FACTORS INFLUENCING THE DIFFUSION OF INNOVATIVE PRODUCTS IN NORTH AMERICAN HOME BUILDING FIRMS

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Short Version Of Thesis Title

The Diffusion of Innovation in North American Home Building Firms

Benjamin Sternthal (8911776)

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ABSTRACT

This report examines the diffusion of innovation to North American home building firms. Innovation is defined as new technologies in the form of new products and techniques.

The organizational structure of the home building firm and the unique mindset of builders/developers running these firms are examined in order to understand the firm and its leader. Technology diffusion theories are then explored to comprehend how innovation reaches the marketplace. Through research, evaluation criteria are established which builders/developers use when adopting innovation. These criteria are tested by interviewing twelve selected builders/developers in the Montreal-Ottawa region and by recording their responses to thirty innovative products.

The study demonstrates that all factors comprising the evaluation criteria are important to different builders/developers at different times. Furthermore, builders/developers cannot be treated as a homogeneous group since their backgrounds are not similar. Accordingly, no model depicting a builder's/developer's decision-making process can guarantee the successful diffusion of an innovation. The author therefore suggests certain guidelines to help innovators diffuse innovation to home building firms.

RÉSUMÉ

Le présent rapport analyse la diffusion des innovations parmi les entreprises nord-américaines de construction domiciliaire. Par innovations, on entend les nouvelles technologies relatives à des techniques et produits novateurs.

Il décrit la structure organisationnelle des entreprises de construction domiciliaire et la tournure d'esprit particulière des constructeurs/entrepreneurs qui dirigent ces sociétés, dans le but de comprendre l'entreprises même et ses dirigeants. Nous y abordons ensuite les théories sur la diffusion des technologies pour mieux saisir comment ces innovations se répandent sur les marchés. Nos recherches ont permis d'établir les critères d'évaluation sur lesquels se basent les constructeurs/entrepreneurs pour adopter les innovations. Ces critères ont été vérifiés grâce à des entrevues auprès de douze constructeurs/entrepreneurs choisis dans la région Montréal-Ottawa, dont les réactions par rapport à trente produits novateurs ont été relevées.

L'étude a démontré que tous les facteurs associés aux critères d'évaluations sont importants pour les divers constructeurs/entrepreneurs, et ce à des moments différents. Par ailleurs, les constructeurs/entrepreneurs ne peuvent pas être considérés comme un groupe homogène, puisqu'ils se situent dans des contextes variés. Par conséquent, aucun modèle décrivant le processus décisionnel d'un constructeur/entrepreneur ne saurait garantir le succès d'une innovation donnée. L'auteur préconise donc certaines lignes directrices pour aider les innovateurs à diffuser les nouveaux produits et techniques auprès des entrepreneurs de construction domiciliaire.

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CHAPTER ONE

INTRODUCTION

This opening chapter is intended to convey background information on the subject and a research strategy necessary to complete the study. The author commences by giving a rationale for study and by explaining the importance of the home building industry to the national economy. Innovation is seen, by the author, as a means to ensure the economic strength of the home building firm

The reader is acquainted with important scholarship on the topic, put forth by institutions like the National Association of Home Builders (NAHB) Then the research question is stated and its key terms are defined The report's objectives are given and the target audience is specified. Finally, a methodology for writing the report and a chapter-by-chapter outline are presented.

1.1 RATIONALE FOR STUDY

Studying the adoption of innovation to North American home building firms is of paramount importance to society because the success of the home building industry has vital economic impact on the national economy. Economists, newscasters and business journals routinely cite housing starts as an indicator of economic performance For the home building firm, innovation is a means of keeping the industry at the leading edge of productivity by increasing its efficiency. Clearly, "construction is viewed as a reflection of a country's activities and economic, social and cultural values It is an integral part of the

economy and its influence extends to almost every sector of an expanding economy" (SHQ 1988, 5)

In 1987, as illustrated in Figure 1.1, building construction accounted for 11 billion dollars of Quebec's Gross Domestic Product (GDP). Residential construction accounted for 7 billion, or 64%, of this 11 billion dollars (SHQ 1988, 7) In 1987, 8.5 billion dollars' worth of investment was placed into private and public fixed capital machinery in the housing sector. This generated 849 million dollars in maintenance, resulting in 30% of all capitol investment in Quebec (SHQ 1988, 7).

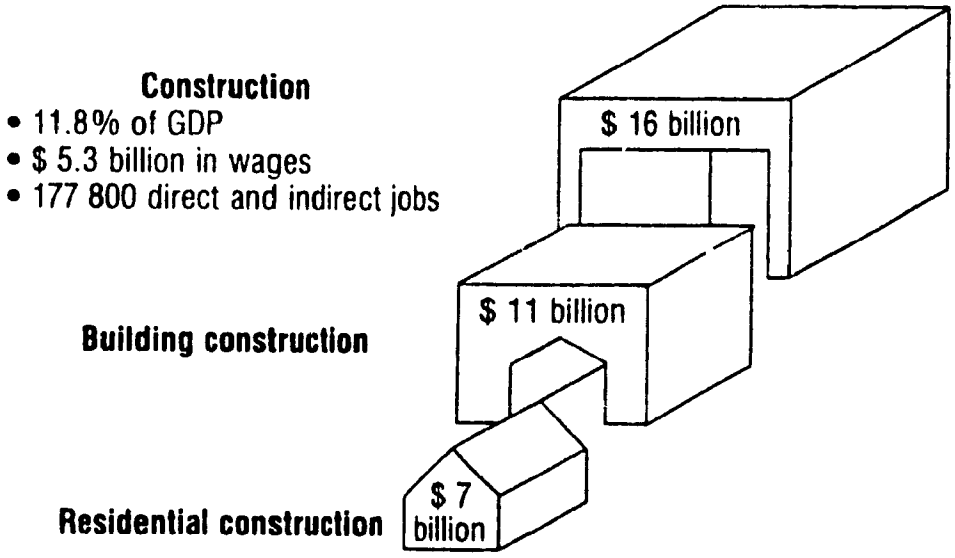

Figure 1.1. Economic Importance Of Residential Construction In Quebec (Source: SHQ 1988)

The construction industry in Quebec employs 124,000 workers of whom 103,900 are directly employed in building, constituting 5% of the total labour force. Workers are

well paid; for example, in 1987, workers received on average $737.25 per week (SHQ 1988, 8).

In 1987, 27.8 billion dollars were spent on residential construction in Canada, accounting for 5.5% of its GDP (CMHC E 1989, 3) and generating over one million jobs (CMHC E 1989, 4). As illustrated in Figure 1.2, the impact on employment of the residential construction industry is extremely high It was estimated in 1986 that for every billion dollars spent in residential construction, 38,000 jobs were created in all sectors of the economy, 11,400 of which were in construction

	Thousands of Person-years			
Industry	Direct	Indirect	Induced	Total
Construction[a]	318.3	2 5	8 4	329 2
Manufacturing	0 0	135.1	81.1	216.2
Transportation, communication and utilities	0.0	26 1	42 2	68 3
Trade	0 0	53 5	143 5	197 0
Finance, insurance and real estate	0.0	12 7	39 4	52 1
Service	0 0	40.0	98 7	138 7
Other:				
Agriculture	0.0	2 4	33 1	35.5
Forestry	0.0	7 6	1 0	8.6
Fishing, hunting and trapping	0.0	0.1	0 7	0 8
Mining, minerals and related	0.0	3.0	1.7	4 7
Total	318 3	283 0	449 8	1,051.1

Figure 1.2: Employment Impact Of Total Expenditures On New Residential Construction By Industry (Canada 1986) (Source. CMHC E 1989)

In addition, the 27.8 billion dollars spent on construction generated 39.4 billion dollars (CMHC E 1989, 5). In Canada, it is estimated that every $1.00 spent on

construction generates $1 83 in all "activity sectors" of the economy. This is remarkably high in contrast to other sectors such as agriculture which for every $1.00 spent generates $1.72, or transportation which generates $1.70, or business services which generate $1.56 (SHQ 1988, 8).

The same general economic characteristics of the industry also appear south of the border In 1988, construction accounted for 8.7% of the United States Gross National Product (GNP) (Wiggins 1988, 72).

In addition, the multiplier effect of the home building industry is significant. Manufacturers and suppliers of raw materials, semi-finished goods, equipment, transportation, communications, services, infrastructure, finance, and commercial retail are all affected by the economic state of the home building industry (Friedman 1993). Undoubtedly, "the residential construction industry is an essential part of our economy and it makes a substantial contribution to the achievement of social and economic objectives" (SHQ 1988, 7). It is for this reason that it is important to study the adoption of innovation to home building firms. The industry is a vital part of our economic system and can only remain strong if it is highly efficient Innovation is a means of enhancing the firm's performance by increasing its efficiency, productivity, competitiveness, by improving the quality of homes built, and by reducing construction costs.

1.2 REVIEW OF LITERATURE

The typical North American home building firm is small, highly competitive, and employs fewer than five fulltime employees who are often family members (Friedman

1991, 3) Having few employees is essential to many home building firms since it minimizes overhead costs during winter, when few projects are in progress, and during times of economic slowdown (NAHB E 1991, 22). As a result, the builder's own staff are frequently asked to perform many tasks For example, the controller of a company will often oversee the accounting and do secretarial work The builder himself often acts as both the developer and builder. He initiates the project, secures its financing, and manages the construction, often with the aid of a superintendent. Most companies have managed to streamline costs by reducing managerial expenses and by hiring staff who are able to perform several different tasks (NAHB C 1989, 20)

Since most home building firms are small and rely heavily on sub-trades, unlike larger corporations, it is understandable that they are unable to sustain losses Consequently, researchers and research institutions like the Société d'Habitation du Québec (SHQ), in their report entitled Technological Innovation in Residential Construction and Production of Housing Using Non Traditional Methods (1988), and Goldberg, in his NAHB report entitled Diffusion of Innovation In the Housing Industry (1989), feel that builders/developers are unlikely to experiment with unproved technologies in the industry because they would be unable to sustain the losses if the technologies were to fail The NAHB report further suggested that it can take up to twenty years for an innovation to be integrated into the market (Jones 1992, 170). Today, the firm's perceived conservative mode of operation is seen as a factor influencing the acceptance and rejection of innovative products.

Traditionally this has also been true. the construction process has been viewed by researchers like Charney, in his report entitled The Adequacy and Production of Low Income Housing (1970), and Roberts, in his article entitled "Home Buying U.S A.: A

Systems Analysis," as operating in a "closed system" whereby the builder/developer and the sub-contractors follow a routine and traditional method of organization and building. Roberts states that, "home builders follow carefully defined routines, and that these routines have been stream-lined to a point at which they permit great efficiency of the activities themselves" (Roberts 1970, 36) According to Roberts, it also means that any change in the traditional routine can bring the system to a halt At present, researchers feel this is still the case. The NAHB's Final Report Of The Advanced Housing Technology Program (1991) cites horizontal and vertical fragmentation of the industry as a cause for the "closed system" operation of the firm (NAHB E 1991, 25) For this reason, the above researchers label the firm as highly conservative, giving its traditional mode of operation as the major factor influencing the acceptance and rejection of innovative products.

In a report written on innovation and the home building industry, the NAHB's Advanced Housing Technology Program (AHTP) has identified new technologies in the market, proposed ideas for improvement of selected products, developed a plan to increase the speed at which developers use innovative products, and developed a quality improvement program for the building industry (NAHB E 1991, 2). Although the NAHB is comprised of home builders, researchers in the organization fail to look at innovation and the home building industry from the builders'/developers' point of view. Alternatively, they choose to examine the problem from the manufacturers' point of view. As a result, the NAHB assumes that the builders/developers are at fault for not implementing innovation.

The Canada Mortgage And Housing Corporation (CMHC) has contracted out research on innovation and the home building industry. This has resulted in a range of differing viewpoints on the subject. Its series entitled The Housing Industry: Perspectives

And Prospective/Working Paper One to Five (1989) consists of five individual reports prepared by Clayton Research Associates and Scanada Consultants. They view the home building industry as being very slow to adopt innovation yet recognize that the industry has adopted many innovations over a forty-year period.

> 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.
>
> (CMHC D 1989, 51)

The home building industry's conservative production process is therefore seen in these reports as a main factor influencing the acceptance or rejection of innovation in the industry.

The same line of thought is presented in the report prepared for the CMHC by James F. Hickling Management Consultants, entitled Technology Transfer and Innovation In the Canadian Residential Construction Industry (1989). However, the authors of this report recognize that, "the low rise residential construction industry is not significantly slower than other industries to adopt innovations in which it finds real advantages" (CMHC B 1989, 21).

Duff and Poitras, in their report (SHQ 1988), feel that the home building industry has conservatively adopted innovation, and they give the following factors as obstacles to the adoption of technological innovation: fragmentation of the industry, regulation (building

codes), inadequate research and development performed by the industry, and an insufficient effort by government to promote innovations.

The Centre De Recherche Industriel Et Technologique (CREDIT) has examined the problem of the adoption of innovation in the home building industry as a question of suitable technology transfer CREDIT advocates greater technology transfers between companies, government, research institutions and universities. They feel that greater collaboration in research between institutions will increase the acceptance of innovation in the home building industry. The benefits to collaboration were numerous in a study they performed on Canadian institutions and companies involved in advanced-materials research and development: "The advantages of collaboration were many, and they seemed to outnumber transaction costs, advantages included increasing technology transfer, the acquisition of new complementary knowledge, fresh financing and the acquisition by companies of new product lines for the markets" (Niosi 1992, 25). Their point of view is helpful in understanding the diffusion of innovation. The author will expand upon their study by examining other factors influencing the acceptance and rejection of innovative products by home building firms.

