the United States. One of these system builders with full design and experience history in high-rise construction, Wates Ltd. of Great Britain, became the partner in the North American venture that came closest to full-scale success—albeit not very close. A Toronto consortium of large developers, consisting of Belmont, Cadillac, Greenwin, Heathcliffe and Meridian, entered into partnership with Wates to form Modular Precast Concrete Structures Ltd. The new company acted as a precast building subcontractor to the developer partners, in competition against their own normal deployment of the Toronto flat-slab system.

At the same time, in the early 1970s, the Jespersen system was brought in and adapted by an entrepreneur under the company name Jespersen-K to operate as an open market system supplier/shell builder for any developer or owner. A production plant was set up by Jespersen-K in Markham, Ontario.

The systems such as Wates and Jespersen encompassed far more than the organization and production-delivery-erection of pre-cast floors and walls to form a precisely fitted building shell. The complete range of building parts could be extensive, including pre-cast stair and elevator shafts, columns, refuse chutes and ducts, stairs and landings, balconies, service core or core-wall units for bathrooms and kitchens and other manufactured components, such as modular (and sometimes moveable) partitions, cabinet-walls, closet-walls, windows, doors and plastic drain-waste-vent subassemblies.[10]

In Jespersen-K's case, the open marketing of even a part of such an integrated system faced great difficulties in finding or enticing much dimensional rationalization or standardization of design of structures, or repetition or scale of projects, among apartment developers and their designers. While the plant and erection process worked well, orders kept the plant running at only half capacity. For this reason at least, the structures yielded somewhat higher costs than normal and not the five percent savings that had been anticipated. Markets thinned out even more, profits never materialized and the venture was closed down.

In the meantime, Modular Precast's adaptation of the Wates system did little better with its huge but not-so-captive market among its owners, which included five major apartment developers in the Toronto region. High-volume pilot trials were retarded and complicated by incomplete industrial engineering work in transplanting the system into Canadian apartment designs; Modular Precast acted only as the subcontracted building supplier, with perhaps too little control of other costs and little profit incentive to drive itself; and it faced the most cost-effective competition in North America (and perhaps anywhere) — the Toronto flat-slab system.

During the 1968 to 1971 period, European system builders experienced cost increases of about 22 percent, at least partly due to changes to prevent structural failures in high-rise use.[11] During the same period, the Toronto flat-slab system overcame much of the influence of general inflation by further increasing its efficiency, rising in costs only about 13 percent from 1966 to 1971.[12] While the pre-cast system could avoid the persistent need for maintenance of at least some details of the Toronto system, the partners and others projected that even full-volume production of apartments would entail first costs of six percent or more above their home-grown system, which was "the most efficient in North America."[13] Further, the popularity of high-rise apartment living was waning and the construction pace finally slackening. The distinctly unprofitable Modular Precast venture was closed down in 1973, and the partners continued with their own Toronto creation in vying for the thinning markets.

SUMMARY

Apartments have been part of the Canadian housing scene for many decades. Walk-up flats in Quebec cities perhaps date back as far as the 1700s. Following the Second World War, the pressures for more rental accommodation and lower costs achievable through denser forms of housing caused a rebirth of apartment construction, with the main surge in most parts of the country beginning in the late 1950s. The early forms were predominately low-rise walk-ups, with the move to medium-rise starting in some centres (notably Toronto) about the mid-1950s. With the availability of new technologies and equipment, the high-rise structures appeared widely through the 1960s.

The low-rise forms of apartments, especially the walk-ups, used basically the same building technologies and employed the same practices as in single-family housebuilding. With the move to medium-rise, seven to 10 storeys, and later to high-rise structures, the image and characteristics of apartments began to change. Apartment buildings became a different product from the traditional low-rise housing form.

New equipment and techniques developed or introduced in the 1960s contributed significantly to the development of high-rise apartment technology. The most significant equipment were the tower and climbing cranes (developed first in Europe and brought to North America in the 1960s), high-rise hoists (first for hoisting of materials and later designed for transport of workmen) and flying formwork and flat-slab design for apartment construction.

Toward the end of the 1960s, there was a strong movement to introduce European building system techniques for apartment construction in Canada, especially in the Toronto area. The European systems involved higher levels of factory content than for the traditional North American techniques, thus necessitating substantial capital cost (within a single enterprise) for plant and facilities. These systems were being introduced to the Canadian market about the same time as the flat-slab system of construction, using climbing cranes and flying formwork to build structures by cast-in-place procedures, was maturing remarkably well, setting the best productivity mark in North America. The Canadian flat-slab system achieved overall efficiencies unmatched by the European systems, which failed to gain a permanent foothold in Canada.

CHAPTER THREE
RESIDENTIAL RENOVATION PRODUCTION PROCESSES

The scope and intensity of residential renovation work, and the general make-up of the industry involved, is discussed in Working Paper One. As large as it is, renovation does not fit the concept of an industry easily: It is not a branch of manufacture, nor a trade, nor truly a collective productive interest. The share of residential renovation work done by firms in the housing industry may be only 30 percent; individual homeowners, landlords and special trade contractors do the remainder. For many renovation firms, most jobs are one-off, surprise-ridden, barely planned and never truly repeatable. In the mid-1980s, as in the mid-1940s, no pattern or discernible stage of evolution, no real changes or hints of change, no technological breakthroughs, presents itself. Indeed, there may be some reversals: a need in the mid-1980s and beyond for the once-traditional materials, skills and techniques that were part of the fabric of house construction/renovation in the mid-1940s, instead of some of the newer materials and procedures used for new housing production in the mid-1980s.

The residential renovation market includes the following features:

- The residential renovation industry is quintessentially adaptable, flexible and responsive to demand and opportunity, at least as much so or perhaps more so as the single-family homebuilding industry. The diversity and volume of activity attests to this. It faces physical constraints and surprises on almost any job in any home. While the small renovator may be able to fit or simply ignore regulatory constraints, these are said to seriously impede larger firms. Regulations are especially inhibiting to sizable projects, such as converting large buildings into apartments.[1]

- Renovation is extremely labour-intensive and may well remain so since breakthroughs are not foreseeable for years to come. In renovation work, as compared to standard forms of new construction, materials have to be custom fitted, and the tradesman must be able to work with designs and materials that are not now commonly used. About two-thirds of the renovation dollar may be spent on labour, versus one-third of the single-family house construction dollar.[2]

- Renovation offers an increasingly favoured alternative for existing homeowners compared to moving into a new home, and is growing and should continue to grow rapidly. The amount of activity correlates with the age of housing stock, as well as the age of occupants, so that certain centres or regions will experience more renovation activity than others.

This chapter traces renovation activities from the 1940s to the mid-1980s in an attempt to discern some trend or pattern of technological change or portents of change.

AN OVERVIEW OF WARTIME AND POST-WAR RESIDENTIAL RENOVATION ACTIVITY

At least three defence-related programs created substantial and significant flurries of renovation activity, helping to bring in most of the technology used currently:

- **Temporary housing** The construction of temporary defence plant housing left a legacy of soundly constructed, well-designed small houses, many of which were later raised, fitted with new basements and, occasionally, as an intervening step, transported to a new site. Wood-frame houses proved to be strong, resilient, light and eminently moveable, often with damage only to the rigidly intolerant plaster.

- **House conversions** During the war, owners of large old houses were encouraged, with government assistance, money and contracting responsibility, to convert them into several apartments to help accommodate the wartime workers.

- **Housing removal related to airport construction** Across the country, vast areas of land were required for airport construction. It required the development and use of huge earth-moving equipment and vast areas of land. The need for land required removal of many houses, a number of which were transported to other sites.

The temporary wartime houses constructed by Wartime Housing Limited have become a permanent part of many communities across Canada. As tenants became owners, their rather radical improvements (raising the home, fitting a full basement under it and installing a complete warm air heating system) helped set whatever pattern or tone can be seen in renovation production. They proved that a wood-frame house can be radically reworked, recreated and renovated, often with just themselves, a few friends or relatives and a knowledgeable tradesman or two. They found they could gain essentially a new home at comparable or much less cost than constructing a new one, and still stay in their own neighbourhood, thus avoiding the cost of a new lot. The process of moving old houses to free up land for airport construction helped to develop techniques that are still used. Two-and-one-half storey mansions were moved, whole or cut in two, as well as smaller storey-and-a-half houses and simple bungalows. The equipment and the techniques for raising and moving the house became better refined and established, allowing existing houses to be fitted with full basements.[3]

CONVERSION CONSTRAINTS

The conversion of older single-detached houses into apartments occurred through the 1940s and 1950s and continued to the mid-1980s; however, the volume of conversion activity in the mid-1980s is constrained by a number of factors:

- **Regulations** Regulations, particularly zoning regulations, can be unrealistically demanding or simply prohibitive. Municipal by-laws discourage non-family multiple housing; hearings are required for zoning changes. As plan examiners and building inspectors are not sufficiently familiar with renovation work, they can impede or complicate the process. Neighbouring homeowners are not usually supportive of such changes.

- **The need for outside professionals** Without expertise in the fields of sales/marketing, architectural or structural design, financing and real estate, it is much more difficult to get a multiple-unit building created from a single-detached home than it is to renovate the home and resell it as such.

- **Higher risk** When buying a house or other suitable building for conversion, the renovator must often do an almost instantaneous cost and profit analysis to make an offer on the property. This absence of in-depth analysis — the renovator's reliance on instant judgment — means a higher proportion of risk.

- **Availability of suitable structures** With few exceptions, large existing two-and-one-half or three-storey single-detached houses are the typical structures converted to multiple occupancies.

- **Available financing** Unlike other forms of residential renovation, which rely on financing provided by the building owner, renovators who purchase with the intent to convert must seek their own financing. A business line of credit at a chartered bank has been the most common method of interim construction financing. However, unlike new home construction where financing is available up to the final sales price, similar lines of construction financing are not always available to the renovator unless based on personal guarantees.