Friedman (1991), of McGill University's Affordable Homes Department, has studied innovation in the North American home building industry and postwar housing innovation. He has come up with concrete ideas concerning the organization and structure of the home building industry with respect to introducing innovation. He has illustrated an understanding of the organization and structure of home building firms and has also suggested ways of diffusing innovation to them. Much of his work serves as a foundation for mine.

Most research examining innovation and the home building industry, with the exception of the CMHC, CREDIT, and McGill University studies, regard the industry's conservative mode of operation as being a key factor in the acceptance or rejection of innovative ideas. It blames the home building industry for not wanting to change its process of construction by adopting innovation This report differs from the above reports since it analyses why certain innovative products are accepted or rejected by the home building firm. The author's research builds upon past studies which have simply looked at the organization and structure of the home building industry and at products rejected by the industry, by examining all the factors which influence the acceptance and rejection of innovative ideas to the home building firm. The author will attempt to demonstrate this examination in the following chapters by exploring the subject from a builder's/developer's point of view

1.3 RESEARCH QUESTION AND DEFINITION OF KEY TERMS

The author will answer the following question.

GIVEN THE NORTH AMERICAN HOME BUILDING FIRM'S ORGANIZATIONAL STRUCTURE, WHAT ARE THE FACTORS WHICH INFLUENCE THE ACCEPTANCE OR REJECTION OF INNOVATIVE PRODUCTS BY BUILDERS/DEVELOPERS?

DEFINITION OF TERMS:

The HOME BUILDING FIRM refers to building/development companies who work on the development and construction of projects The developer in most cases will also act as the general contractor for the development. These projects are strictly constructed for residential occupation and can consist of condominiums, row housing, detached housing,

semi-detached housing, and apartment units. These companies at times may perform renovation work, but the majority of their work lies in new construction. Companies which prefabricate house construction are not included in this definition since they are subject to an entirely separate report, nor are owner builders who act as general contractors for their own homes included in this definition of the firm.

ORGANIZATIONAL STRUCTURE refers to how home building firms organize and structure themselves in order to operate effectively. What lines of communication exist between persons working in the office and on the site? Who performs what jobs, and why? How much influence does the owner or president have on the entire development and building process? How does the crucial decision-making process in the life of a project work? How does the organizational structure of a company influence the delivery of a project? What is the correlation between the size and organization of home building firms?

INNOVATIVE PRODUCTS or INNOVATION refers to new technologies in the form of new products Quite simply, "An invention when applied for the first time is called an innovation" (Mansfield 1968, 99) The NAHB refers to innovation as an "idea, practice or object that is perceived as new to a potential user or adopter. Innovation must involve a fundamental change in technology and can be of two types" (NAHB B 1989, 4):

1) A product innovation is an object that improves the utility of the house or any of its components.

2) A process innovation is a new method or object (e.g. tool, equipment etc.) that has an impact on the method of housing construction.

Given the scope of this paper, the author has chosen to deal only with product innovation. Innovations in design and tools are subjects for two completely separate papers.

BUILDERS/DEVELOPERS refer to individuals who operate home building firms and work at both the development and construction of housing projects. They "put together the entire housing package, including land acquisition, design, construction, marketing and sales" (CMHC C 1989, 1). Since most individuals operate like this, it is more logical to call them Builders/Developers

1.4 OBJECTIVES

In answering the research question the author will.

* Gain a better understanding of the organizational structure of the home building industry;
* Gain a better understanding of the process of technological diffusion of innovation in the home building industry;
* Observe the variety of innovation accepted and rejected by home building firms,
* Gain knowledge of the types of products which will work within the home building firm's organizational structure;
* Determine if the home building firm is conservative in adopting innovation,
* Determine if we can truly assume that the home building firm is deficient in using innovation;
* Determine if the home building firm is utilising certain innovations which meet its requirements to ensure success.

1.5 INTENDED AUDIENCE

The prime users of the report will be scholars of innovation in the North American home building industry. Secondary users will be the manufacturers of innovative products, builders/developers, architects, designers, and engineers who are responsible for inventing

and using innovative products. Although parallels in the home building industry outside North America may be found, this report can be suggested for use only in understanding the employment of innovation in the North American home building industry.

1.6 METHODOLOGY

The author answers the research question through a literature review and interviews with builders/developers. In the literature review, the author assumes a historic approach when examining the organizational structure of the home building firm and refers to some innovations which the home building industry has adopted or rejected. Moreover, the review is used to gain a better understanding of technological diffusion into the industry and to develop a set of evaluation criteria guiding builders'/developers' decisions on technology. The author examines scholarly works on the subject by researchers like Goldberg and research institutions like the NAHB in order to determine the factors influencing the acceptance or rejection of these innovative products. An attempt is made to use current sources except where historical points require traditional research. Ascertaining whether the firm is eager or reluctant to accept or reject innovative products is based on the findings of this study

The structured interviews enforce and supplement the literature review by demonstrating the builder's/developer's perception of the importance of evaluation factors attained through research. The NAHB classification chart as shown in Figure 4.2 is used in classifying innovations shown to builders/developers. Innovations are therefore placed

in the following categories: foundation, structural frame and enclosure, plumbing and sanitary, heating ventilation and air conditioning, and energy supporting systems

1.7 LAYOUT OF REPORT

This report is comprised of six chapters In Chapter One, entitled INTRODUCTION, the author introduces the topic and gives a rationale for the study A theoretical framework for the research is presented, along with the research question and objectives of the research. A methodology for writing the report is established, and the intended audience for it is specified. Finally, an outline for the report is proposed

Chapter Two, entitled THE ORGANIZATIONAL STRUCTURE OF THE HOME BUILDING FIRM: HISTORICAL PERSPECTIVE, presents the organizational structure and delivery process of the North American home building firm from a historical point of view. This chapter illustrates, constraints on the firm due to its organizational structure and delivery process, problems and limitations which builders/developers face due to the organizational structure and the delivery process of the industry, and the framework which the industry follows. This is expressed from 1945 until the present, using statistics, charts and diagrams as evidence The above subjects are explored in an evolutive fashion in the hope of determining the roots of present restraints in the industry

Chapter Three, entitled THE ROLE OF THE KEY PLAYERS INVOLVED IN THE ADOPTION OF INNOVATION IN THE HOME BUILDING INDUSTRY, builds upon the preceding chapter by examining the parameters for innovation in the home building industry. First, theories about innovation are examined Then, the author examines

technology diffusion theories of innovation put forth by Mansfield, Schumpeter, the NAHB, the CMHC, and CREDIT. Having understood the organizational structure of the home building industry as examined in Chapter Two, and the process of technological diffusion, an attempt is made to determine the avenues of technological diffusion which will lead innovations to the home building firm and into the marketplace. The parties involved in the diffusion of innovation, consisting of the government, the manufacturers, the home building firm, and the sub-contracting firm are examined Finally the diffusion of two innovative products is explored to further comprehend ideas put forth in the chapter.

Chapter Four, entitled FORMING EVALUATION CRITERIA, specifically addresses the research question by proposing evaluation criteria, attained through research, influencing builders'/developers' decisions on technology. Further, a scientific evaluation procedure enabling the author to record and analyze the data is presented.

The necessity of approaching builder/developers to verify the validity of the evaluation criteria, and the interview procedures are illustrated. The rationale behind choosing innovative products to present to the builder/developer and the matrix designed to assist in recording data are explained Finally, data analysis procedures are established

Chapter Five, entitled BUILDER'S/DEVELOPER'S INSIGHT ON EVALUATION FACTORS, illustrates the builder's/developer's views on the factors comprising the evaluation criteria put forth in the previous chapter. Each of the factors of the evaluation criteria is discussed, and an attempt is made to illustrate discrepancies in the researcher's views of the criteria and that of builders/developers

The content of this chapter is derived from a literature review and from the author's analysis of the information from the interviews with selected builders/developers.

The concluding chapter, entitled BUILDER'S/DEVELOPER'S EVALUATIVE PROCESS FOR INNOVATIVE PRODUCTS, firmly answers the research question by illustrating the factors which influence the acceptance or rejection of innovative products, using ideas presented throughout the document. Based upon the factors which influence the adoption of innovation to the home building firm, conclusions are drawn as to whether the firm is eager or reluctant to adopt such innovations. Finally, suggestions are made as to how innovators can introduce innovation to home building firms.

CHAPTER TWO

ORGANIZATIONAL STRUCTURE OF THE HOME BUILDING FIRM: HISTORICAL PERSPECTIVE

2.0 INTRODUCTION

In order to determine and comprehend the factors influencing the acceptance or rejection of innovation in North American home building firms, one should truly understand the organizational structure of home building firms. This requires an understanding of the personal character of builders/developers. It is the author's belief that a historical perspective is worthwhile since builders/developers learn and make decisions based upon the industry's history and their personal experiences. Such a focus is required to understand the rationale and limitations which influence such firms today in adopting and rejecting innovative ideas.

In this chapter the author examines the setting from which builders/developers have emerged. Then, the author looks at the organizational structure of home building firms since 1945 with respect to the factors influencing the adoption of innovation. Finally, the organizational structure of the home building firm today is examined, with particular attention paid to some of the factors characterizing these firms which influence the acceptance or rejection of innovative products. In order to gain a greater understanding of the home building firm of today, the profiles of several players such as Bruce McLaughlin and Robert Campeau are examined.

2.1 THE NEW FRONTIER

> A long time ago came a man on the track, walked thirty miles with a sack on his back. He put down his load where he thought it was the best. He made a home in the wilderness. Built a cabin in the winter snow, and he ploughed the ground while the cold winds blew. All the travellers walking down the track, they never went further and never went back Then came the churches then came the schools, and then came the lawyers and then came the rules Then came the trains and the travellers with their loads Then came the mines and then came the yards Then there were some hard times and then there was a war...
>
> (Dire Straits, "Telegraph Road")

North America's development has been influenced by the continent's "frontier mentality." Fuelled by demographic growth and economic expansion, North Americans have persistently pushed back the frontier and replaced it with urban development Ostensibly, mistakes had marginal consequences since the supply of virgin land seemed to be inexhaustible. The goal was the complete development of the frontier However, such an expansionist vision was devoid of consideration for the long-term cost and consequences of action. So streams were paved over as supplies of water were redirected for the use of urban and rural societies. Towns and cities emerged where the hinterland once stood untouched by man. Charged with the spirit of the time, engineers such as William Van Horne completed the Canadian Pacific Railway in 1885 and succeeded in linking the Atlantic to the Pacific by steel and rolling stock. The line was laid across an extremely difficult terrain and was widely regarded as "a tremendous [financial and engineering] accomplishment for such a young country" (Herstein 1970, 265). Most importantly, the frontier was irreversibly opened for mass immigration and urban development.

By the turn of the century the frontier had been extinguished, as illustrated by the emergence of sporadic communities which formed the foundations of modern day cities. Inspired and driven by a vision similar to Van Horne's, home builders/developers set out to conquer the "urban frontier " In the post-Second World War period, infant cities were transformed into sprawling metropolitan areas by builders/developers. Indeed, the home building firm served as the vanguard in the wave of modern urban expansion.

The adoption of innovation by home building firms greased the wheels of expansionist development in urban centres. Only by examining the mindset of builders/developers can this unique transformation be analyzed and understood. It is within this context that these modern soldiers of expansion are understood Furthermore, their entrepreneurial spirit must be viewed as a key factor in the acceptance and rejection of innovative ideas by the home building firm. The means and methods which builders/developers employed will be examined presently.

It is the author's opinion that in order to truly understand the organizational structure of the home building firm today we must examine its evolution. This will enable us to understand in greater depth the adoption of innovation by such firms today. The ensuing section illustrates the evolution of such firms since 1945.

2.2 THE EVOLUTION OF HOME BUILDING FIRMS SINCE 1945

Prior to the Second World War. North American home building firms consisted primarily of skilled carpenters who would build one house at a time for individual families,

or on speculation.[1] All components of the houses were manufactured on the site, resulting in a longer construction period than today.

After the Second World War, a tremendous need for housing arose The combination of the backlog of demand stemming from the great depression along with the large number of servicemen returning from the war requiring adequate housing resulted in a North American housing shortage (CMHC H 1989, 6). The federal government and the public were concerned as to whether private industry could supply enough housing to meet this demand. In Canada, the government created and administered Wartime Housing Limited, a company, which built 16,849 units between 1941 and 1945 (CMHC H 1989, 13). Home building firms like Campeau Corporation, which built 16,000 units in the Ottawa region from 1950 onwards (CMHC C 1989, 23), eagerly rose to the challenge Similarly, S.B. McLaughlin constructed 8,000 housing units in Mississauga from 1950 to 1970 (Lorimer 1978, 11). Levitt Construction built 3,000 to 5,000 units per year by 1950 (Eichler 1981, 112), and the Canadian Equity and Development Corporation[2] built 8,121 units from 1953 to 1962, housing 28,426 persons (Sewell 1977, 35) Home building firms proved that sudden and overwhelming post-war demand for housing could be supplied

Success was made possible by developers' access to large land tracts which allowed for economies of scale, publicly financed services, and the availability of low-cost mortgages to the average citizen. Growth was further facilitated by the Canadian Central

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[1]Building on speculation refers to a builder completing a unit which is for sale prior to having sold it. Since the builder is speculating that a customer will buy the unit, he is at tremendous risk.

[2]This corporation was owned by E.P. Taylor and built the Don Mills project north of Toronto.

Mortgage and Housing Corporation which guaranteed mortgages for Canadians. In the U.S.A. the Federal Housing Administration (FHA) served a similar function.

Meanwhile, government provided transportation to such projects with the construction of extensive highway systems. Indeed, it was the completion in the early 1950s of the Don Valley Parkway linking downtown Toronto to North Toronto which made viable the Don Mills project, owned by The Canadian Equity and Development Corporation (Sewell 1977, 35).