HOMEBUILDERS BECOME INTRIGUED WITH HOME RENOVATION

The demand for housing ensured ample opportunity for growth in new home construction through the 1950s and 1960s; renovation activity never faded away but remained a largely minor part of total housing construction activity. The flurry of renovation in the 1970s through to the mid-1980s—improving kitchens and bathrooms and adding space to existing housing—attracted homebuilders and others to enter this segment of the housing industry.

A few large project-builders, with product-manufacturing divisions, organizational abilities and success in producing new houses, set up renovation divisions. For example, Campeau Corporation made that move in the early 1970s. However, the headaches of dealing with individual homeowners with their ever-changing aspirations and expectations, gave Campeau considerable cause to question the move by the end of the decade. Still more importantly, such a business division could not compete with the myriad army of small specialist tradesmen in the field.[4]

Housing framers and small-scale carpenter-homebuilders (the generalist successors of the master builders of earlier days) also became more active in renovation markets. They were, and are, successful at least in higher-quality renovation projects; they too have difficulty competing in costs with the handyman-renovators and the do-it-yourselfers who simply want a little help from specialists occasionally.

A survey of the renovation market in 1985 suggests the handyman is still dominant in the market. Canadians do up to 85 percent of their own painting, weatherstripping, landscaping and replacing light fixtures. Ontarians also did 53 percent of their own kitchen work and 64 percent of their bathroom work.[5]

A PROBLEM-RIDDEN FIELD

The rapid growth in residential renovation activity since the early 1970s has occurred despite many problems. According to a 1981 study, homeowners ranked home improvements as one of the most difficult purchases,[6] partly because unlike new construction, where materials and procedures are reasonably standarized and understood, renovations differ from project to project and from structure to structure. Only the repairing and purchasing of used automobiles was as equally maligned and mistrusted as home renovations. The renovation industry also calls for contractors and tradesmen having a broad range of skills, of which customer relations is one of the most essential.

LACK OF CONSUMER PROTECTION

By the nature of the industry, residential renovation firms are generally small and unsophisticated. Although many diverse skills are necessary, virtually any handyman with a hammer can enter the market and call himself a renovator by simply obtaining a municipal licence to operate. Little, if any, financing is required to start a business; many renovators are not bonded; a sizable proportion of renovators do not provide written guarantees, though a number of these provide verbal guarantees. Repairs and renovations can cover a wide range of services. Unfortunately, little distinction is made among various types of renovators, which encourages tradespeople to pass themselves off as qualified in any repair or renovation area of interest to the consumer.

Since not all renovation work requires a building permit, and much appears to be done illegally without one, inspections by qualified enforcement officials do not occur in many instances. Standards for quality and legislated warranty programs for renovation work do not exist.

REGULATIONS, CODES AND STANDARDS

Government regulations, building codes and standards have not kept pace with the renovation industry; probably they cannot and perhaps they should not. The industry cannot be thought of as mature; attempts at full regulation could stifle innovation. Municipal requirements such as zoning by-laws can significantly restrain renovation activities. Confusion and conflicts frequently exist between provincial and municipal regulations (for example, fire code requirements), although these conflicts generally do not constrain or affect the act of improving single-family houses. With the exception of the Ontario Building Code, which includes provisions for renovation, generally regulations, codes or standards have not addressed the issue. Codes for new construction cannot be imposed usually on renovation without undue awkwardness or costly redundancies and waste.

LABOUR

One of the prime differences between new housing construction and renovation is the understanding of the process, and of housing construction and materials in general. It is one of adaptation, rather than straight application. It is also one where the act of dealing with the client, the individual homeowners, adds a critical dimension. Unlike new construction, where designs and requirements are relatively clear and precise, where the end product is a known, renovation work can be full of surprises. It requires constant on-site supervision and management. Yet, the many unforeseeable events demand decisions be made instantly. As one Guelph renovator stated, "You almost have to handhold all the sub-trades, as well as the customer, just to keep control."[7]

Since renovation work uses essentially similar, if not identical, sub-trades as new construction, the renovator must compete for the same available labour pool.

Second, sub-trades prefer the more controlled and repetitive nature of new construction. Adding to the problem of having sub-trades available when required is the lack of skilled craftsmen, who are no longer in plentiful supply. Also, the types of tradesmen best suited to do renovation work are those having a broad range of skills and the ability to undertake various functions and work with designs and materials not commonly used. For example, manufactured finished and semi-finished products are used considerably in renovation work, but plasterers and finishing carpenters have become scarce.

NEW TECHNOLOGIES

Even more so than in new single-family construction, noticeable technological advances in renovation have been few and far between. Measures to conserve energy in the 1970s resulted in the creation of special trade contractors, such as air-sealing and insulation contractors. Complementing these specialty trades were new materials and products including weatherstripping, add-on plastic glazings and insulations (foams and cellulose). With the introduction of prefinished products, including plastics—all designed to speed up new home construction—came the decline of several products and techniques that they replaced. In particular, plastering suited renovation work quite well because the older houses are often anything but square, level or plane-surfaced (partly because they were plastered in the first place); the square-sheet drywalls and prefinished materials, with all their advantages, are generally difficult to cut, fit and firmly support in retrofit situations. On the other hand, with the renewed interest in rehabilitation has come the growth of specialty items, such as kitchen cabinet refacing, countertops and plastic millwork, which make the job easier for professionals or do-it-yourself homeowners.

The renovation market and building supply dealerships have grown hand in hand. Materials packaged in small quantities and single-stop shopping—aimed at the do-it-yourselfer and handyman but picked up eagerly by the specialist trades and renovators as well—have facilitated renovation activity.

However, efforts to introduce large innovations have not achieved much success. Mass production of home renovations or renovated homes is almost a contradiction in definitions, and even the mass production of large components has proven generally to be an ineffective approach for renovation work. As an extreme example, efforts to stack unit bathrooms in existing multi-storey tenement buildings in an effort to create luxurious apartments encountered crippling difficulties and costs. While inherently much less difficult, ventures to market factory-manufactured add-on rooms, such as sunspaces, have encountered unforeseen (albeit often foreseeable) costs, largely because existing houses offer restricted access, out-of-plane and out-of-plumb surfaces, and often wiring and plumbing hidden in unexpected locations.

The renovation contractor must be trained and knowledgeable about moisture, ventilation and air quality in housing. As a consequence of some renovation and energy conservation activities, such as sealing, caulking and weather tightening, houses are made significantly more airtight than they used to be. This means the relative humidity of the indoor air tends to increase, given the same life style as before, and moisture problems or air quality problems may ensue. The renovator must be familiar with the function and requirement of heat recovery ventilators. The renovation activities are custom projects, in many instances, and require the application of different skills and knowledge than required in the production of new housing.

THE NEED FOR RENOVATION GENERALISTS

Where master builders once ruled the homebuilding industry successfully, it is clear that the growing home renovation business could use a new trade—the master renovator. The ultimate goal would be to increase quality, reliability and efficiency in the important job of making new homes out of old. While the master renovator's main expertise would have to include carpentry, structural and at least para-electrical skills, this new trade also should call for an expanded appreciation of materials and equipment and estimating, costing, and organizational skills exceeding even those of yesteryear's renovators. Good client relations skills and orderliness are also necessary attributes, as these tradespeople frequently are required to work in the client's home while the client continues to live there.

It may be a long time before the arms-length application of codes, standards, inspections and acceptances can intrude constructively into the business of upgrading the existing housing stock with more quality assurance. The renovator will continue to be constrained by physical and cost limitations and realities, although somewhat less so by regulations and controls. Quality will depend on the knowledge and contractual firmness of the renovator and the homeowner client.

SUMMARY

The residential renovation industry, which has experienced rapid growth since the early 1970s, continues to be dominated by the do-it-yourselfer and special trade contractors. It is labour intensive and may remain so as much of the work requires a customized approach and continual adaptations of products and materials. In some cases, it involves working with designs and materials no longer commonly used.

Clear technological advances in renovation have been few and far between. The key differences between renovation and new home construction relate to the understanding and organization of the process rather than to the actual materials and techniques used. As renovation is very much a personalized form of business, customer relations are of prime importance. The tradesmen best suited for renovation work are those having a broad range of skills and an understanding of various construction types and details.

The renovation contractor must also be trained and knowledgable about moisture, ventilation and air quality so conditions that will invite problems can be avoided.

Despite the growth of renovation activity, the residential renovator continues to be constrained by physical and financial limitations, as well as by building regulations and controls. Constraints also take the form of lack of business management skills because many of these contractors were initially tradespeople.

CHAPTER FOUR
LABOUR IN THE RESIDENTIAL CONSTRUCTION INDUSTRY: SOURCES AND CHARACTERISTICS

The residential construction labour market is a diverse conglomeration of trades and skills and is essentially a segment of the much larger labour market that serves the overall construction industry. The size and nature of the part of the labour market that operates primarily within the residential construction sector undergoes frequent change, in concert with the relative amount of building activity in the residential sector in comparison to all other construction activity.

This chapter looks briefly at some of the characteristics of the residential building labour force, from types of skills and sources of workers, to education and training, wages and unionization.

AN OVERVIEW

A Focus on Crafts-oriented Skills

The single-family home building industry has been and continues to be, albeit to a lesser extent, identified as an industry requiring a large complement of crafts-oriented skills and trades, with the primary skill being carpentry. In earlier days, the key member of the housebuilding team was the master carpenter.[1] Along with his apprenticed helpers, he was involved with the entire process from staking out and establishing the line and levels for excavation, to building forms for the foundation walls, through to the final finishing work of hanging doors and installing hardware, applying finishing trim and building the kitchen cabinetry. Other skilled trades were involved at the appropriate times in the building process for such tasks as installing electrical or plumbing services or the heating system, including the distribution network of ducts or piping.

The early forms of apartment construction required a similar array of skills as the form and nature of construction were basically the same. The major differences were in the application of materials and systems to satisfy codes for multiple occupancy as opposed to single-family occupancy (for example, to meet requirements for fire and sound separation between dwelling units). However, as apartment structures increased in size and height, other materials and forms of construction were found to be better suited and less costly for meeting the new needs, and the masonry trades became more visible as a significant element in the construction process.

Importance of Various Trades

A study carried out in 1976 by Central Mortgage and Housing Corporation (CMHC), now Canada Mortgage and Housing Corporation, provides estimates of the relative contributions of the various on-site trades in the construction of a single-detached dwelling.[2] The estimates relate to the 1969–71 period.

The study showed that of the total on-site person-hours, carpenters accounted for 28 percent, labourers 25 percent, painters nine percent, bricklayers seven percent, plumbers five percent and electricians four percent. A variety of other trades made up the remaining 22 percent of the person-hours.

A comparison with a previous study carried out by CMHC in 1955 suggests substantial shifts in the distribution of labour among construction trades between 1955 and 1969.[3] In spite of two studies showing labour trade distributions on different bases, the earlier study on a percent of cost base and the later study on percent of person-hours base, shifts in amounts of work by different trades apparently did take place. Many of these shifts resulted from changes in construction technology that occurred during the intervening years, with introduction of new materials, new techniques and new equipment.

As an illustration, in 1955, plasterers accounted for approximately seven percent of the total cost of on-site labour; in 1969, the proportion had decreased to less than one percent. The reason for the decline was that, in the 1960s, the plastering of walls was gradually replaced by gypsum or other wallboards used in residential construction. In the 1969–71 period, drywall applicators and finishers each accounted for just under four percent of on-site person-hours for single-detached housing.

Another shift was evident in the relative use of electricians. In 1955, they accounted for three percent of the total cost of on-site labour; in 1969–71, the proportion had increased to approximately five percent. This increase in electrician's time in the housebuilding process was probably owing to the growing availability and use of electrical products in the home, thus requiring the installation of more electrical outlets and more complex electrical systems, including increased use of electric heating.

COMPOSITION OF THE CONSTRUCTION LABOUR FORCE

The composition of the labour force in the residential construction industry can only be approximated by referring to construction labour force data from the 1981 Census of Canada. No separate data are presented that refer to the residential construction industry by itself.

A review of 1981 Census of Canada data suggests the following composition:[4]

- Almost all of the workers (98 percent) are male;
- About 80 percent of the male workers are under the age of 50, while about 88 percent of the female workers are under the age of 50;
- Young females appear to be entering the labour force at a greater rate than young males: At the time of the 1981 Census, 36 percent of female workers were under the age of 25, while for male workers the proportion was 23 percent;
- Within the total construction labour force (male and female combined), approximately 25 percent had a high school diploma or a higher level of formal education in 1981, while an additional 25 percent possessed a trade certificate or diploma and approximately 23 percent had less than a grade nine education;
- Approximately 87 percent of the workers were wage earners, while about 13 percent were self-employed; and
- Approximately 77 percent of the work force were born in Canada, with about 20 percent having been born in Europe, half of this group coming from southern Europe.

SOURCES OF LABOUR

Immigration of Skilled Trades

Construction labour for the housebuilding industry traditionally has come from two sources: immigration of tradespersons and persons born and trained in Canada.

Immediately following the Second World War, the decline of construction of war plants and facilities was soon replaced by expansion in construction for civilian purposes. During the building season of 1945, the demand for skilled labour in the building industry substantially exceeded the available supply. Some relief to this situation was experienced the following few years with the demobilization of the returning war veterans and the completion of vocational and apprenticeship training by large numbers of these veterans. At the same time, an additional source of skilled construction workers was the immigration of tradespersons from Europe, with an especially large number coming from the United Kingdom. This inflow of skilled building workers, including carpenters, bricklayers, painters, plasterers, electricians and plumbers, as well as others, became a significant source of new building tradespersons during the late 1940s through the decade of the 1950s.[5] The immigration of construction workers fluctuated quite widely from 1946 to 1951, reaching a high point of over 10,500 in 1951 (90 percent were classified as skilled workers, with carpenters constituting 29 percent of the total, electricians 23 percent of the total and bricklayers 18 percent of the total as the major trades). Immigration continued at a rate averaging about 7,700 persons per year for the next five years, hitting a peak of almost 16,400 persons in 1957. The annual level then declined and over subsequent years has been substantially lower owing to fluctuations in construction activity and employment opportunities and periods of high inflation and high unemployment in the country.

During the first 25 years of the post-war period, the United Kingdom had traditionally supplied a significant proportion of skilled construction tradespersons, many of whom became the foundation of Canada's construction labour force and leaders in the industry. In more recent times, from the 1970s, a growing proportion of both skilled and unskilled workers have come from southern European countries (Italy, Portugal, Spain) and also from Asia (Pakistan and India).

A profile of the construction labour force derived from the 1981 Census of Canada shows that, at that time, approximately 50 percent of brick and stone masons and tile setters came from southern Europe. In some regions of Canada, particularly in the West, the roofing trades have recently seen a large influx of immigrants from Pakistan. Immigrant workers are attracted frequently to the major metropolitan areas, principally into the single-family housebuilding sector, which is often less unionized and therefore can be entered more easily than the more unionized sectors of the construction industry.[6]

Compared to the high levels of immigration of tradespersons experienced for some time following the Second World War, immigration statistics for recent years (1978 to 1984) show an average of about 2,100 immigrants per year in the construction trades category; in 1984, 19 percent were carpenters, seven percent were brick and stonemasons, and painters and plumbers were each about six percent.[7]

During the period from 1945 through 1960, more than 94,000 construction workers immigrated to Canada. The majority (88 percent) were skilled tradespeople. This influx of workers from abroad was significant, to the extent that in the early 1960s, immigrants made up between 20 and 25 percent of the country's construction labour force, and even a higher proportion of the skilled tradespersons.

Training and Apprenticeship

To meet the anticipated need of skilled tradespersons for the construction industry following the Second World War, the federal government entered into a 10-year federal-provincial training scheme with the provinces in 1944. A fund was set up by the federal government to assist the provinces in the expansion of training facilities, with special provisions made for war veterans to help them re-establish themselves in their previous, or new, trades. The program appeared to be an immediate success, with more than 3,800 persons receiving training in 1945 and enrollment over 7,000 in 1946. However, a decline set in during 1947 and 1948 when the number of veterans interested in training for building trades in vocational training schools dramatically dropped.

On-the-job apprenticeship training became the preferred approach to learning new skills or improving existing skills. Moreover, the increasing numbers of skilled immigrants during this period helped to relieve the pressure to train more tradespersons for the industry.

The on-the-job apprenticeship training approach for maintaining a supply of skilled tradespersons has continued through the years, generally with reasonable success but with varying degrees of involvement by those who need the tradespersons, namely the builders and contractors. For example, a survey of the Canadian homebuilding industry carried out in 1971 by CMHC indicated only 16 percent of builders participated in manpower training programs.[8] Medium-sized firms were the most active with 17 percent participation and small builders least active at 10 percent. Sub-contractors showed the greatest level of involvement with 22 percent participation in training programs, mostly in the traditional trades of carpentry, plumbing and electrical skills.

Concern has been expressed at different times and in different segments of the industry about the adequacy of apprenticeship training programs. For example, a study commissioned by the T.E.D. Commission in Manitoba in 1968 reported some concern and dissatisfaction by union representatives with certain elements of the apprenticeship program in the province.[9] It indicated that with the exception of electricians, the number of apprentices in all other trade categories had fallen during the previous seven or eight years; particular concern was expressed about the relatively few carpenter apprentices each year.

In spite of localized shortfalls in apprenticeship trainees and concern over future availability of skilled workers, a profile of the construction industry published in 1978 stated:

> Manpower training for construction workers is well established on a federal and provincial basis. Yet, with the rapidly changing pattern of construction work, it will be incumbent on management, labour and government to work together to review and amend the manpower training programs to ensure that properly qualified tradespersons are available in the numbers required to meet current and future demands.[10]

However, concerns are still being expressed and situations studied for specific trades. A brief prepared by the Masonry Contractors' Association of Toronto in 1985 expressed concern about the aging of the population of bricklayers and that young people are not entering the trade in adequate numbers.[11] It was indicated in the brief that shortages would occur in the foreseeable future if this trend continues. An apprenticeship subsidy program to encourage young people to enter the trade and thus reduce the cost of training to the employer was proposed. In Quebec, in a study of housebuilders in the early 1980s, the greatest problem areas were the availability of (that is, shortages of) labour; problems created by poaching (that is, one builder attracting tradespersons away from others); and the existence of overly rigid collective agreements.[12]

UNIONIZATION, WAGES AND PRODUCTIVITY

Unionization

A Royal Commission headed by H. Carl Goldenberg, studying the construction industry in Ontario in the early 1960s, described the construction industry as a group of related firms whose principal common denominator is the employment of the same labour force and bargaining with the same trade unions.[13] Three distinct features of the industry were listed: permanent location of product; temporary location of employment; and irregularity of employment caused by unstable markets, cyclical fluctuations and seasonal considerations.

Although the above description was made in reference to the overall construction industry, it applies equally, or perhaps even more specifically, to the housebuilding industry.

There seems to be a substantial amount of uncertainty and confusion in the housing industry, especially in the single-family building sector, about the extent of unionization of the various trades. Apart from Quebec, where union membership was made compulsory with the passing of the Construction Industry Labour Relations Act of 1968, unionization in the industry appears erratically distributed in various sectors and in various geographic regions. A study by Paul Malles for the Economic Council of Canada in 1975 stated:

> There is every indication that union membership is most heavily concentrated in the nonresidential sector—mainly in commercial, institutional, and industrial building, and, to a lesser extent, highway- and bridge-building. Union membership is also high in the more specialized trades; but it plays only a minor role in the residential construction sector, except possibly in high-rise apartment construction.[14]

An earlier study in 1971, focusing specifically on the Canadian homebuilding industry, found that builders reported 10 percent of their trades were fully unionized, as opposed to subcontractors, who reported 41 percent were fully unionized; 43 percent of builders reported no unionized trades, while 13 percent of subcontractors were non-unionized.[15] In terms of individual trades, information received from builders and subcontractors was more consistent. Plumbers and electricians were the most heavily unionized, painters and labourers the least.