Clearly, home building firms responded to this shortage of housing by organizing into efficient manufacturing teams. Builders/developers, running home building firms:

> ...looked at the old ways of home building, they saw disorder, hours and days of downtime, and people constantly trying to figure what to do next and how. To merchant builders, the picture that perfectly described traditional home building was a group of men standing around a hole or on a lot scratching their heads. This was not American manufacturing as merchant builders understood it. Their model was a production line turnir g out Henry Ford's Model T
>
> (Eichler 1981, 65)

The construction site was seen as an assembly line which would bring order to an archaic slow-moving system of construction. These firms proceeded to make the industry more specialized Where carpentry was once broken down into rough and finishing work, these firms further divided it into layout, framing, and rafters. The same specialization was achieved in the other trades such as plumbing, painting, and electrical engineering, resulting in the rapid completion of projects. The specialization of sub-trades only became possible as the steadiness of their work increased, eliminating their need to work outside of their

particular trade. Undoubtedly such specialization led to the schedule becoming the new "Magna Carta" of the industry.

Such performance became possible in the early 1950s as new modes of financing were made available to developers. Construction loans which were once perceived as too risky for financial institutions were now given to home building firms, financing approximately 75% of the project's costs Home building firms were quick to learn how to over-mortgage deals, thus allowing for surplus funds to finance other deals [3]

> Construction loans therefore not only funded the project to which they were applicable but, through direct over borrowing and even more through indirect means (deferred payments to subs and suppliers), provided excess working capital. This money was used for deposits, down payments and front-end costs on subsequent projects where such amounts could not immediately be covered by other construction loans.
>
> (Eichler 1981, 51)

Furthermore, suppliers gave home building firms lines of credit which allowed them to pay for materials as long as 30 days after delivery

The "super builder" was created, building hundreds of houses per year. Contrasted to the "super builder," the smaller home building firm, which constituted the majority of firms, had an owner who used consultants like engineers, lawyers and designers when needed, and maintained a staff consisting of superintendents, a salesmen, a bookkeeper, and a secretary/ receptionist (Figure 2.1).

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[3]In order to over-mortgage a project a developer must have purchased land earlier, enabling him to over-inflate the cost of land.

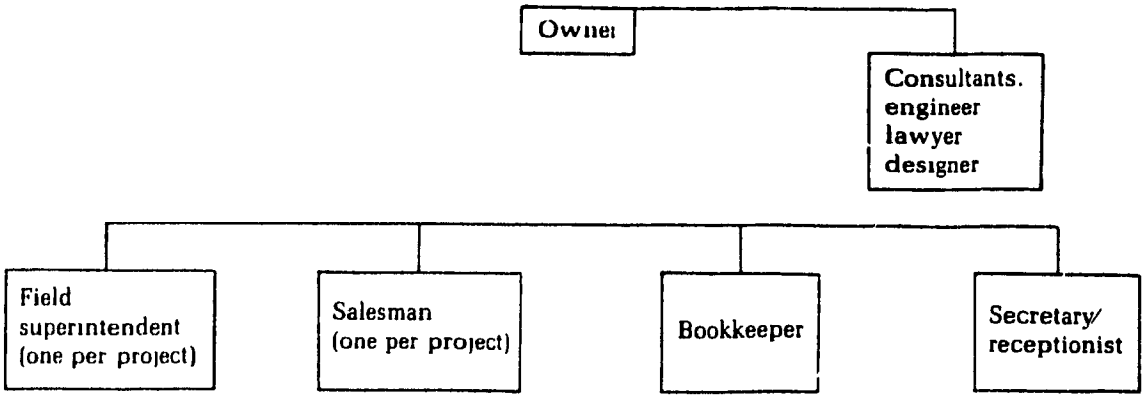

Figure 2.1 Organizational Chart Of A Small Home Building Company (Source: Eichler 1981)

"Super builders" producing more than 300 houses per year had three times the staff on the payroll as shown in Figure 2.2. In order to achieve greater economies of scale, the "super builders" diversified their products and markets throughout the 1970s and up into the mid-1980s.

Undoubtedly, most "super builders" like S.B. McLaughlin, Levitt Construction, Campeau Corp., and Nu West Developments experienced far less success as giants in the field than they had in their earlier years as small-time developers. The main reason for their failure was that the original small firm was able to control all aspects of development; when the company expanded, control was delegated by the builder/developer to far less competent and self-interested management.

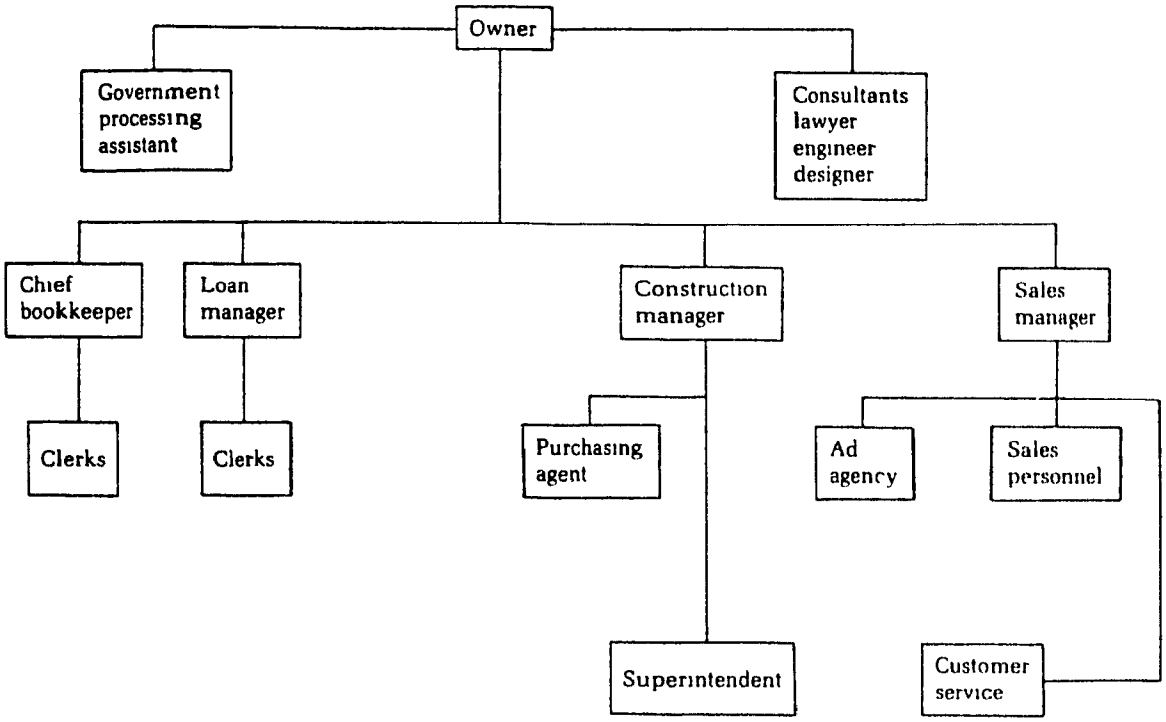

Figure 2.2: Organizational Chart Of A "Super Builder" Home Building Company (Source: Eichler 1981)

Let us now look at the home building firm of today to see how it functions and how that effects its adoption of innovation.

2.3 THE TYPICAL HOME BUILDING FIRM OF TODAY

2.3.1 THE CYCLICAL NATURE OF THE INDUSTRY

The organizational structure of today's conventional home building firm has emerged in response to the historical and economic environment in which it had to function. This environment, as illustrated in Figure 2.3, is one which has been characterized by boom and

bust cycles. The home building firm has adopted its particular structure so that overhead operational costs are kept to a minimum so as to survive periods of economic slowdown.

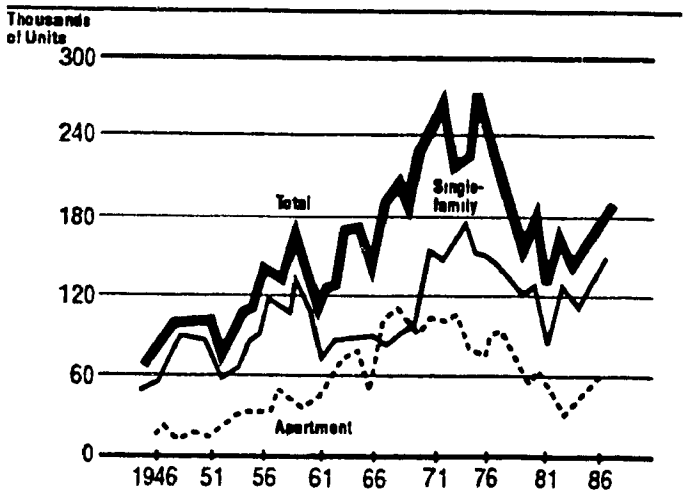

Figure 2.3: Housing Starts And The Economy 1946-1986 (Source: CMHC C 1989)

2.3.2 FINANCING

Financial institutions constitute the most important locus of power in the home building industry by virtue of their control over builders/developers (Friedman 1987, 34). This control is achieved by the financial institution's willingness to finance projects. Few builders/developers are capable of building a project without financing, leaving them at the mercy of such financial institutions (Goldberg 1983). It is therefore of paramount importance to understand both the process by which builders/developers arrange financing and the financial institutions' criteria for lending.

The criteria of financial institutions for loaning money to a specific builder/developer depend mostly on his proven "track record." Thus, a builder/developer who has had previous financial troubles will encounter difficulties in receiving adequate

financing from his financial institution. The conservative attitude of financial institutions towards them makes it extremely difficult for new builders/developers (who lack proven "track records") to arrange for financing. Often they will have to find partners who can provide them with access to necessary funds.

The financing of projects is commonly achieved through two methods Permanent Financing, consisting of Completion and Progress Draws Financing, and Bridge Financing.[4] Permanent Financing is long term, 5 to 25 years, and typically takes the form of a mortgage extended through a mortgage company The financial institution will lend approximately 75% of the cost of the project. In some cases, when government agencies such as the CMHC are involved in the financing, up to 95% of the cost of the project may be loaned

In Completion Financing the builder/developer is given money by the financial institution 35 days after the completion of the project,[5] whereas in Progress Draws Financing the financial institution disperses funds according to the percentage of the project which is complete. For example, when the foundation of a project is built, the

---

[4]Bridge Financing is often referred to as Interim Financing

[5]35 days is the maximum period for which a sub-contractor can take a lien on the project, for disputes in the payment of his work Financial institutions must ensure that there is clear title of ownership of the project, in the event that, in the future, they take over the project due to the builder/developer defaulting on his loan

A lien is, "a claim, encumbrance, or charge on property for payment of some debt, obligation or duty" (Black's Law Dictionary, 1990).

builder/developer will rece e 15% of his loan.[6] Very few permanent financing companies offer progress draws financing to builders/developers.

Builders/developers who are unable to arrange for this type of financing must arrange for Bridge Financing in order to attain capital to build the actual project. Bridge financing is short term, one to two years, and given by chartered banks and private lending institutions In order to receive bridge financing, banks and lending institutions require that the builders/developers arrange for permanent financing in the form of completion financing This ensures such lending institutions that if the project does not sell, the builder/developer will receive funds after completion of the project, by the mortgage company, in order to pay them back Having permanent financing also permits the builder/developer to arrange financing for customers by transferring the mortgage to them, providing their credit rating is acceptable to the mortgage company.

Financial institutions would appear to show little concern for the physical construction of the project. However, prior to releasing funds, they insist that their inspectors (who can be architects or engineers) inspect the houses to ensure that the construction meets the requirements established by the building code. Accordingly, a builder/developer wishing to use innovative products in the construction of homes will not be discriminated against by financial institutions as long as these products meet the standards of the building code Nevertheless, if such innovative products increase the cost

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[6] Financial institutions require that builders/developers require sub-contractors to sign a "Waivers of Lien Form" upon receiving their pay. This ensures that there is clear title to the property by the builder/developer, in the event that, in the future, the financial institution is forced to take over the property due to the builder/developer defaulting on his loan.

of construction to the point where the financial institution feels that the homes will not sell, then they will be very hesitant to give the builder/developer financing (Friedman 1993)

Clearly, financial institutions exhibit a greater interest in the type of dwelling units and location in which a builder/developer is building than in the actual physical construction of the units. If the condominium market is saturated in the Montreal area, and a builder/developer seeks financing to build such a project, it is quite unlikely that financial institutions will give him financing.

2.3.3 ADMINISTRATIVE MANAGEMENT

Due to the economic environment in which home building firms operate, most firms are relatively small and often family controlled (Friedman 1991, 3) Few managerial employees are engaged. In fact, 80% of the firms in Quebec have fewer than five fulltime employees (SHQ 1988, 13).

2.3.3.1 THE BUILDER/DEVELOPER

Builders/developers assume most managerial roles needed to run the company They are responsible for arranging financing, advertisements, project management, office management, and numerous other tasks (as illustrated in Figure 2 4) This has resulted in the builders/developers being extremely busy and overworked, since they must look after most matters of running the firm. This stress must be taken into consideration as a factor influencing the adoption and rejection of innovative products.

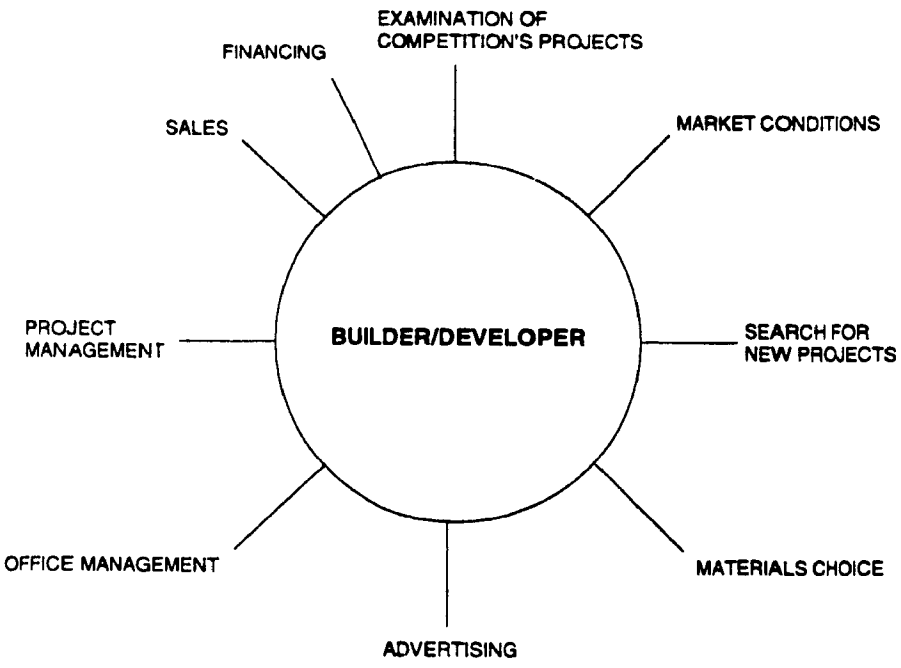

Figure 2.4: Builder's/Developer's Administrative Duties

2.3.3.2 THE BOOKKEEPER

Most companies have a bookkeeper on staff who is responsible for accounting and secretarial work (See Figure 2.5). This person is a fundamental part of the company since he ensures the smooth logistical operation of the company. The bookkeeper will often take care of the payroll and ensure that all bills are paid. He can also act as the builder's/developer's assistant. As the company grows, the bookkeeper assumes more of a managerial role, acting as a supervisor to other employees.[7] In order to perform at such a

[7]At this point in growth the bookkeeper is often called the controller and is responsible for administering the operations of the office.

demanding position he must be extremely capable, efficient, and able to perform a number of different tasks.

2.3.3.3 THE SUPERINTENDENT

Depending on the quantity of work and the builder's/developer's knowledge of construction, some companies may have a fulltime superintendent on staff who is capable of managing more than one project (See Figure 2.5). This person acts as a project manager and runs all aspects of the project. He works very closely with the builder/developer and manages the sub-trades to ensure that the work is done properly He is often responsible for organizing the scheduling of the sub-trades to ensure that the site runs efficiently and according to schedule

2.3.3.4 REAL-ESTATE AGENCIES/SALESPERSON

Large home building companies will have a salesperson on staff who receives a base salary and gets commission on his sales (See Figure 2.5) Smaller home building companies cannot afford the cost of having a salesperson on staff and must resort to real estate agencies who charge a certain percentage of the sales as commission These agencies perform the necessary advertising and have a large customer base to draw upon for sales

Employees working for home building firms are remarkably versatile, capable of performing more than one task effectively and efficiently Paradoxically, these employees operate as specialized generalists in a multidimensional field Consultants such as engineers, lawyers, accountants, architects and designers are hired when needed for specific jobs (See Figure 2.5).

During times of economic slowdown, home building/development firms can operate with as few employees as one bookkeeper. This ability to operate with low overhead cost

is a remarkable aspect of the home building firm, one which ensures its survival. Clearly, "builders/entrepreneurs who form the core of the home building firm, try to maintain equilibrium by keeping lean and mean" (NAHB C 1989, 20).

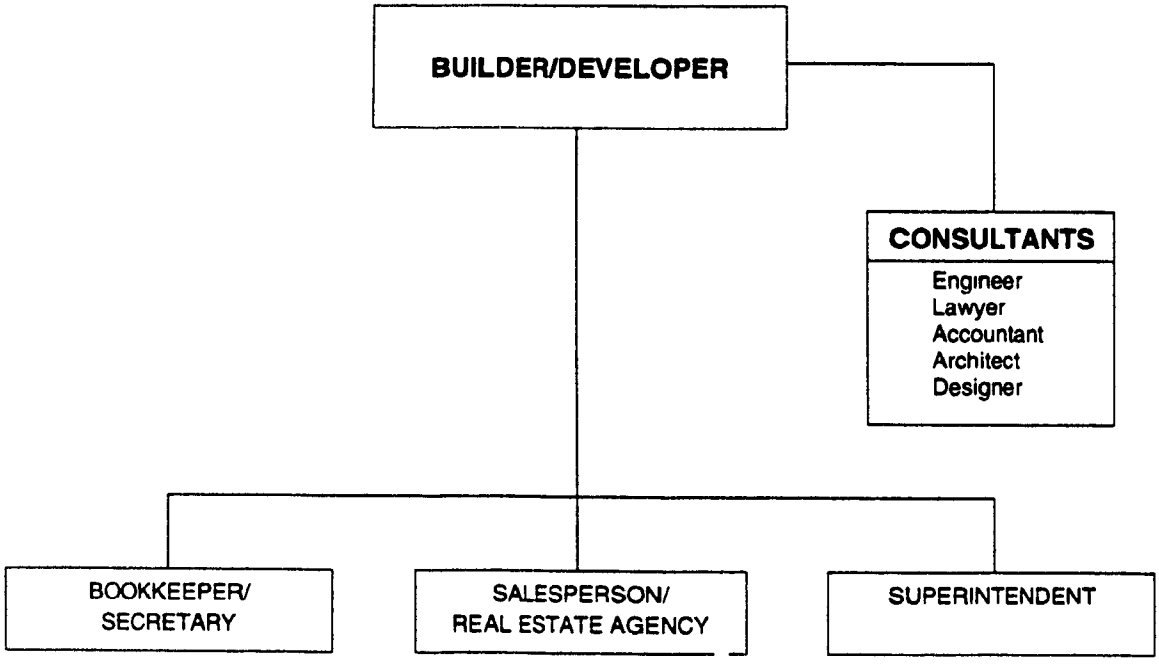

Figure 2.5: The Administrative Structure Of The Home Building Firm (After Eichler 1981

Understanding how home building firms are administered is essential to the comprehension of the factors influencing the their acceptance and rejection of innovative products. An exploration of the administrative structure of the firm offers substantial insight into the determining factors which influence such decisions.

2.3.4 CONSTRUCTION MANAGEMENT

The construction process has emerged as an extremely fragmented mechanism, forming a pyramid in which many sub-trades perform crucial tasks orchestrated by the superintendent or builder/developer. This allows builders/developers to obtain competitive prices for services from sub-trades when required, while not having to keep them permanently on staff. Firms such as I&S Construction of Montreal will often subcontract 90% of their construction work (Sigler 1993).

2.3.4.1 THE SUB-CONTRACTORS

For any given project, different sub-contractors are used for electrical, plumbing, painting, carpentry, roofing, foundation, etc. Some sub-trades are further separated into more specialized divisions. Subs specializing in carpentry work can be divided into those working at framing, flooring, form work, or cabinet making (Friedman 1991, 5). This results in each sub-trade operating as a team with different goals. Communication lines run from the builder/developer or superintendent to each sub-contractor but not from sub-contractor to sub-contractor, as illustrated in Figure 2.6 This process has turned the construction site into an assembly line, making it a streamlined, extremely efficient operation (Friedman 1987, 27).

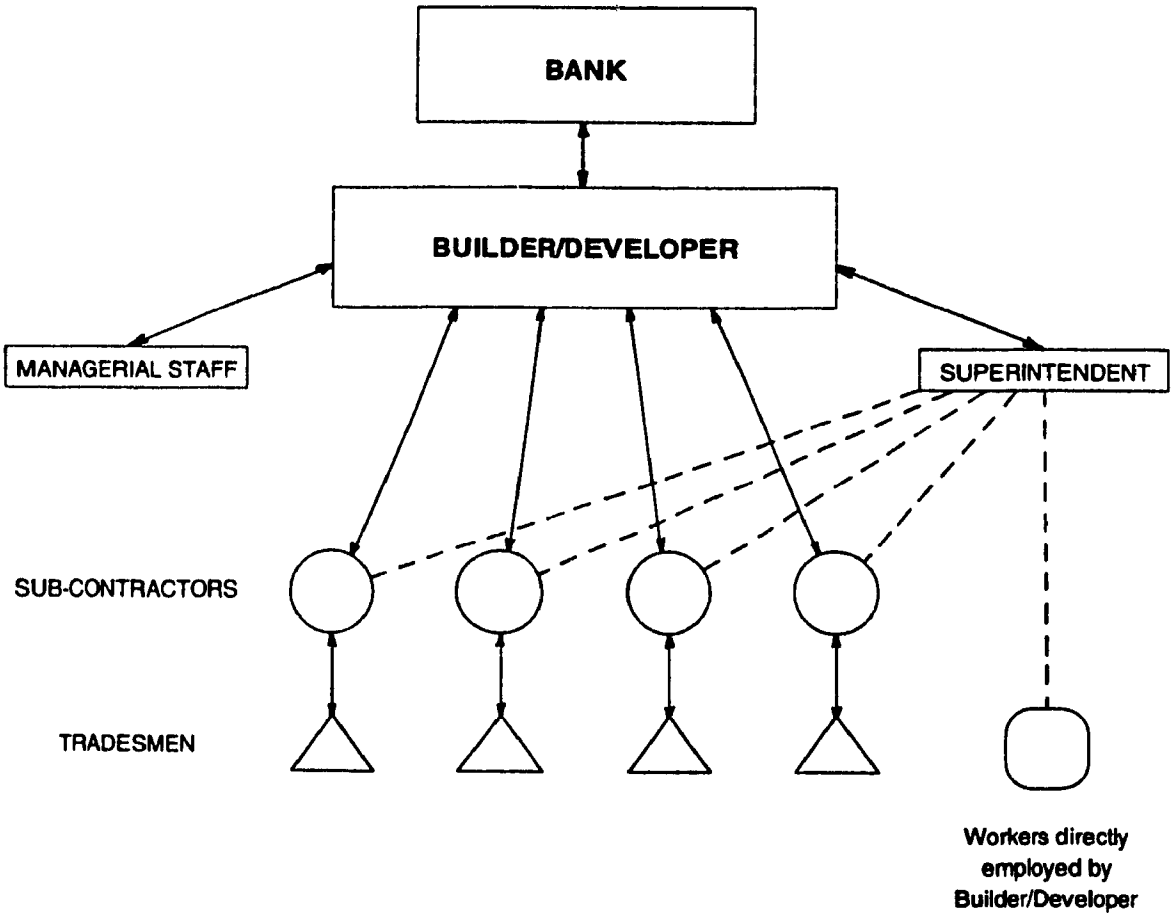

Figure 2.6: Lines Of Communication In Project Development

The sub-contracting firm, like the home building firm, operates with as few employees as possible. Larger firms will have a bookkeeper on staff who administers the office and answers calls (See Figure 2.7).

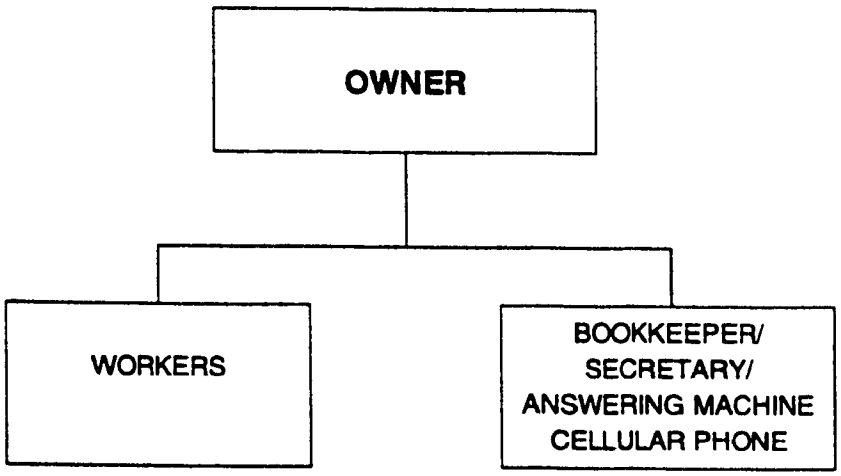

Figure 2.7: The Traditional Sub-Contracting Firm

A) THE OWNER

The owner of the sub-contracting firm, like the builder/developer, is overworked and occupied with the day-to-day operations of his firm. The owner is responsible for giving estimates, choosing materials, managing his workers, keeping budgets, getting new jobs, and numerous other tasks (as illustrated in Figure 2.8).