A Royal Commission, headed by Judge Harry Waisberg, studying certain sectors of the building industry in 1974 found:

> In Ontario, the commercial division [of the building industry] is almost completely unionized, while the residential division, if confined to single-family dwellings, is not.[16]

The inconsistency of the employer-employee relationship and the absence of a permanent place of work can affect profoundly the labour force, making the union the only constant factor in the work life of the union member. For this reason, from discussions with persons in the industry, it appears the proportion of organized skilled, and unskilled, labour is growing, though unionization has not yet made significant inroads into the single-family house-building segment of the industry. The only exception may well be with larger builders operating in an active metropolitan area, such as Toronto in the mid-1980s.

Education

A recent trend influencing the nature of the building construction labour market is the increasing levels of education of the labour force. The educational attainment of young people is growing much more rapidly than the numbers of white collar, or blue collar, jobs in which high school and university graduates have commonly become involved. Some of these people are attracted by what is perceived to be generous wages earned by workers in the construction industry. A comparison of the 1971 and 1981 Census data shows that for the category of other construction trades, which includes most of the trades employed in the building construction industry, in 1981 only 23 percent had less than grade nine education compared to 45 percent in 1971; over 60 percent had some high school education, a high school diploma or trade diploma compared to just under 50 percent in 1971; about 15 percent had some university training in 1981 compared to less than five percent in 1971; and in 1981, about two percent had a university degree, double the percentage in 1971.

This changing pattern may have notable effects on the labour force. Young people who enter the industry because of lack of opportunity in other fields may become discontented in working in an area not clearly related to their training and working under the supervision of persons whose formal education is much lower. This situation could possibly lead to increased instability of the labour force. Also, it has been suggested that an influx of articulate, better-educated young people may affect labour relations. However, labour relations can be influenced from both directions, from the union's position and its capabilities in negotiating and administering labour relations, as well as from management's position.

Wages and Productivity

For the majority of workers in the building construction industry, employment can be highly irregular; for some it can be relatively short in terms of number of weeks per year. Wide variations in annual earnings can also exist as hourly wage rates in the industry are higher than for many non-construction industries. In fact, studies have shown that in spite of the shorter employment periods worked, the annual average income of a construction tradesman is often higher than a non-construction worker who has worked longer. Another possible factor contributing to the relatively higher earnings of the construction worker is the longer hours worked and overtime earned each week.

A study published in 1975 showed that average wage rates in construction increased at an annual average rate of about six percent over the 1951–1970 period, compared to manufacturing at about slightly less than five percent and all industries at about five percent.[17]

A brief review of data from *Canadian Housing Statistics*, published annually by CMHC, suggests that over the 1949–80 period, the average hourly earnings in the building construction industry in Canada increased at an annual rate of about eight percent. Over the same period, the construction cost per m^2 of NHA-financed single-detached dwellings increased at an annual average rate of just over five percent. Comparison of figures such as these suggest increased productivity in the industry. However, productivity is an ill-defined term, and rates of productivity or changes do not lend themselves to easy or accurate measurement. Some of the improved productivity in the housebuilding industry is the effect of factor substitution, the result of which is less physical input in terms of labour. For example, changes in the technology of residential construction over the years, has led to substantial decreases in on-site labour, and even substitution of cheaper labour, relatively speaking, for many of the tasks that still need to be done on-site. The lower skills can be used because of improvements in materials, material application techniques and in equipment, including the wide range of portable power tools and other labour-saving devices. Other improvements in productivity have occurred because of the growth in numbers of special trades contractors, who have devised methods to increase the efficiency of undertaking specific tasks.

DIRECT EMPLOYMENT VERSUS SUBCONTRACTING

During the decades of the 1950s and 1960s, builders commonly employed a wide range of trades to carry out much of the work using their own labour forces. Specific trade contractors had not emerged to any great degree. In many cases, builders, because of the pent-up demand for housing, were able to offer reasonable continuity of employment. As a result, a good amount of employee-employer loyalty developed. With increasing competition in the marketplace and also because of the emergence of certain specialty trades (such as drywall installers and finishers, and roofers) and the opportunities afforded to both builder and tradespersons through unit-price contracting, speciality subcontractor companies emerged on a broad scale. Such companies ranged from small firms employing one or two persons, skilled in specific trades, such as electrical or plumbing, to large groups employing substantial numbers in trades such as plastering or drywall. Several of the today's large builders, including Harold Freure in Kitchener, Ontario, started their careers as tradespersons but quickly assembled a sizable group of tradespersons and provided this skill on a subcontract basis to single-family builders and apartment developers.

The subcontracting of various trades has become the norm in the industry, although distinct variations in subcontracting activity exist between the various provinces. A survey of home builders carried out by the Canadian Home Builders' Association (then known as the Housing and Urban Development Association of Canada) in 1974 showed that across the country, the trades identified as having the highest incidence of subcontracting were electrical (70 percent), plumbing (69 percent), heating/sheet metal (67 percent) and painting (67 percent).[18] The lowest incidence of subcontracting was for unskilled labour (five percent) and carpentry (19 percent), meaning that builders still count on having their own carpenters as the key trade. Certainly, carpentry-related tasks, such as rough framing, are commonly subcontracted, but the builder will have his own carpenter-supervisor to monitor the work.

SUMMARY

The residential construction labour market is a diverse conglomeration of trades and skills. Traditionally, the focus has been on crafts-oriented skills and trades, with the prime skill being carpentry. Studies carried out through the late 1960s and early 1970s indicated that approximately 28 percent of on-site person-hours was for carpenters, whereas the next most used skilled trade accounted for less than 10 percent.[19] For low-rise forms of construction, this focus is still predominant today and will continue because of the significance of the woodframe construction technique in the Canadian market.

The majority of workers in the residential construction labour market are males, though in recent years young females have entered the labour force at increasing rates.

Since the Second World War, especially during the decade following the war, immigration has played a significant role in the supply of skilled trades to the residential construction field. Carpentry skills were predominant in the mix of tradespeople immigrating. Other trades substantially sustained through immigration have been brick and stonemasons and tile setters. The 1981 Census of Canada showed that approximately 50 percent of these tradespeople in the construction labour force originated from southern Europe.

In spite of the probability of higher immigration levels in the future, as well as a decline in demand for new housing in the 1990s, concern has been expressed about the future adequacy of certain skilled trades, such as masonry, for the residential construction industry. An aging population of skilled workers and lack of adequate apprenticeship training have created this concern, but changing patterns of sources of immigrants may do little to alleviate this concern.

CHAPTER FIVE
THE PRODUCTION OF SERVICED LAND

The starting point in the complex array of activities that constitute the production segment of the building industry is the production of serviced land. A location for the yet-to-be-built structure has to be selected and made ready. The serviced lot has to be produced.

This chapter examines the procedures and operations that must be followed or performed as part of the land development and servicing process and indicates where and why various changes have taken place over the past four decades. It also reiterates, using previous studies, some of the constraints that have prevented or delayed wide acceptance of some practices or standards that appear to offer improvements both in service quality and cost-effectiveness. The focus is on the production of serviced land for low-rise forms of single-family housing.

LAND DEVELOPMENT AND SERVICING—AN ESSENTIAL, AND COMPLEX, PROCESS

An essential part of the housebuilding industry is the development and servicing of the land where the housing is to be situated. Even though it is a critical part of the process, most small housebuilders, a group constituting the bulk of the builder fraternity, have never had the financial resources to get involved in land development. However, the inability to finance land acquisition and development on an individual basis did not prevent some of the smaller builders in various centres from doing so. The pooling of resources to acquire and service land, as well as to spread the risk, led to the birth of several co-operatively owned land development companies, such as Ladco, established in Winnipeg in 1955; Carma, established in Calgary in 1958; or Buildevco, established in Kitchener in the late 1950s.

Many—in fact most—builders neither saw a need nor had any desire to become involved in land development. However, there were exceptions (for example, Bramalea, Campeau, Costain, Nu-West or Qualico), who became involved and made land assembly and servicing an integral part of their building programs.

The land development process can be complex, involving several stages and requiring special know-how and skills, as well as access to adequate financing. Although some typical housebuilders are involved in the land development process, the higher incidence of procurement, development and servicing of land was, and still is, generally carried out by firms specialized in the field; this is a general distinction from the traditional housebuilder, who is specialized in his particular field.

LAND DEVELOPMENT ACTIVITIES AND THEIR CHANGING CHARACTERISTICS

Land development activities can be described under three general periods, over the span of years following the Second World War through to the mid-1980s.

First Period—1946 to the Early 1950s

The first period includes the early years following the Second World War, up to some time in the early 1950s. The change from one period to another, which is not clearly definable and took place at somewhat different times across the country, involved a change in the abilities and policies of the various municipalities to provide serviced land.

During the first period, the activities relating to land development and servicing were primarily the domain of the municipality. At the end of the Second World War, many municipalities had large municipally owned land banks, acquired through tax defaults during the years of the Depression. With the increased demands for new housing during the early to mid-1940s, and especially immediately following the war, this land formed the base for community expansion. The municipal governments installed trunk sewers, water mains and streets to residential blocks or subdivisions laid out by city planners. The serviced lots were then sold to private builders, who built the houses.

Second Period—From the Early 1950s to the Early 1960s

The second period, commencing in the early 1950s and continuing through into the early 1960s, was characterized by municipal governments beginning to withdraw from the land development and servicing field, either because they were unable to keep up with the demand or were unwilling to continue to provide the services. In the faster-growing communities, financial constraints and the lack of qualified personnel to continue the process exacerbated the situation.

The surplus of land that many municipalities had in their possessions following the war was reduced significantly by the early 1950s, so that before long, in the faster-growing communities, further development meant more costly extension of sewer lines, water mains, roads and other facilities. Higher costs and increasing administration expense were having a visible impact on tax levels, so that land development and servicing became less appealing to many municipalities; thus they withdrew from that activity. A gap between the demand for and supply of serviced land began to occur in certain municipalities, which created both a need and an opportunity for some builders. Many builders were now faced with having to buy raw land and provide the necessary services to have enough serviced land to sustain their building operations. A private land development business thus came into existence.