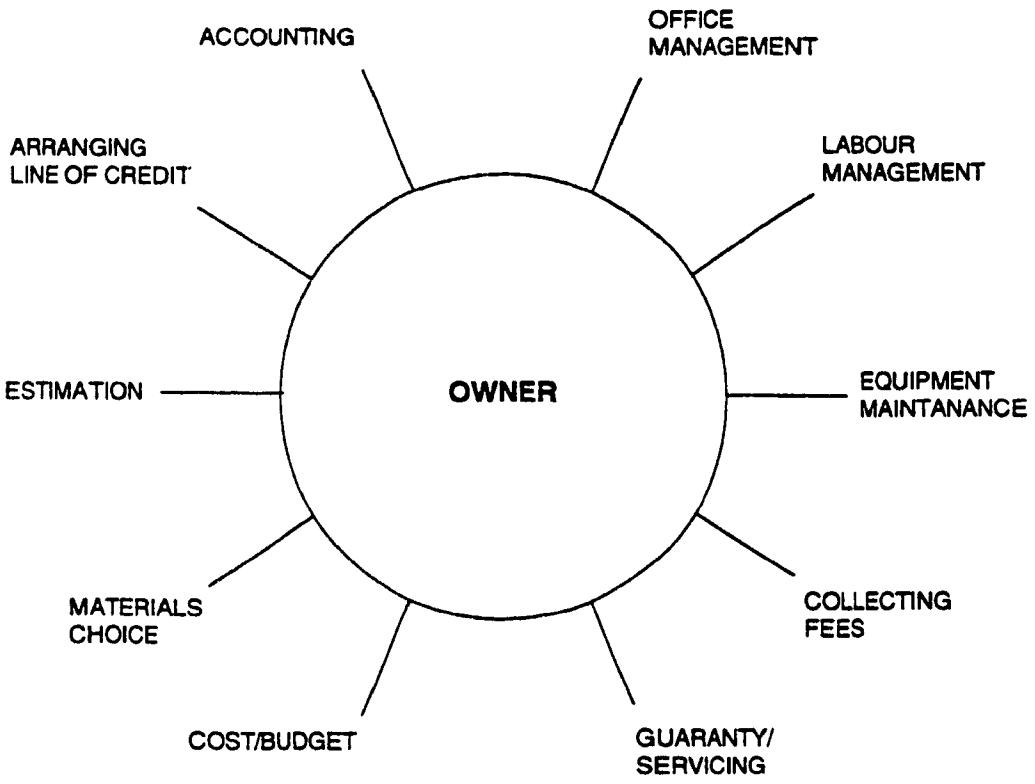

Figure 2.8: Sub-Contractor's Administrative Duties

B) FINANCE

While many sub-contractors have access to formal lending institutions, most finance material costs for jobs by receiving lines of credit from suppliers of materials. A line of credit entitles the sub-contractor to pay for his materials from 30 to 90 days after purchasing them. This provides him enough time in which to get paid by the builder/developer. Sub-contracting firms will borrow from lending institutions when purchasing expensive pieces of equipment. If they are not using this equipment frequently, most firms will prefer to rent them. The biggest problem facing sub-contractors is collecting payment for work. If a builder/developer is not satisfied with the work or does not have the

funds to pay the sub-contractor, then the sub-contractor is forced to absorb considerable losses. Although the sub-contractor can put a lien on the builder's/developer's project, such an action involves the use of lawyers which can be quite expensive.

While the builder/developer has influence on the adoption of innovation relating to all trades, the sub-contractor only has influence relating to his own trade A sub-contractor for plumbing may decide to use plastic piping if it costs less for the piping and is easier to install, reducing labour costs. A builder/developer may demand its use because it is cheaper and has a competitive market advantage. It would appear that both the builder/developer and the sub-contractor have significant influence in the adoption of innovative products in the home building industry.

2.3.4.2 THE SUB-CONTRACTING FIRM OF TOMORROW

In the past decade we have witnessed the emergence of larger and more professionally operated sub-contracting firms. The primary difference in the new emerging sub-contracting firms, in contrast to the older ones, is that many new firms are also manufacturers of the products which they install (See Figure 2 9) For example, in the past, builders/developers wishing to put fireplaces in their units would hire a bricklayer (the sub-contractor) who specialized in building fireplaces The bricklayer would purchase the materials necessary to complete the job At present, builders/developers order a fireplace from a local manufacturer who will sell and install the unit. The firm acts as the new sub-contractors, manufacturing and installing their product. Therefore the new sub-contracting firm has given rise to some very large companies requiring professional staff such as engineers, managers, marketing experts, as well as facilities like factories containing expensive equipment to manufacture the product. This has enabled innovation to be diffused

more quickly and easily, because the manufacturer now installs and uses the new products which his company has developed.

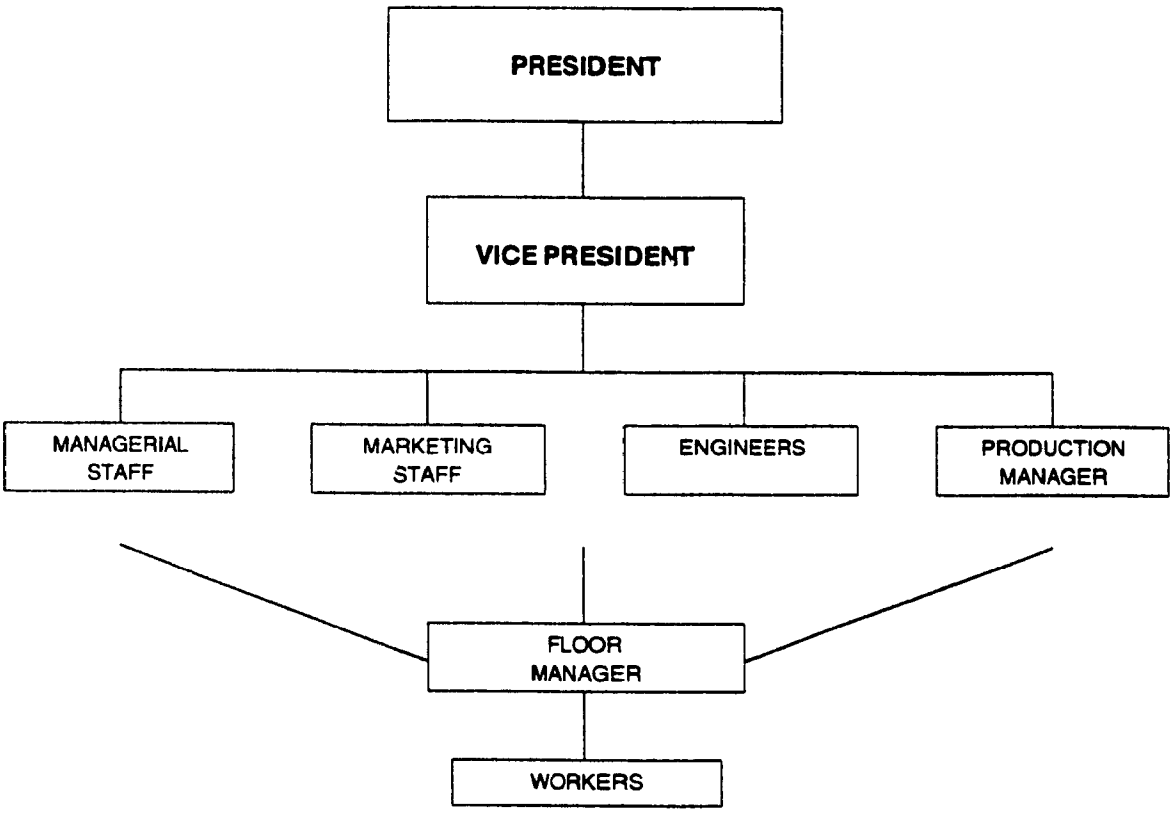

Figure 2.9: The New Sub-Contracting Firm (After Friedman 1993)

2.3.5 HOME BUILDING FIRM'S CLOSED SYSTEM OF OPERATION

Home building firms have often been characterized as operating in a "closed system" (Figure 2.10). This routine method of construction has allowed home building firms to become highly efficient. The project development time is kept to a minimum by building and selling homes as quickly as possible. The builder/developer will decide on the project, build and sell it, and with the profits start the cycle over again. Therefore, the adoption of

innovation into the home building firm must take into consideration its closed system mode of operation.

The industry has often been labelled as being reluctant to break out of this traditional closed system mode of operation (Friedman 1987, 28) This traditional manner of operation must be understood in a positive sense Home building firms are small and cannot sustain large losses This traditional mode of operation has enabled them to make profits while minimizing risk.

It is the author's belief that we must understand and respect this mode of operation in studying the adoption of innovation to the firm, since it has enabled home building firms to survive in a competitive, high-risk industry which is highly sensitive to cyclical economic shifts. Clearly, this traditional mode of operation will be a factor in influencing the acceptance or rejection of innovation by the home building firm

The organizational structure of the home building firm has resulted in an operational system which is highly efficient, slow to change, and minimizes as much risk to the firm as possible. The builder/developer and administrative staff must perform many tasks, often resulting in their being overworked It is only by appreciating the home building firm within this context that we can truly understand and determine the factors influencing its acceptance and rejection of innovation.

The author now looks at the builders'/developers' particular character in order to gain greater insight into how these entrepreneurs administer their companies.

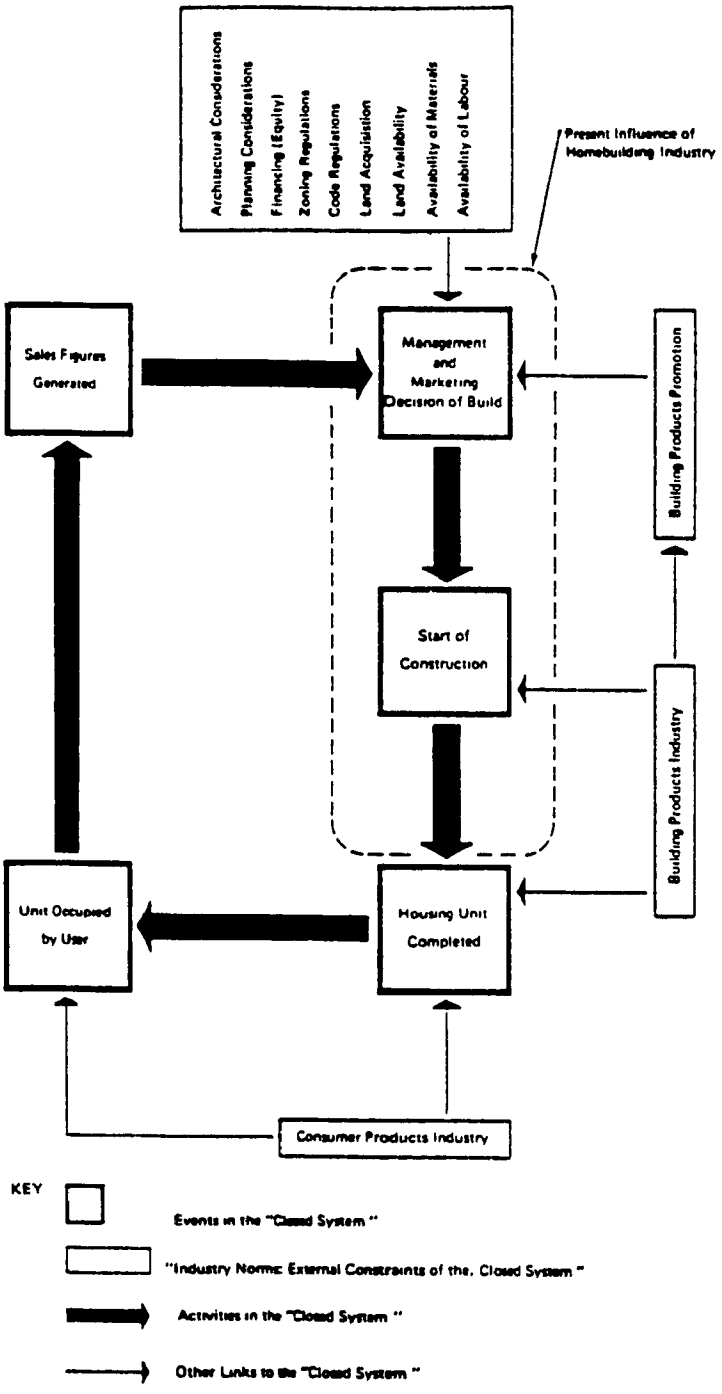

Figure 2.10: The "Closed System" Mode Of Operation In The Home Building Firm (Source: Charney 1971

2.4 THE ENTREPRENEURS: A PROFILE OF BUILDERS/DEVELOPERS

> All men dream but not equally Those who dream by night in the dusty recesses of their minds awake in the day to find that it was vanity: but the dreamers of the day are dangerous men, for they may act out their dreams with open eyes to make it possible
>
> (T.E. Lawrence 1962, 23)

Builders/developers form a unique group of visionaries who commanded enough ambition and perseverance to succeed at realizing their dreams Since they are at the helm of home building firms and thus shape their character, it is essential to recognize that their particular entrepreneurial spirit is a key determinant in the organizational structure of such firms. When innovative products served to assist them in realizing their dreams, these entrepreneurs actively embraced them as tools of development When it came to the adoption of innovation, the cards were held by them The very seeds which led to the growth of builders/developers in time proved to be their nemesis Undoubtedly, their naked ambition resulted in phenomenal success stories, however it also resulted in many spectacular failures. This paradox will be examined in the following paragraphs

Most builders/developers entered the home building industry with little knowledge of construction but with a profound understanding of profit. They looked at the home building firm and tried to manage it in a more efficient way by reducing overhead costs and by taking on most of the managerial responsibility themselves (Eichler 1981) This meant that consultants like engineers, lawyers, architects, and accountants were hired only when needed (Lorimer 1978). As one author writes, the builder/developer ventured into managerial areas previously monopolized by professionals (Lorimer 1978, 9)

> They are a fascinating and diverse lot, but what they have in common is a strong sense of independence, aggressiveness, rough edges, and self centredness. They pushed ahead, they were willing to take risks, and their self confidence increased as they witnessed their own, often amazing success.

They explored new construction techniques and innovations which helped to reduce the time and cost of construction. Bill Levitt broke housing construction down into twenty-six steps, producing approximately thirty-five homes a day (Rosenbaum 1983, 385). Builders/developers clearly understood that their objectives were to produce good-quality, competitive housing which would yield 15% to 20% return on their investment (Kryzanowski 1989) They worked extremely hard to ensure that all projects ran according to their plans and calculations It becomes evident that builders/developers tend to be "hard working, independent, and the last of the true entrepreneurs....Based on their strong confidence in their projects and themselves, they exercise considerable control over all phases of their business affairs" (Kryzanowski 1989, 10).

Having generally understood the builder's/developer's autonomous, free-dealing mentality, one can appreciate the potential for their adoption of innovative products. Only if such products increase efficiency, decrease costs or enhance competitiveness, will they attract the attention of builders/developers.

Let us now turn to two builders/developers, Bruce McLaughlin and Robert Campeau, who serve to highlight the idiosyncratic nature of this particular group of entrepreneurs. Although these men achieved far larger companies than the typical home building firm, the establishment of their companies and their particular characters are identical to other firms and builders/developers.

2.4.1 BRUCE McLAUGHLIN: S.B. McLAUGHLIN & ASSOCIATES LTD.

> Being a developer is like being a hockey player. Everyone who plays hockey appreciates the sheer joy of gliding on the ice, but it's the goals that keep us going. It's a good feeling, all right, when you score a goal. But it doesn't last. You have to keep trying for another or you lose interest in the game.
>
> (Bruce McLaughlin, Lorimer, 15)

Bruce McLaughlin started his building/development career in 1941 at the age of 15. After the Second World War he became a contractor, building cottages north of Toronto in the summer and houses in Port Credit in the winter. While building his first home he lacked proper financing and completed the foundation himself.

Fed up with the expensive fees which lawyers charged for simple transactions, McLaughlin decided to sever his dependence on them and so pursued a law degree in 1953. He enrolled at University of Toronto and then at Osgoode Hall Law School. After receiving his law degree, he returned to building in the late 1950s.

McLaughlin was aware of the pressure on urban land in the Toronto area and foresaw that growth would expand westward towards the airport. As a result, he purchased as much land as he could in Mississauga along Highway 10. The land was purchased under a system called "Builders Terms."[8] By 1970 he had developed 720 acres of land and built 8,000 housing units. During the same year he diversified his operation by developing a 1.5-million-square-foot shopping centre--"Square One"--which had 170 stores. By 1972 he had

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[8] This financing system was common amongst many developers in North America at the time. It allowed the developer to pay for 10% to 20% of the purchase price of the land in cash, while leaving the vendor with the balance of sale which was payable over an extended period. During the extended period, whenever the developer needed more land, he could exercise a "main levee" provision, which enabled him to pay for the amount of land needed at that time.

taken over Caledon Development Corporation. His revenues in 1972 were 28.3 million dollars and his land holdings were estimated at being worth 135 million dollars (Lorimer 1978, 12) If McLaughlin would have remained in housing development he might have remained a very successful man today, but he set his sights on yet a higher goal.

In 1974 he purchased Grouse Mountain Ski Resort in North Vancouver in the hope of developing the base of the mountain as a suburban area. He failed to understand the Vancouver market. Consequently, his Condo project was unsuccessful. In the mid-1970s he purchased 2,500 acres of land 12 miles from Montreal's Mirabel Airport, erroneously speculating that urban expansion would occur in this area. In 1976 he lost 30 million dollars building the Holiday Inn in Montreal which was supposed to be completed for the Olympic Games of 1976, but which was only completed in 1978 due to many construction problems (Lorimer 1978, 9) By the mid-1980s he developed the Court Mont Royal Project in Montreal. The costs of renovating the old Mount Royal Hotel were significantly higher than estimated The interior design proved to be nonfunctional, and the exclusively expensive stores limited the clientele. The centre failed and went bankrupt in 1991. In the mid-1980's McLaughlin acquired Mont La Reserve Ski Centre in St. Donat, Quebec. He attempted to develop condominiums at the base of the mountain. Their selling price of approximately $200,000 was far too expensive for the market and the type of project. Launching the project in the 1990s, in the midst of the current recession, proved to be its death blow. The market collapsed and potential buyers were nowhere to be found. The Ski Centre closed in November of 1992 (Philips 1992, C9).

Clearly, McLaughlin's insatiable appetite for scoring grander goals proved to be his Achilles Heel, nevertheless he stands out as an extremely innovative and creative man.

McLaughlin "has constantly looked for new fields to conquer and ways of going beyond the conventional achievements of other developers" (Lorimer 1978, 15) Although his efforts have resulted in financial failure, his courage and determination are most admirable

Builders/developers like McLaughlin are extremely important factors in the adoption of innovation in home building firms. They run one-man shows with determination and originality. If they are impressed by an innovative product, and the product works to their benefit, they will implement it with little hesitation. As educated risk-takers, these developers will take chances on products which show potential benefit

2.4.2 ROBERT CAMPEAU: CAMPEAU CORPORATION

Robert Campeau started building houses in 1949 in Ottawa He was an innovative man who jumped on most opportunities for profit. His goal was to produce quality single detached houses, affordable to the common man By 1953 his construction company had assets of $563,000 (Lorimer 1978, 20). He implemented mass building strategies and closely monitored cost by close supervision on the construction site After observing the use of prefabricated roof trusses in Florida, he quickly introduced them to his projects, reducing the cost of construction (CMHC C 1989, 23). Moreover, Campeau was the first builder in North America to use the tower crane in constructing high-rise apartments (CMHC C 1989, 23). During the winter, when few projects were in progress, he would manufacture wall panels for spring construction, allowing him to have his houses completed and on the market well before the competition's. By 1975 his assets were estimated at $545,913,000 (Lorimer 1978, 20). By the 1980s Campeau completely left housing development for commercial development which was considered more lucrative. Today, he is no longer the major player that he was in the 1970s.

Critics of Campeau's one-man-show management style were "completely bewildered as to how operating control of this type of situation is effectively maintained" (Lorimer 1978, 20). What remains clear is that his strong-willed, ambitious nature has led him to beat the competition, employing tighter management and the adoption of many new construction techniques

Such determination is characteristic of many builders/developers like Campeau and McLaughlin. Lorimer (1978, 29) suggests that:

> Owning their own companies, managing them every day, making the major decisions without having to answer to anyone except themselves, seizing opportunities where they saw them, squeezing the most they could out of their limited cash resources, the entrepreneurs got the land development industry going in Canada and built the first successful development corporations.

Their character and management style lends extremely well to the adoption of innovation in the home building firm. If builders/developers can be shown and convinced that a new product will reduce the cost of construction, facilitate the construction process and reduce labour costs, or offer a competitive advantage, then these entrepreneurs will implement such products with characteristic enthusiasm and drive. Robert Campeau demonstrated that useful innovations like prefabricated roof trusses are eagerly adopted by home builders. Builders/developers, at the helm of their firms, are therefore major players influencing the adoption and rejection of innovation. Understanding their criteria for decision-making and their perception of the industry is of paramount importance if we are to appreciate other factors influencing the acceptance and rejection of innovation in the home building firm.

2.5 SUMMARY AND CONCLUSIONS

In order to appreciate the factors influencing the adoption of innovation in the home building firm, one must fully understand the organizational structure of home building firms. This can only be achieved by looking at their development from a historical perspective and by examining the unique mindset of the builder/developer who leads such firms. To conclude.

* Home building firms, as known today, started after the Second World War in response to the shortage of housing in North America

* Home building firms reorganized the construction process into an efficient assembly-line method of construction, sub-contracting most work to specialists

* Sprawling metropolitan areas were created by builders/developers who were inspired and driven by the continent's "frontier mentality."

* Innovation served to enhance this expansionist dream wherever possible.

* The cyclical nature of the industry has led to a management style which is lean, resulting in employees performing various different tasks

* Innovation must fit within the organizational structure and goals (i.e profit, efficiency) of home building firms in order to be implemented

* The construction process is characterized by a routine method of construction Any attempt to introduce innovations which will alter this routine can bring the construction process to a halt.

* The builder's/developer's entrepreneurial spirit is a key determinant in the organizational structure of the home building firm, and lends very well to the adoption of innovation.

* Most home building firms are "one man shows" run by builders/developers Therefore it is crucial to comprehend their unique character in order to understand the adoption of innovation to the home building firm

Now that we have examined the organizational structure of home building firms, and understand the past and present characteristics of, and constraints upon, such firms, we

must explore the parameters brought to bear upon the adoption of innovation in the home building industry. Such parameters extend beyond the home building firm. In the following chapter, the author sets out to understand innovation and the parties involved in the production, dispersal, regulation and use of it.

CHAPTER THREE

THE ROLE OF THE KEY PLAYERS INVOLVED IN THE ADOPTION OF INNOVATION IN THE HOME BUILDING INDUSTRY

3.0 INTRODUCTION

This chapter examines diffusion theories of innovation and the role of key players involved in the diffusion of innovation to the home building industry. It is essential to understand the adoption of innovation to the industry in order to comprehend the adoption or rejection of innovative products by home building firms. First, innovation theories will be examined. Then, the author investigates technology diffusion theories of innovation put forth by scholars and institutions specializing in the field. Innovation is examined in terms of a "push and pull" process, and the barriers to this process are explored. Finally, theories concerning the adoption of innovation are studied.

Having understood the process of technological diffusion and adoption, an attempt will be made to determine the avenues of technological diffusion which will lead innovations to the home building firm and into the marketplace Although many parties are responsible for this procedure, only the main parties involved with innovation are examined, namely the government, the manufacturers, the home building firm, and the sub-contracting firm.

The author examines government's role with regard to the adoption and diffusion of innovation by looking at its regulative process The effects of the building code, the evaluation process, and the administrative process on the adoption of innovation are explored.

After having understood the government's role with respect to innovation, the author will examine the manufacturers' role towards innovation. The organizational structure of manufacturing firms, the commercialization of innovation, and the costs of innovation are examined.

The author then proceeds to look at the home building firm to ascertain its attitudes towards innovation The focus of this section will be directed on the builders/developers as key players in the adoption of innovation. The author will examine their perception of the usefulness of innovation, the risk which they face from innovation, and the economic gains and losses which they confront.

The diffusion of roof trusses and drywall are explored in order to illustrate the ideas conveyed in the chapter. Finally, a summary and conclusions are given with a particular focus on the government, the manufacturers, and the home building firm.

3.1 THE DIFFUSION OF INNOVATION

> There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things... Whenever his enemies have occasion to attack the innovator they do so with the passion of partisans, while the others defend him sluggishly so that the innovator and his party alike are vulnerable.
>
> (Niccolo Machiavelli, in Rogers 1983, 1)

The diffusion of innovation is a complex process which encounters obstacles at every stage of its path. This process can be considered as a form of communication which puts forth new ideas resulting in change. As Rogers (1983, 6) states, "Diffusion is a kind of social change defined as the process by which alteration occurs in the structure, and

function of a social system." When innovative ideas are adopted or rejected, certain consequences occur which lead to social change.

The diffusion process has four main elements. First, an innovation must be presented. Second, this innovation is communicated through certain channels Third, members of a particular social system become the recipients of the innovation. Finally, this all occurs over a period of time (Rogers 1983, 10).

The diffusion of innovation occurs when it is introduced to the marketplace and obtains significant use (See Figure 3.1) Determining at what level significant use occurs is a difficult task, since innovations adapt and change as they are employed in the marketplace. It is difficult to differentiate between the actual number of users and the potential number of users. Furthermore, measuring diffusion by sales or through other financial methods does not always illustrate the rate of diffusion of an innovation (CMHC B 1989, 16). Significant use is therefore considered to occur when an innovation gains 20% of its target market's use (CMHC B 1989, 14).

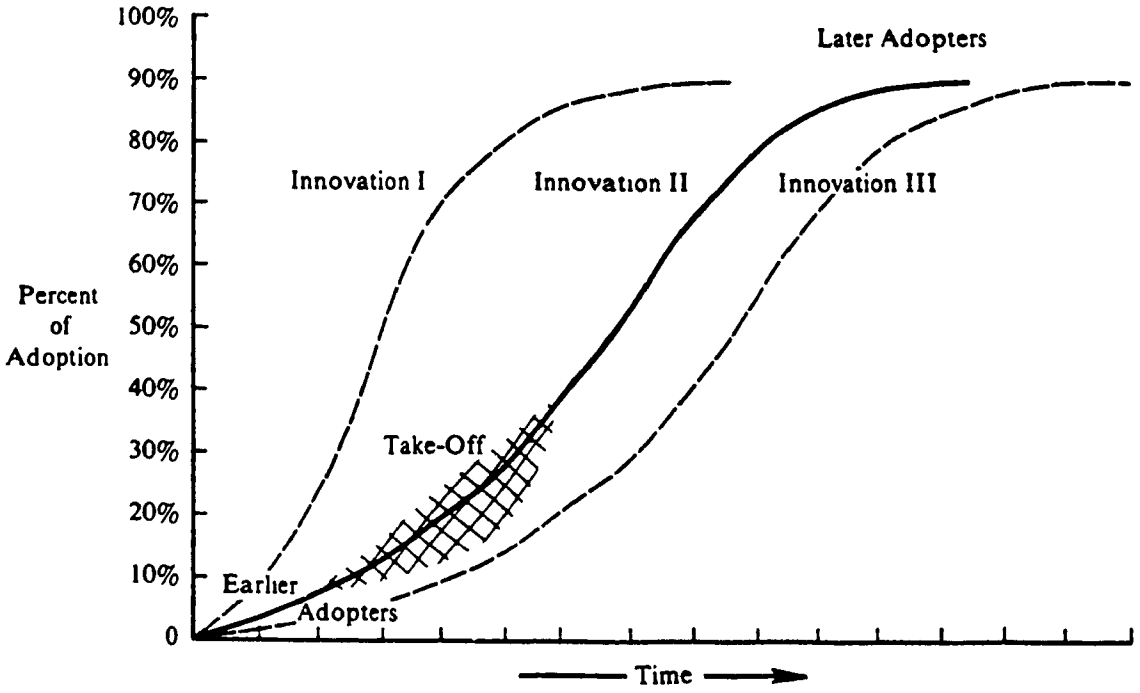

Figure 3.1: The Diffusion Process (Source: Rogers 1983)

The diffusion mechanism is part of a process of technology push and market pull (Figure 3.2). In order for an innovation to be diffused there must be a demand for it. An innovator recognizes this need and pushes the new product into the marketplace. Regardless of how impressive an innovation may be, without market pull, it will not be embraced by the market place (Brown 1991).