The door to the land development business having been opened, several companies became involved in a sizable way, but all had different motivations. Some went in believing it was a potentially profitable line of business; others, who were primarily housebuilders and especially the large project builders, entered the field because of their difficulties in obtaining adequate supplies of serviced land where and when it was needed.

In centres characterized by a sizable number of smaller builders, groups of these builders banded together and assembled sufficient resources to acquire large tracts of land at realistic price levels, then subdivided and serviced this land to provide building lots for the members of the group.

In Winnipeg, Ladco (Land Acquisition and Development Company) was formed in 1955. The group forming Ladco consisted of approximately 38 members, 32 of whom were smaller builders in Winnipeg.

Carma Ltd. was started in 1958, the concept being initiated by three Calgary builders—Albert Bennett, Howard Ross and Roy Wilson. Up to that time, the City of Calgary had been the prime developer of land in the city, but as the population continued to grow, the city was having increasing difficulty in bringing sufficient numbers of serviced lots onto the market to keep up with the demand. Concerned about this shortage and with the knowledge and encouragement of the city, the builders formed Carma. The number of builders participating in the Carma operation soon numbered 45.

Buildevco (Builders' Land Development Company) was formed in Kitchener in the late 1950s by 33 members of the Kitchener affiliate of the National House Builders' Association.

Third Period—From the Early 1960s to the Present

The third period, which is characterized by the substantially increased involvement of both municipal and provincial governments in the land development and servicing process, commenced some time in the early 1960s. However, this time government involvement is more from the aspect of control rather than planning and implementing the servicing. Although basically unchanged, gradual changes have taken place over the years since the 1960s, so that even though the primary role of government involvement has not appeared to change, the actual conditions and processes in the land development business have, and in substantial measure.

Land development in the mid-1980s is more complicated than it was immediately following the Second World War. More and better planning is required today; also, the review and approval process takes place through a myriad of agencies or government bodies, which requires a great deal of time and patience. An article in *Canadian Building* in 1985 stated:

> Depending on the municipality, there are, on average, 40 conditions of approval to meet before a spade can be put into the ground.[1]

Another author writing about Canadian land development companies and making a comparison to the relative ease of the approvals process in certain United States cities stated:

> In Houston, developers can bring a project on stream in 18 months. In Canada, it can take 18 months just to clear all the government authorities at the municipal and provincial levels.[2]

THE LAND PACKAGE—HOW HAS IT CHANGED?

The ultimate product of the land development process in the single-family housebuilding sector in the mid-1980s is a piece of land of some size and configuration, provided with services for water, sewage and storm drainage and fronting onto a paved roadway with proper street lighting, probably with concrete curbs and sidewalks and perhaps even underground wiring for power, telephone and cable television service.

Over the period from the 1940s to the 1980s, the types and number of services installed, the processes of design and approval and the parties who install and pay for the services have all undergone change of one degree or another. Some indications of the nature and impact of some of the more visible or significant changes are outlined later in this chapter.

The subdivision and use of the land has also undergone change since the 1940s. Most of the changes have been precipitated by builders/developers attempting to control or reduce costs, not necessarily because of the cost of the land itself but also because of the costs of providing the services. In *Down to Earth*, it was stated:

> Now that the price boom has ended, servicing costs will again become a major determinant of lot prices; our research has shown that hard servicing costs and not raw land costs are generally the major cost in producing serviced lots.[3]

However, in addition to attempts to control servicing costs, the changes in subdivision patterns and land use and, in turn, on housing type mix were influenced by availability of land and by the attempts of builders/developers to optimize their overall return on the subdivision development.

Changes that took place in the land component were basically in lot sizes and configuration, with some reflection on what was to be placed on the lot. In the 1940s and early 1950s, the typical lot and subdivision layout was the rectilinear configuration—rectangular-shaped lots neatly lined up in a rectangular (or square) grid pattern. Almost all single-family housing was the single-detached form located on individual lots. To add variety and aesthetic appeal and to attempt to achieve greater densities of housing, in the late 1950s and early 1960s, various other subdivision layouts were introduced by town planners; included were cul-de-sacs, interior block systems, curved street patterns, loops, crescents and other varieties. Perhaps Manor Park in Ottawa in the late 1940s and the Don Mills subdivision in Toronto in the mid-1950s were the first in the country to incorporate these innovative approaches to planning. Other subdivisions followed somewhat similar patterns in the late 1950s and early 1960s: Whitmore Park in Regina, Silver Heights in Winnipeg and Glendale in Calgary were some of the early leaders.[4]

During the mid- to late 1960s, the noticeable trend was to large lots with larger houses, but it was never made clear whether the larger houses were being built because larger lots were being developed or whether larger houses were being sought by the buying public and these larger homes needed larger lots. The shift to larger lots and houses reflected buyer preference of that particular period.

Increasing costs of servicing land, coupled with rapidly rising energy and transportation costs during the early 1970s, caused a shift to building more combined forms of housing, such as semi-detached and row housing; these higher-density forms were more suitable for smaller lots. The mix of housing forms thus changed quite noticeably, from the use of almost 100 percent single-detached in the 1940s and 1950s, to a mix of 70 percent (or more) single-detached and 30 percent of other forms in the late 1960s, to extremes of 40 percent single-detached and 60 percent of other forms in the late 1970s.

To accommodate this shift to higher densities and still maintain reasonable levels of aesthetic and social compatibility, new planning rules and guidelines were introduced. In the late part of the 1970s, the "zero-lot line" concept was introduced and eventually accepted by many municipalities. This approach, where the single-detached unit can be built right up to one property side line, leaving proper clearance from the adjacent unit on the other side of the property line, offered single-detached housing at higher densities—by use of narrower lots—and provided greater compatibility with semi-detached and row housing units within subdivisions. Other variations of the zero-lot line concept soon followed, including such concepts as "linked housing."[5]

All of these thrusts were designed to reduce the per unit costs of housing, primarily by making better use of the land. Narrower lots help the builder to reduce the servicing costs, including both the hard costs of installing the site services, as well as to reduce the lot levies or other assessments made by the municipality to cover other community or municipal services.

WHO PROVIDES THE SERVICES?—AND WHAT RANGE OF SERVICES?

The pattern and content of services provided in the expansion of a community or in the development of a new subdivision has been obvious over the past four decades. While some of the changes are not visible, since they consist of expansion and changes that include underground services, other portions, which include improved roads, curbs and sidewalks, are readily visible. The number and types of services that are provided today are greater than those provided in the late 1940s, and the bureaucracy involved in the planning and approval processes has increased substantially.

Builder/developers reminisce about the early days of the 1940s and early 1950s, when they could take their set of plans for a small building program (probably not worthy of the term subdivision by today's standards) into the municipal planning office and within a matter of hours would have their approval sorted out. Today, at the best of times, on a typical subdivision, the minimum time one can expect to obtain an approval is about two months—and this applies only in some communities. More typical is a time span of six to eight months, and up to 18 to 24 months in some regions where a wide array of agencies must be consulted and each must grant approval considering their own specific areas of focus and concern.

In the late 1940s, the main services provided consisted of water distribution, graveled roads, swales (open shallow ditches) and ditches for storm water runoff, and septic tanks and beds for sanitary disposal. The water distribution, graveled roads and ditches were installed by the municipalities under local improvements.

Gradually, other services were included in the development program and installed at the time the subdivision was being built. These included underground storm sewers, sanitary sewers (to avoid the need/use of septic tanks), paved roadways, curbs and gutters, and sidewalks. Generally, these changes started to occur in the 1950s but in some locations not until much later.

The number, type and quality of services that are installed in a community are predominately a local matter of concern. No national code exists for community servicing standards, which explains why there are significant differences in servicing standards from province to province and even from municipality to municipality within a given province. The basic division of responsibility between provincial governments and municipal governments is that the provincial government has jurisdiction over water and sewage because the influence and impact of inadequate standards extends far beyond the border of any individual municipality, while the municipality has jurisdiction for roads and storm sewers within its territory, as well as curbs, gutters, sidewalks and any other local improvements.

Certain differences in standards are dictated by the particular region or location, considering differences in soils, topography and climatic conditions. The presence of near-surface bedrock in the Halifax/Dartmouth area, along with a Maritime climate, will dictate different standards to what is called for in Winnipeg in areas of leda clay and Prairie climate. Other differences are the result of the levels of knowledge and sophistication of both the approval authorities and the developers.

Up to and into the 1940s and early 1950s, the work and cost of putting the services into place was borne by the municipality. The capital costs of the services were recovered from the homeowners through taxes for local improvements. In effect, the costs were amortized over a long time period (25 to 40 years, or whatever amortization period was placed on the municipal bonds issued to obtain funds for the installation of the services).

The increasing demands for more housing following the Second World War put extra pressure on the municipalities to keep up with the supply of serviced land, reducing the available supply of provincially or municipally owned land. To supply their needs, the private developers found they had to get involved and were permitted and encouraged by the municipalities to install the required services. This was both the beginning of a private land development industry and the beginning of major and significant changes in the entire process of financing land servicing. Gradually, the responsibility and cost of subdivision servicing was transferred from the municipalities to the developers. Quebec was a notable exception for most of the post-war period, as most municipalities retained responsibility for and control of land development up to the mid-1970s (services were installed by the municipality and the costs recovered through taxation as local improvements). However, because of pressure on municipal finances, Quebec municipalities began to shift more of the servicing costs to land developers in the mid-1970s. Generally, all provinces today follow the rule that services are installed and paid for by the developer.

WHEN ARE SERVICES INSTALLED?

In the 1940s and 1950s, the time when the municipality would install various services was flexible. It was common for builders to be building houses in little more than a muddy field with nothing but a rudimentary roadway visible. Some of the underground services may have been put in place, but they were not visible. The sequence has stayed generally as it was then with the deep trenching utilities being installed first, followed by the installation of the shallow trench utilities and finally the local improvements on the surface put in place last.