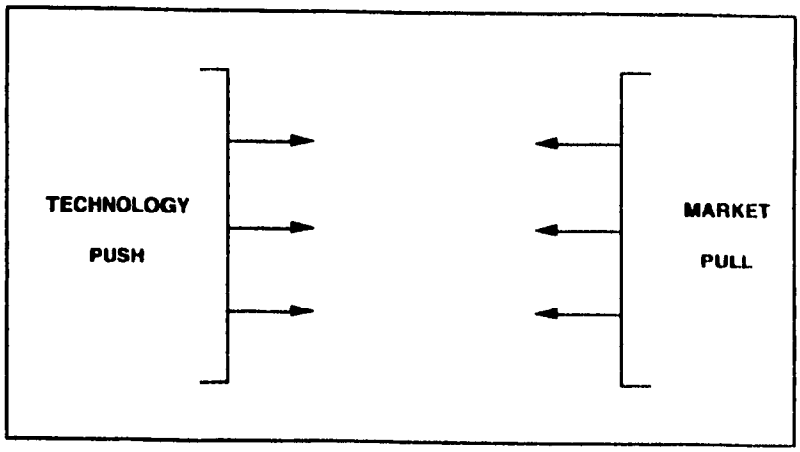

Figure 3.2: The Process Of Technology Push And Market Pull (Source. Brown 1991)

Furthermore, the demand for an innovation and the push of an innovation are kept in balance by price elasticity. This price, as illustrated in Figure 3.3, is commonly referred to as the equilibrium point because supply meets demand at this point (McCarthy 1988, 63)

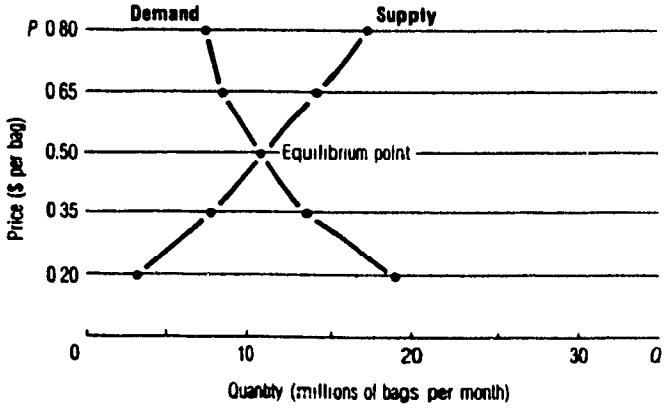

Figure 3.3: The Equilibrium Of Supply And Demand (Source: McCarthy 1988)

There are many impediments to the diffusion of innovation such as the business infrastructure consisting of: start-up companies, small corporations, and large corporations,

all of which have different means and methods at their disposal (Figure 3.4). Government agencies, researchers, and consumers may also hinder the diffusion of innovation if it fails to meet their particular criteria (Brown 1991) Therefore, it is of paramount importance to appreciate the obstacles which hinder the process of the diffusion of innovation in the marketplace.

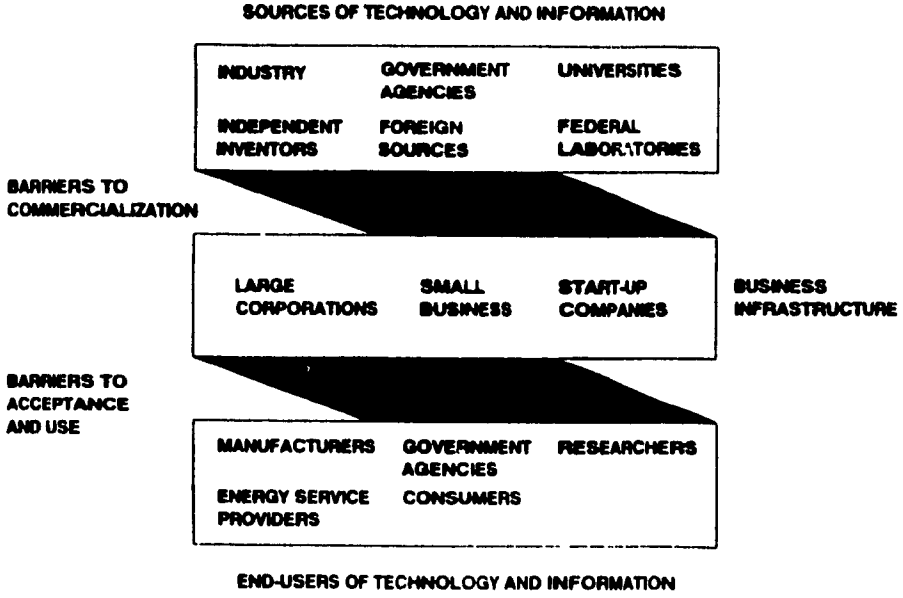

Figure 3.4: The Barriers To The Diffusion Of Innovation (Source: Brown 1990)

3.2 THE ADOPTION OF INNOVATION

The success of a particular innovation is contingent on its being adopted. The adoption process can be broken down into several stages known as the A.I.E.T.A. model (CMHC B 1989, 16).

* AWARENESS
* INTEREST
* EVALUATION
* TRIAL
* ADOPTION

The inclusion of a further stage to this model seems appropriate This stage can be called the CONFIRMATION STAGE whereby users of innovation monitor their choices to determine if they were correct in adopting or rejecting an innovation

Rogers (1983, 15) further explains the adoption process by explaining the adopters' criteria through five attributes:

* RELATIVE ADVANTAGE
* COMPATIBILITY
* COMPLEXITY
* TRIABILITY
* COMMUNICABILITY

RELATIVE ADVANTAGE refers to the advantage which a new innovative product has over an older one. For example, Polybutylene water piping can be considered quicker and easier to install than copper water piping, resulting in a reduction in labour cost (NAHB C 1989, 66). Consumers weigh this advantage in determining if they will purchase it. Indeed, the greater the relative advantage, the quicker the innovation will be adopted.

COMPATIBILITY refers to the extent of relearning a tradesman will have to achieve in order to use a new product. An innovation is considered compatible when it recognizes and works within the existing operational structure and methods of the industry it is targeting. For example, fireproof chiprock is extremely compatible because it is applied to wood and metal studs using the same procedure as regular chiprock (US Gypsum Co. 1992). The greater the compatibility of an innovation, the greater the likelihood it will be adopted.

COMPLEXITY refers to how complicated an innovation is to use. If the innovation is far more complex than the previous product it will have a harder time being adopted. Smart House electrical systems are examples of highly complex systems which require electricians with higher levels of skill and knowledge for installation (Electronic House 1992, 8)

TRIABILITY refers to whether the innovation can be tried at a low risk. If the innovation can be tried in small quantities, or is easy to replace in case of failure, then it has a greater chance of being adopted Treated wood foundations are very risky for adopters since the cost of having to change a defective foundation is exorbitant (CMHC A 1987).

OBSERVABILITY refers to the ease with which the intended users of innovation can understand or see the product. Innovations which remain buried behind walls, such as insulations, are not noticed by users. Innovations which can be understood and seen by users are adopted faster.

Clearly, an innovation which offers greater relative advantage, compatibility, triability, observability, and simplicity will be adopted more readily than other innovations.

The adopters of innovation can be classified into five categories (NAHB C 1989, 37)

* INNOVATORS
* EARLY ADOPTERS
* EARLY MAJORITY
* LATE MAJORITY
* LAGGARDS

INNOVATORS are venturesome adopters who have the ability to understand and apply new innovations. They frequently have large amounts of capital, allowing them to cope with the great uncertainty and risk of adopting innovation. Often they push an

innovation into the marketplace, and as a result assume a leadership role in their industry These pioneers comprise 2.5% of all adopters (See Figure 3.5).

EARLY ADOPTERS make up 13.5% of all adopters. They are considered authorities on the innovations which they have adopted They reduce the uncertainty of an innovation by exhibiting its feasibility (see Figure 3.5)

The EARLY MAJORITY consist of 34% of adopters They adopt innovations before the majority of adopters (See Figure 3.5). Their motto can be expressed as, "Be not the first by which the new is tried/Nor the last to lay the old aside (Alexander Pope, in Roger 1983, 249).

The LATE MAJORITY are 34% of the total adopters They adopt innovation after the average, usually due to economic necessity. They have scare resources, forcing them to adopt a conservative outlook towards innovation (See Figure 3 5)

The LAGGARDS comprise 16% of adopters Their traditional views force them to be last in the marketplace to adopt innovation. They refer to the past, using history as a basis for decision making. Their limited resources force them to be overly conservative (See Figure 3.5).

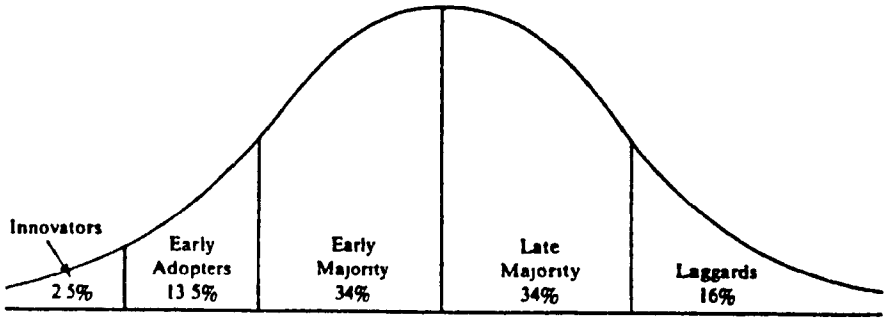

Figure 3.5 The Adopters Of Innovation (Source: Rogers 1983)

In the following section the author will examine the key players involved in the diffusion and adoption of innovation in the home building industry: the government, the manufacturers, and the home building firm. The author recognizes that other players exist, however the above players represent the greatest impact on the home building industry.

3.3 THE GOVERNMENT

3.3.1 THE AGENCIES

Since the Second World War, two principal government organizations, CMHC and the National Research Council (NRC), have dealt with the adoption and diffusion of innovation to the home building industry. Their traditional mandate has been the promotion of the construction of residential units. They have attempted to establish good building practices by improving the quality of materials and components. Research and development and the dissemination of information are its tools to achieve its goals. CMHC advises the government on all matters concerning housing and can allocate funds to builders who adopt

innovations. NRC was established in 1941. It developed the first National Building Code which sets minimum standards for design and materials in construction (CMHC B 1989,8)

Both organizations have been very active in the creation and diffusion of innovation CMHC and NRC have been responsible for the development of numerous winter construction techniques, the R-2000 program, and materials approval As Dalpe and DeBresson (1988, 1) state, "The role of government should be to increase the stock of knowledge available to industry."

At the provincial level, numerous organizations exist to promote innovation, but very few specifically focus on the construction industry For example, in Quebec, four organizations exist which are involved in the diffusion of innovation· Fonds Pour La Formation et L'aide à la Recherche (FCAR), Agence Québecoise De Valorisation Industrielle de la Recherche (AQVIR), Centre de Recherche Industrielle du Québec (CRIQ), and Concordia University's Centre For Building Studies (SHQ 1988, 25)

3.3.2 THE REGULATORY PROCESS

Charney (1971, 144) suggests that the government's "purpose in the home building industry is to regulate and control." This view is supported by Duff and Poitras (SHQ 1988, 22) when they suggest that, "the legislative and regulatory framework tends to prevent technological change, because the prescriptive nature of the codes encourages only traditional building techniques."

The building regulatory process can be divided into three components code requirements, innovation evaluation process, and administrative process (CMHC I 1991, 1) Let us examine each component with respect to the diffusion and adoption of innovation.

3.3.2.1 THE BUILDING CODE

The building code is a compilation of minimum requirement standards for construction, necessary to protect citizens using buildings. As explained in CMHC's (I 1991, 2) report entitled Innovation And Building Codes:

> The design and construction of buildings must be regulated to protect the health and safety of people who use them. Just as society must have laws to protect innocent people against the excesses of the more predatory elements of society, so must building users be protected against the ill informed and unscrupulous practitioners within the building industry.

These standards consist of a mixture of performance standards and prescriptive requirements Performance standards are specific standards such as fire resistance, design loads, and sound resistance Prescriptive requirements are more general, consisting of grades such as adequate, safe, sufficient. They can be interpreted differently by various private firms and by different government inspectors. Provincial and municipal governments are able to increase the requirements of the code thereby further complicating the problem.

Therefore, the code must be written clearly, concisely, and in simple language. The code must encourage performance by allowing for alternative solutions. It ought to give superior innovations the opportunity to be safely proven.

3.3.2 2 THE EVALUATION PROCESS

The second component of the building regulatory process is the evaluation process. The Canadian Construction Materials Centre (CCMC), a division of NRC, tests innovations to determine if they meet the standards set by the code. Private industry feels that the length of time it takes for an innovation to be approved inhibits the diffusion and adoption

of innovation. However, an efficiently run evaluation process could potentially promote the diffusion and adoption of innovations As expressed by CMHC (I 1991, 34):

> The evaluation component indeed appears to be the key ingredient in the regulatory process facilitating or inhibiting innovations.

The evaluation process can act as a gatekeeper, enhancing or slowing down the diffusion and adoption of innovation However, once an innovation is approved it gains trust in the marketplace. Such evaluative organizations must therefore be accessible, easy for companies to use, and quick in performing their tests

3.3.2.3 THE ADMINISTRATIVE PROCESS

The third component of the building regulatory process, the administrative process, is often viewed as the most troublesome by private firms This is largely the result of the multiple levels of government (federal, provincial and municipal) and several offices involved in administering the building code Since provincial and municipal governments are permitted to publish their own code, implementers of innovation find themselves dealing with numerous government offices Often these offices are not informed of the policies of their colleagues, causing further confusion. As SHQ suggests in a report (1988, 22)

> The variety of regulation along with the multiple branches of government responsible add to the confusion to the construction industry

Support services for the code may vary from region to region thereby enhancing the problem.