Responsibility for installation of services was transferred from the municipality to the developer in the late 1950s and early 1960s, and more attention was paid to the timing of service installations as a way of reducing costs and maintaining better control of operations on the site. Most of the underground services would be installed and a graveled roadway put in place before house construction got under way. Final road paving, curbs and gutters and other local improvements would be delayed until most of the building work had been completed and heavy vehicles and traffic no longer frequented the site. In recent years, it has become the practice for all services to be in place before housebuilding gets under way; it is common to see a subdivision laid out with roads, curbs and hydrants but no houses. Some builders take exception to this extent of pre-installation of local improvements because some damage to curbs or sidewalks is bound to occur and the make-good process adds extra costs to the program.

SERVICING COSTS—WHO PAYS?

In earlier days, municipalities installed most of the services in a subdivision according to whatever standards were applicable and recovered the costs for the installation and maintenance of these services through various forms of realty tax applied to the homeowner.

Later, beginning in the late 1950s when many municipalities had difficulty financing the installation of the required services, the burden was transferred to the subdivision developer. The developer was compelled then to arrange and pay for the installation of the services. These costs became part of the cost of developing the subdivision and were, for the most part, ultimately passed on to the homebuyer as part of the purchase price of the house. Thus, the builder/developer was required to provide and sell (to the homeowner) the services, which in earlier times would have been the municipality's responsibility. The homeowner then pays for these services as part of the mortgage rather than through local improvement taxation.

In some cases, the subdivision developer was obliged to pay for services that had much greater capacity than was required for their immediate development to allow for extension to adjacent areas for future development. Such situations were cited even back in the 1950s when a group of Ontario developers had to size the main trunk sanitary sewer and pumping facility to be able to serve an area of 688 ha (1,700 acres) of development, even though they were developing only 127 ha (315 acres).[6] A similar situation reported by Ladco occurred in St. Boniface in 1955 when they were required to develop a pumping station and provide other right-of-ways and a road allowance to serve at least 202 ha (500 acres), even though they were only developing 73 ha (180 acres).[7] Thus, the homebuyers of the first portions of the developments paid to subsidize some of the costs of services provided for homebuyers in the adjacent future development areas.

In the mid-1980s, the standards of servicing are within the control of local governments and the costs of servicing and possible savings are also, to some degree, within the control of the municipal government. However, since the responsibility for the servicing was passed on (in most municipalities) to the developer, the municipalities have no incentive to adopt the most effective servicing techniques or systems. The municipalities are more likely to adhere to excessive or obsolete standards that they have been applying for a period of time and are familiar with in terms of expected performance and maintenance costs. The authority vested in the municipalities and lack of any form of a national or even provincial code for land servicing has hindered widespread adoption of change.

With regard to excessive or obsolete servicing standards, the situation in Canada is not much different to that in the United States. A recent long-range planning report of the National Association of Home Builders stated:

> Over the years, more than 20,000 jurisdictions nationwide have established development standards designed to protect various community interests. Amid growing awareness of the need for more affordable housing, recent government studies have concluded that many of these standards are excessive. In 1978, after surveying 17 common site development standards in 87 communities, the General Accounting Office (GAO) found that alternatives to existing standards could reduce construction costs significantly without jeopardizing the health and safety of new homebuyers.[8]

Changes culminating in overall cost savings and operating improvements generally occur as a result of persistent urging by dedicated design professionals and with the full co-operation and confidence of the developer and the municipal authority. It becomes obvious then why significant changes and improvements occur infrequently.

THE APPROVALS PROCESS

The most significant change in the land development process over the past 40 years is the growth of bureaucracy in the planning and approvals process and, according to developers, the process is not getting any easier but continues to grow more complex and time-consuming.

The difficulty and frustration of the land developer can be envisaged from the following excerpt taken from *Down to Earth*:

> It cannot be stated too often. Developers can produce no more than the public planning process permits. This is because each basic precondition for bringing land to market is decided by local and provincial governments: regional plans (where required), official plans (where required), zoning, local services, subdivision approval and, most basic of all, the provision of the trunk sewers. As a result, apart from making atomic bombs, the development business must be one of the most tightly restricted businesses there is.[9]

An earlier report, prepared for the Housing and Urban Development Association of Canada by Andrzei Derkowski in 1974, entitled *Costs in the Land Development Process*, gave some insight into the range of complexities of the approval process when he studied 10 major cities and indicated the number of agencies involved in the process and the minimum time required to gain approval on a routine subdivision application.[10] Highlights of his findings, as well as some information about who installed and paid for servicing of the subdivision, are shown in Exhibit 4. Depending on which city the development took place, any number from five to 50 departments or agencies may be involved in the process. The minimum times indicated for routine cases ranged from two months to 18 months: Montreal, Hull, and Saskatoon each showed two months, while Ottawa and Toronto showed 18 months. While some of Derkowski's information has received various criticisms, the main conclusions remain valid—the number of agencies or departments involved and the minimum processing times vary widely across Canada.

An article in *National Builder* in 1962 describing a Campeau project in Ottawa suggested at that time it took from six months to two years to work through the various agencies to get a plan of subdivision registered and that builders involved in land development agreed two years of planning before building was more realistic.[11] In the Derkowski report in the mid-1970s it was stated:

> One of the universal trends of all planning control systems across Canada has been towards complexity: an increasing number of steps and of reviewing agencies, with involvement, in many instances, of several levels of

Exhibit 4: Subdivision Approvals And Servicing In Selected Cities — 1974

City	Estimated Number of Departments or Agencies Involved	Minimum Approval Time For Routine Subdivision (Months)	Lots Per Gross Acre	Standard Lot Frontage Metres (Feet)	Services
Calgary	20	3	4.4	15.24 (50)	Installed and fully prepaid by developer (except oversizing)
Edmonton	20	6	4.2	15.24 (50)	Constructed fully paid by developer including front-ending of oversizing
Halifax	8	6	4.0	18.29 (60)	All services installed by developer (except pavement and curbs)
Montreal	5 to 8	2	4.5	15.24 (50)	Local improvements
Ottawa	40 to 50	18	4.4	15.24 (50)	Installed and paid by developer
Hull	5	2	4.0	15.24 (50)	Local improvements
Regina	10	3	4.4	15.24 (50)	Installed and fully paid by developer
Saskatoon	8	2	4.4	15.24 (50)	Development and servicing by city
Toronto	In the order of 40; potential maximum of 90	18	4.4	15.24 (50)	Fully prepaid and installed by developer
Vancouver	25	9	4.0	18.29 (60)	Constructed prepaid by developer
Winnipeg	15	6	?	15.24 (50)	Installed and prepaid by developer

Source: Andrzej Derkowski, Costs in the Land Development Process, *prepared for the HUDAC Economic Research Committee, December 1975.*

government. The overall effect of such a system, even when operated with the greatest efficiency, can only be delaying and restrictive. However, there are many reasons for which the system seldom acts efficiently or expeditiously.[12]

It appears the process of land planning and approvals has changed over the past four decades to the point of over-restriction. The numbers and complexity of regulations have increased in many instances, and costs and delays have increased as a result. The broad type of regulations that exist are conceived or intended for the public good; they protect various interests of the public at large. The challenges appear to carry out a degree of rationalization of the regulations and to make the process of applying the regulations more efficient.

SERVICING, SERVICING METHODS AND STANDARDS

Servicing Product and Materials

The products and materials installed to provide the necessary services for housing are inconspicuous to all execept those involved in the building process. Many of the products and materials are underground and once installed are out of view. Changes that occur do not make an impression on the typical homeowner other than in quality of service and amount of maintenance in the longer term. Little impact is still felt on the typical homeowner since maintenance of the service system is done usually by the municipality.

Though change has occurred in below-ground services, it has not been as extensive as those that have occurred at or above ground level. Materials used for piping have changed: for water service, from cast iron in the pre-1960s period, to ductile iron cement lined in the 1960s through early 1970s, to asbestos cement and plastic (PVC) for mains and polyethylene for service tubing from the mid-1970s; and for sanitary service, from concrete or clay in earlier times, to a choice of asbestos cement, concrete, PVC or vitrified clay, which are all available and in use today.

Other more subtle forms of change, such as changes in wall thicknesses of piping, have occurred in response to feedback from builders. Once such changes were properly assessed and approved, the specification or standard was changed accordingly.

When dealing with underground servicing, costs of failures and of repairs can be high. Therefore, land developers, or municipal engineers, are reluctant naturally to try new concepts or materials. Also, should failure occur, it is difficult to ensure proper assessment of the cause of failure and to convince developers or municipalities to try again.

Servicing Methods

Various changes have evolved in the size and nature of equipment used in the land development industry. Such changes are derived often from developments in the general construction and earth-moving field.

For example, in the 1950s, a backhoe with a capacity of 0.57 cubic m (three-quarter cubic yard) was considered to be a large unit. Today, on a typical development site, the smallest unit one would expect to see would be a 1.15 cubic m (one-and-one half cubic yard) unit.

About the same time, heavy earth-moving was carried out using a bulldozer equipped with a blade for pushing the earth. Eventually, again from the general contracting field, self-propelled earth-moving units emerged. However, the early units were somewhat underpowered, and in tough conditions the old reliable bulldozer had to be called upon to provide a push in the loading cycle. The power of the units was gradually increased so that later models had adequate power to be able to operate without assistance.

Over the years, there has been a shift from straight mechanical equipment or cable-operated equipment to equipment using hydraulic controls. Hydraulic controls provide greater sensitivity of control, as well as greater reliability.

The compaction of backfilled areas was one process that continued to plague developers for many years. The difficulty in properly compacting the trenches and backfilled areas created the need for repeated repairs at some time in the future after the earth had settled. Specialized equipment has been developed to improve the backfill and compaction operations and to minimize the repair or make-good work necessitated by any settlement.

Servicing Standards

The standards by which services are installed have changed over the past four decades, and their need, benefit and cost continue to be the subject of debate. However, change does not take place easily. Once entrenched, the planning and servicing standards that are applied in a municipality are difficult to change. Suggestions or pressures for change are few and infrequent for a number of reasons:

- Developers do not welcome unnecessary delays, and such delays can be expected when new systems or concepts are introduced;

- To obtain approvals as expeditiously as possible, plans should be submitted that conform to existing standards;

- Authorities reflect more favourably on plans and details that comply with standards and materials that are familiar and have a good record of performance.

There has never been, and probably never will be, a national code dealing with servicing of land and covering the nature and levels of service that should be implemented for various types of communities. The range of standards that were in effect in the late 1970s in 43 communities across Canada are vividly outlined in a study prepared in 1979 for HUDAC's (now CHBA) Technical Research Committee by Paul Theil Associates Limited.[13] The summary of engineering and planning standards illustrated wide differences between municipalities with basically similar conditions. The cost effect of using different standards was illustrated in a comparison between Scarborough and Brampton, both with a similar climate, soil topography, labour costs and material costs.

Conclusions from the Theil study show:

> The servicing standards reflected in the cost shown for Brampton represents many of the cost-effective servicing techniques referred to in the HUDAC research documents, whereas Scarborough standards represent more conventional methods, which although more expensive do not result in as high a level of servicing.[14]

The Theil study concludes by quoting from the findings of the Federal/Provincial Task Force on the Supply and Price of Serviced Residential Land:

> The difficulty is that servicing standards are a traditional municipal responsibility and provincial governments are extremely reluctant to compel changes they cannot achieve by persuasion. Perhaps on this issue the traditional reasons for not interfering, no matter how good, ought to give way to better. One solution which provincial governments could consider would be to impose on their municipalities value/effective standards as upper limits beyond which the municipalities could not demand anything further.[15]

THE LEARNING PROCESS AND TRANSFER OF KNOWLEDGE

The transfer of knowledge and technology occurs more readily today in our communications-oriented society than in earlier years. In those earlier years in the housebuilding industry, transfer of knowledge was not a natural phenomenon. It occurred but not in any formalized or official manner. Many of the more active builders indicated they counted on visits to trade shows in the United States, combined with visits to operations of their American counterparts, to get new ideas and information on new products or materials.

As builders' associations became more prevalent and active, a certain amount of technology transfer and exchange of knowledge occurred through contacts and conferences. Periodic meetings of associations of municipal engineers and of planning authorities provided forums for exchange of information on land development and servicing.

Work in this category (that is, to study ways to improve the process of developing and servicing residential land) was carried out in the 1970s by the HUDAC Technical Research Committee and widely disseminated throughout the building industry.

A significant amount of transfer of knowledge in the planning and servicing category occurs with the changing of personnel. When a person in a responsible position in the planning office of a municipal government decides to take a new position in a different municipality, the knowledge and standards from the previous job are carried over to the new employer. With this type of transfer, some concepts that may be new to one municipality may, in fact, be in the process of being phased out in another municipality.

SUMMARY

The process of developing and servicing land for residential purposes is complex, varying considerably from one region to another and from one municipality to another within a region. Wide differences in engineering and planning standards exist even between municipalities with basically similar conditions including climate, soil conditions and topography.

The land development and servicing process has experienced notable changes over the past 40 years, which can be loosely described under three periods: the first period after the Second World War and into the 1950s, characterized by almost all development and servicing of residential land being done by the municipalities; period two from the 1950s into the early 1960s, characterized by a transfer of land development and servicing activities and costs from municipalities in the private sector; and period three from early 1960s to present, characterized by steadily increasing involvement and control by municipal and provincial governments over the standards and approvals sector of the process.

The land package has changed over the years from larger lots provided with a moderate amount of services to smaller lots with a full range of services. Most of the main thrusts and changes have focused on reducing the per unit cost of housing primarily by using the available land better. The forms of single-family housing have changed as part of this process from a predominance of single-detached units in the 1940s and 1950s to a wide range of forms available today, including single-detached, semi-detached, row and even linked housing.

In the evolution of the land servicing process over the post-war period, the costs providing the services were transferred to the developer. However, the standards to which services are installed are within the jurisdiction and control of the local government. The local government does not pay for the services, so there is no real incentive for them to encourage or adopt the most effective servicing techniques or systems.

In Canada, servicing standards are generally a municipal responsibility. Lack of any form of a national or provincial code for land servicing has hindered widespread adoption of change. Municipalities have little incentive to change familiar and workable standards and practices, although better or more effective materials or methods may be available.

One of the more significant changes in the land development process over the past 40 years is the growth of bureaucracy in the planning and approvals process. The number and complexity of regulations have increased. In most instances, the regulations serve specific purposes to protect the public, but the detailed provisions and process of administering the regulations has become so cumbersome, it often impedes the overall process, thereby adding unnecessary costs.

CHAPTER SIX
CONCLUSIONS

Over the past several decades, the changes in the appearance, structure and functional performance of the single-family house have not been revolutionary. However, for the production process itself, many small changes combined to achieve a marked advance from the mid-1940s through the 1960s. Since that period, little progress in the production process has taken place, but the industry continues to adapt and apply new materials, components and methods that have proven cost-effective or of value. Most of the new materials and products are the result of research and development work done by others (that is, other than the builder), primarily by materials and components manufacturers and, secondarily, by public bodies. Unlike a true product industry, the prime producer—the builder—in the residential construction industry tends to play a secondary or responsive role in the development and testing of new materials or products, correcting deficiencies, removing arbitrary constraints to change and exercising much control over suppliers or of the R&D concerning new materials or products that the builder eventually uses. The codes and standards shaping the product are created largely outside the builder's hands.

Apartment construction has evolved somewhat differently. Apartments have been part of the Canadian housing scene for many decades and continue to be a significant portion of the annual output of the residential construction industry. The low-rise walk-ups were the predominant forms of apartments following the Second World War and into the mid-1950s. This form and type of construction emerged naturally from traditional single-family house construction technology which used similar methods and materials. However, in the mid- to late 1950s, several factors influenced apartment builders to focus on building up rather than out, ushering in the fairly rapid move to medium-rise and then high-rise forms of apartment structures. Engineers and developer-builders both initiated and adopted unprecedented changes. In approximately one decade, from the late 1950s to the late 1960s, the apartment building changed in its production process and end product more than the single-family house has in an entire century. As a result, high-rise structures became a common form of new apartment accommodation. The adoption, adaptation and development of new equipment and techniques for high-rise apartment construction revolutionized the industry almost overnight. The Toronto "flat slab/climbing crane/flying formwork" system for apartment construction, combined with the use of the "Hi-rise" workmen and material hoists, quickly became recognized throughout North America. Toward the end of the 1960s, there was a strong thrust to introduce some of the European building systems into the apartment construction market in Canada. However, the Canadian cast-in-place flat-slab system achieved overall economies that the European systems could not better; the European systems failed to gain a permanent foothold in Canada for that main reason.

Another important segment of the residential construction industry is home renovation. This segment has experienced rapid growth since the early 1970s, but it continues to be dominated by the do-it-yourselfer and special trade contractors. Because renovation work relates as much (or more) to the process as to the actual materials and techniques used, few clear technological advances have been attributed to this segment of the industry.

A key element in any industry is the size, composition and stability of the labour force. The residential construction labour force is a diverse conglomeration of trades and skills, and the size and composition during any period is influenced significantly by the ebb and flow of building activity in the residential sector and in the overall construction industry. The single-family homebuilding industry traditionally has required a large complement of crafts-oriented skills and trades, the foremost being carpentry. In the early post-war years, the industry benefited substantially by the immigration of significant numbers of skilled tradespeople from Europe, with an especially large number from the United Kingdom. Over the intervening years, immigration has played a continuing, yet much less significant, role in the supply of skilled trades, the needs being satisfied primarily through apprenticeship programs or on-the-job training. The present concern is over the adequacy of certain skilled trades for the years ahead.

An essential early step in the residential construction process is the development and servicing of land on which the housing will be built. It can be a complex and time-consuming process, primarily because of the number and nature of the steps involved in the planning and approvals process. This process has changed over the past four decades, but the change has been to increased complexity and restriction and therefore, in most instances, to increased cost. The land package and services also have changed over the past four decades; most of the main thrusts and changes have been focused on reducing the per unit cost of housing by placing more on the available land. A major cost element is the installation of the services, yet the lack of any national or regional code for standards of servicing, along with reluctance by municipal authorities to approve a new material, product or concept, inhibits the application of the most value-effective standards available.

However, although the residential construction industry is disparate and fragmented, it is also resourceful and resilient, always capable of producing housing of the type and volume demanded by the marketplace. While it may be evolving toward more of a powerful product industry, it remains an ingeniously responsive and adaptive industry capable of manoeuvering around the many constraints rather than removing or reshaping them.

FOOTNOTES
WORKING PAPER TWO

INTRODUCTION

1. For purposes of this paper, much of the discussion and findings on single-family housing apply equally to semi-detached and row housing.

CHAPTER ONE

1. Jill Wade, "Wartime Housing Limited, 1941–47: Canadian Housing Policy at the Crossroad," *Urban History Review* (Winnipeg: Institute of Urban Studies, University of Winnipeg, June 1986) Vol. XV, No. 1. Wade has traced some of this evolution to more fundamental and unadorned forms of lower-cost housing. Her review indicated that the National Housing Act Administration (NHAA) had followed further on the pre-war simplifications, especially in its NHAA prefabricated housing production. Wartime Housing Limited (WHL) then pushed this process of reduction further until "WHL housing ... resembled the cabins of ... frontier Canada generally or the workers' cottages of British Columbia resource towns."

2. Descriptions of house size and form are derived from CMHC, *Canadian Housing Statistics*, with further breakdowns from various Scanada surveys. Comments on kitchens and the like are based on direct observations, Housing Standards (published by DBR/NRC) and CMHC plan books of the period.

3. The temporary wartime housing is discussed in Working Paper One.

4. The renovation industry is discussed in Chapter Four.

5. Platform frame provides clear working advantages: Each floor becomes the stage for the construction and tilt-up of the walls for each storey.

6. By 1951, CMHC data indicated that about 17 percent of NHA houses used such wood siding, while 30 percent used stucco and 47 percent used brick veneer at least on the first storey.

7. The history of the introduction of light roof trusses into Canadian housing is presented in Working Paper Four.

8. CMHC data for 1965 suggest that painted wood was still used on 14 percent of NHA houses, with brick on 35 percent. General observations would suggest that much less than 14 percent of non-NHA housing was using site-painted wood by that time.

9. The shifts to 38 mm by 140 mm (two inch by six inch) studs raises questions about overall economics and long-range use of forest resources. It provides more incentive to quicken the development and use of reconstituted wood composite framing to yield greater depth of framing from less material. Such developments are discussed briefly in Working Paper Five.

10. Surveys and analyses under way on moisture control, Scanada Consultants Limited.

11. The factory-based house may be defined as one in which most or all of the rough shell, at least, has originated in one or more factories as large panels, components or sections, as distinct from individual pieces of material. Where essentially all of the house is produced in a factory whole, or in two, three or a few finished box modules, the terms "manufactured house" and "house manufacturing" tend to be favoured today. "Modular housing" is a common term for such highly factory-based housing manufactured in box module form.

    Much of this section is constructed from the field notes of R.E. Platts who, in studying the prefabrication industry for NRC and in private industry work to date, made site visits and conducted interviews with manufacturers and developers. Much is drawn as well from the experience of S.A. Gitterman, who worked with and studied the industry with CMHC's forerunners and CMHC itself.

12. "Stressed skin" is the generic term for all structures where thin sheet coverings are major contributors to structural performance, by virtue of full bonding to

"web" members, which transfer stresses between the covers and stabilize them against compressive buckling. Modern aircraft wings are prime examples. In housing, laminated panels with plywood or hardboard covers (skins) bonded to wood webs have been the common components in stressed skin systems. The surviving component in wide use is the "flush" hollow-core door interior and exterior. Military and Arctic use continues, following the pioneer successes of the 1940s to the 1950s GP (General Purpose) hut, which used plywood-skinned panels for floors, exterior walls, partitions and roofs and hardboard-skinned box beams for main roof structures.

13. W.B. McCutcheon, "Canada Adapts Prefabrication," *Canadian Business*, March 1947.

14. *Ibid.*

15. *Ibid.*

16. R.E. Platts, *Prefabrication in Canadian Housing* (NRC 7856, Ottawa, 1964).

17. E.G. Faludi, "Prefabricated Houses," *The Canadian Forum*, September 1941.

18. McCutcheon, *op. cit.*

19. Scanada work for provincial governments and others in the early 1970s indicated that modular fashion, pushed in large part by DREE grants (Department of Regional Economic Expansion), peaked with two or three times too many plants in the Atlantic area and parts of Quebec.

20. Personal communications 1985–87 from Ed Locke, President, Ontario New Home Warranty Program.

21. Recollections of R.E. Platts concerning various discussions between CMHC and NRC on using the social housing stock to begin cataloguing and building a data bank on technical problems, 1960s, and extending that to a feedback system.

22. CMHC, *Postwar Housebuilding in Canada: Cost and Supply Problems*, Ottawa, 1951.

23. Estimates and judgments by R.E. Platts, from experience, including the benchmark work studies:

    A.T. Hansen, *A Cost Study of Two Wood-frame Bungalows*, NRC 9590, Ottawa, June 1967; and

    Cost Study of a Two-storey Wood-frame House, Scanada for the Housing and Urban Development Association of Canada, Ottawa, January 1973.

    The site person-hours eliminated were not simply transferred to a shop or factory: In almost every case, the factory production itself (for example, plywood versus lumber, plastic pipe versus cast iron) consumed less hours too.

24. CMHC, Post-war, *op. cit.*

25. Estimates, *op. cit.*

CHAPTER TWO

1. Much of the information throughout this chapter is contributed from private industry work and studies by C.E. Bonnyman, and particularly from his Corporate New Products work with Anthes Imperial (Molson Industries Limited) during the peak period of apartment construction/production equipment and systems developments through the 1960s.

2. The origins of efficient scaffolding can perhaps be traced back to India and the Far East in general. Bamboo poles were (and still are) manila rope-lashed together as vertical struts and cross-bracing, supporting platforms of thicker bamboo to form a network of catwalks and access levels surrounding the building. Such networks were and are used to great heights. In comparison, the nailed lumber scaffolding used widely in Canada until about 1950 was relatively crude and often unsafe. The lashed bamboo was the model and forerunner of the tubular steel and clamp scaffolding of the 1950s. German developments in jacking formwork inspired the full development of flying forms in Canada in the early 1960s.

3. Concerning medium-rise and particularly high-rise apartment construction, it appears that engineers essentially developed new codes in parallel to their development of the new art, rather than fitting the

new art to existing codes. Codes did not protect or extend a limiting prior art in high-rise apartment construction because there was no prior art. Technologically, apartment evolution proceeded rather free of irrational or arbitrary constraints.

4. "This Crane Cut Cost by 35%," *National Builder*, February 1962.

5. CMHC, *Postwar Housebuilding in Canada: Cost and Supply Problems* (Ottawa: CMHC, 1951).

6. Scanada Consultants Limited, *Industrialized Housing Production: Potential Gains Through High-volume Programming* (Ottawa: CMHC, 1970).

7. *Ibid.*

8. Peter Barnard Associates, *Concrete Building Systems in the Toronto Area, 1968–74* (Ottawa: CMHC, December 1974).

9. *Ibid.*

10. Scanada, *op.cit.*

11. In 1968, the Ronan Point collapse in England shocked the system builder's world. Constructed with a British adaptation of Denmark's low-rise Larsen and Nielsen system, the building progressively shed a corner room section 18 storeys high following a gas explosion on the 18th floor. The pendulum swing after that was to an engineering over-redundancy of structural networking to prevent such progressive collapse, with cost effects felt immediately in Europe and in the transplanting of such pre-cast systems to North America.

12. Barnard, *op.cit.*

13. *Ibid.*

CHAPTER THREE

1. Discussions with the Toronto Home Builders' Association.

2. George Przybylowski, *Housing Ontario*, Vol. 25, No. 2, March–April 1981.

3. Personal recollections, R.E. Platts and others.

4. *Ibid.*

5. Survey by Environics Research Corporation, Toronto, 1985.

6. Consumer and Corporate Affairs Canada, *Consumers' Perceptions of Purchase Shopping Problems and Solutions* (Ottawa: CCAC, 1981).

7. Personal interviews conducted by Scanada Consultants Limited.

CHAPTER FOUR

1. In some specific urban markets, the masonry trades were also key elements of the single-family housing process for several decades, such as for construction of significant numbers of solid masonry houses in Toronto.

2. CMHC, *Labour Requirements for the Residential Construction Industry*, Program and Market Requirements Division, National Office, March 1976.

3. CMHC, *Manpower and Material Components of the Residential Building Program* (unpublished: January 15, 1957).

4. Census of Canada, 1981.

5. CMHC, *Canadian Housing Statistics* (Ottawa: various years).

6. George V. Haythorne, *Construction and Inflation*, Prices and Incomes Commission (Ottawa: 1973).

7. *Employment and Immigration Canada, Immigration Statistics*, 1984.

8. C.J.B. Roberts, *A Survey of the Canadian Homebuilding Industry*, Task Force on Low-Income Housing (Ottawa: CMHC, 1971).

9. UMA Planning Division, *Challenges for the Residential Construction Industry*, prepared for the T.E.D. Commission, 1968.

10. *Construction Industry Profile—Part II*, prepared by Construction Industry Development Council, November 1978.

11. *Bricklayers' Apprenticeship Asssistance Program*, brief prepared by Masonry Contractors' Association of Toronto, July 1985.

12. Langlais, Hurtubise et Associés, *Quebec House Builders Study*, prepared for the Research Division, Policy Development and Research Sector (CMHC, September 1984).

13. Trew Davidson, *The Goldenberg Report*, an Ontario Royal Commission Report (Toronto, 1965).

14. Paul Malles, *Employment Insecurity and Industrial Relations in the Canadian Construction Industry*, Economic Council of Canada (Ottawa: 1975).

15. Roberts, *op cit.*

16. Judge Harry Waisberg, *Report of the Royal Commission on Certain Sectors of the Building Industry*, Volumes One and Two (Queen's Printer for Ontario, December 1974).

17. R.A. Jenness assisted by D.E. Angus, *Manpower in Construction* (Economic Council of Canada, 1975).

18. HUDAC and CMHC, *Survey of Housebuilders 1974*, Table 10.

19. CMHC, Labour Requirements, *op cit.*

CHAPTER FIVE

1. John Fennell, "Action Needed on Regulations," *Canadian Building*, July/August 1985.

2. Susan Goldenberg, *Men of Property* (Toronto: Personal Library, 1981).

3. David B. Greenspan, Chairman, *Down to Earth*, The Report of the Federal/Provincial Task Force on the Supply and Price of Serviced Residential Land, April 1978.

4. Thomas Gordon Young, *The Typical Residential Subdivision in Canada: Controlled Suburban Residential Developments Around Major Cities From 1945 to the Mid-1970s* (Faculty of Graduate Studies, University of Manitoba, February 1977).

5. "Linked housing" is a form where each unit is essentially a single-detached unit but is linked to the adjacent unit or units, either at the garage wall or by an underground sub-wall connection, which permits the builder to build on narrower lots, thereby increasing density.

6. Gordon S. Shipp, "Trials and Tribulations of a Subdivider," *National Builder*, 1956.

7. "Land Subdivision — A United Effort," *National Builder*, 1956.

8. National Asssociation of Home Builders, *Housing America—The Challenges Ahead*, a long-range planning report (Washington: NAHB, 1985).

9. Greenspan, *op cit.*

10. Andrzei Derkowski, *Costs in the Land Development Process*, prepared for the HUDAC Economic Research Committee, December 1975.

11. Peter Emmorey, "Land Development Paperwork Cost Me $300.00 An Acre — Campeau," *National Builder*, February 1962.

12. Derkowski, *op cit.*

13. Paul Theil Associates Limited, *Comparative Subdivision Servicing Study Cost Analysis of New Techniques*, prepared for the HUDAC Technical Research Committee, December 1979.

14. *Ibid.*

15. *Ibid.*