Furthermore, due to the large and bureaucratic nature of government agencies like CMHC and NRC, communication to the numerous small manufacturers and builders/developers is difficult. The organizational structure of CMHC is divided into

various departments (e.g Loans, Appraisals, Architecture, Planning) (CMHC I 1991). Persons working in departments are often unknowledgable about their colleagues' work in other departments The problem arises from the fact that the building code is an essential aspect of all departments Therefore, a manufacturer wishing to introduce innovation or a builder/developer desiring to use one will often not know where to turn to for assistance when dealing with the government.

This dilemma is further complicated when provincial and municipal governments are involved Only large manufacturers and large builders/developers have similar organizational structures, allowing them to understand how to deal with government agencies, but the smaller company will find itself lost in a sea of bureaucracy. This point becomes increasingly important when we consider the small size and vulnerability of the typical home building firm

Additionally, government employees who enforce the code but do not design it may not understand the logic and purpose behind certain regulations. This can lead to unreasonable inflexibility with regard to the use of innovation. As one government agency suggests (CMHC I 1991, 23):

> Equally important to knowledge of the requirements however, is an appreciation of their intent and objectives. Without this appreciation the enforcing official has little choice but to take a narrow literal meaning for each requirement. This may also lead to a reluctance to accept equivalencies [innovation] even where the official has this authority.

Lastly, numerous government-sponsored programs exist with respect to the diffusion of innovation. Nevertheless, few companies have access to such programs as illustrated in Figure 3.6 Only larger, more professionally managed firms are sufficiently informed and

able to sort through the complex procedure of being accepted to benefit from such programs (Brown 1990).

A more cynical view:

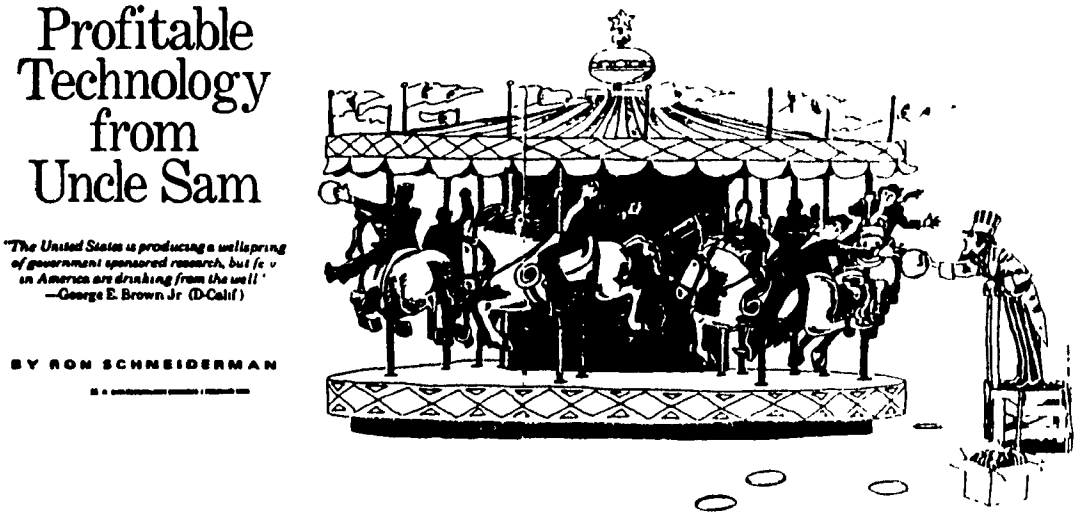

Figure 3.6: Profitable Technology From The Government (Source. Brown 1990)

It is evident that government can act as a gatekeeper to the diffusion of innovation (Figure 3.7). Nevertheless, we must understand that government is responsible for the safety of its citizens and that this insistence on safety first is naturally going to inhibit the diffusion process. Government's insistence on safety can lead to better products being developed and eliminate the risk of product failure, which benefits consumers and manufacturers. However, government must ensure that smaller manufacturing and home building firms have sufficient access to assistance regarding the code. It must ensure that it is operating in the most efficient manner possible, given its responsibility of safety first.

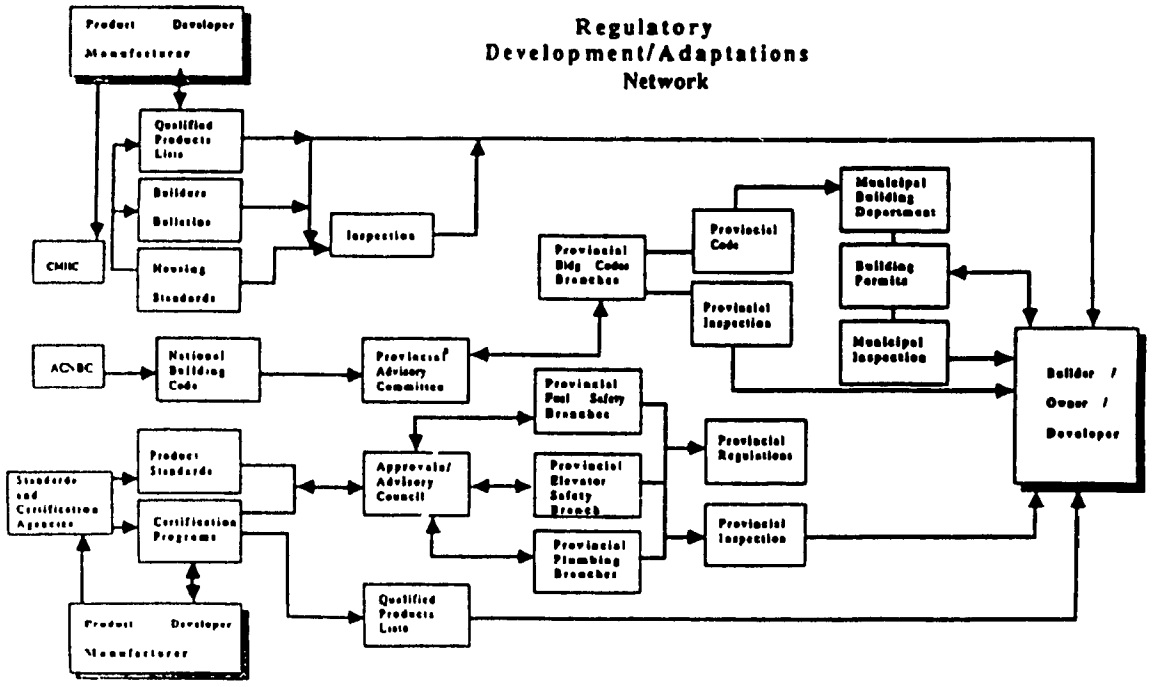

Figure 3.7. Regulatory Development/Adaption Network (Source CMHC B 1989)

In the following section the author will examine the role of manufacturers in the diffusion of innovation to the home building industry.

3.4 THE MANUFACTURERS

> Our greatest and only resource is the miracle of human creativity in a relation of openness to the divine. It is a resource that above all we should deny neither to the poor, who can be the most open of all to the future, nor to the rich or excellent of individuals, who can lend leadership, imagination, and wealth to the cause of beneficent change.
> (Gilder 1982, 314)

The manufacturers are the driving force behind the introduction and diffusion of innovation. Competition amongst numerous firms is intense since only a few giants, such as Dow Chemical Inc., monopolize the industry. Often, firms will compete in the manufacture of similar products such as roofing materials, enhancing the diffusion of these products. Like the builders/developers, these unique groups of entrepreneurs command enough perseverance to succeed at realizing their dreams. This entrepreneurial spirit drives them to produce newer and better products, granting them a particular niche in the market for public consumption.

3.4.1 THE ORGANIZATIONAL STRUCTURE OF MANUFACTURERS

The manufacturers are the only group in the home building industry who have high overhead costs. These costs result from the large investment needed to develop and produce innovation, and range from R&D to production equipment and facilities (Charney 1971, 140). As a result, manufacturing firms tend to be more permanent in location than other firms in the home building industry.

3.4.1.1 THE PRODUCTION PROCESS

Production by the manufacturer must meet the demand created by home building and sub-contracting firms. Accordingly, firms tend to be process and task oriented (Charney 1971, 140).

Firms are process oriented, dividing themselves into functional departments such as:

* ESTIMATING
* ORDERS
* ENGINEERING
* PRODUCTION
* SALES

Firms are task oriented by having their production equipment and order-processing procedures adaptable to the mosaic of demands from the home building and sub-contracting firms. Clearly, a buyer must comprehend this mode of production in order to minimize production costs.

The sales representative is often the link between the manufacturer and the buyer. His strengths lie in the ability to sell, rather than a deep understanding of the products. As technology becomes increasingly complex, sales representatives often lack the understanding of how certain products may be used with other products, resulting in inferior house construction (Charney 1971).

Undoubtedly, it is crucial to comprehend the organizational structure and the production process of manufacturers in order to understand the commercialization of innovation by them It will be useful to examine the latter process.

3.4.2 THE COMMERCIALIZATION OF INNOVATION

The commercialization of innovation is a lengthy process, as illustrated in Figure 3.8 First, basic research consisting of concept development, market analysis, financial analysis, and a working model must be established. Then technology development consisting of engineering design, prototype development, and developing a production prototype must occur. Finally, market penetration occurs initially through limited production and marketing, and then by pull production and marketing. The evolution of a product through basic research to market penetration can take up to nine years (Brown 1990, Figure 3.8).

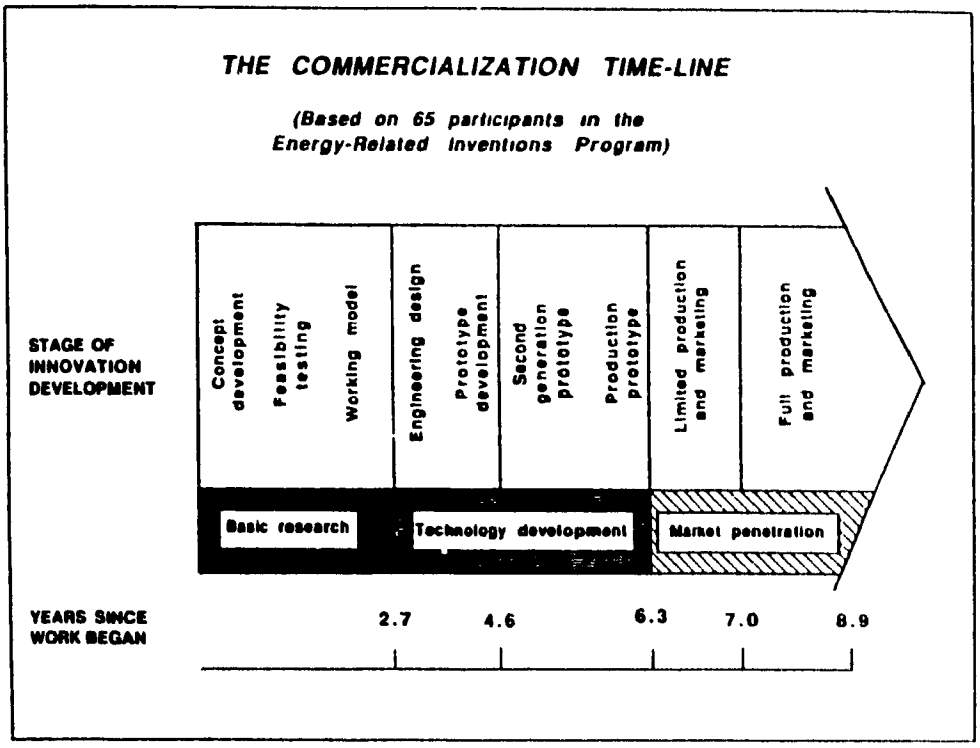

Figure 3.8: The Commercialization Time Line (Source: Brown 1990)

In Chapter One, innovation was defined as an invention which is applied for the first time. In order for this invention to reach the market, to become an innovation, the innovator must assume risk. This process often takes much time, creating a time lag between invention and innovation (application) in all industries. The time lag is greater for industrial products with which the home building industry deals than for consumer products (Mansfield 1968, Figure 3.9). The diffusion of innovation into the home building industry does not occur instantaneously.

Invention	Interval (years)	Invention	Interval (years)
Distillation of hydrocarbons with heat and pressure (Burton)	24	DDT	3
Distillation of gas oil with heat and pressure (Burton)	3	Electric precipitation	25
Continuous cracking (Holmes-Manley)	11	Freon refrigerants	1
Continuous cracking (Dubbs)	13	Gyrocompass	56
"Clean circulation" (Dubbs)	3	Hardening of fats	8
Tube and tank process	13	Jet engine	14
Cross process	5	Turbojet engine	10
Houdry catalytic cracking	9	Long-playing record	3
Fluid catalytic cracking	13	Magnetic recording	5
Gas lift for catalyst pellets	13	Plexiglass, lucite	3
Catalytic cracking (moving bed)	8	Cotton picker	53
Safety razor	9	Nylon [b]	11
Fluorescent lamp	79	Crease-resistant fabrics	14
Television	22	Power steering [c]	6
Wireless telegraph	8	Radar	13
Wireless telephone	8	Self-winding watch	6
Triode vacuum tube	7	Shell molding	3
Radio (oscillator)	8	Streptomycin	5
Spinning jenny	5	Terylene, dacron	12
Spinning machine (water frame)	6	Titanium reduction	7
Spinning mule	4	Xerography	13
Steam engine (Watt)	11	Zipper	27
Ball point pen	6	Steam engine (Newcomen)	6

Figure 3.9: Time Interval Between Invention And Innovation (Source: Mansfield 1968)

Furthermore, innovation results from the establishment of a new "production function" which requires time. This process must not be viewed as an isolated event. As Schumpeter (1939, 101) states, innovation "tends to come about in bunches, simply because first some and then most firms follow in the wake of successful innovations."

The utilisation of a new technique therefore makes it necessary for other components to improve, which increases the product's diffusion time (DeBresson 1986, 11). For example, the introduction of polyurethane insulation resulted in: specialized sub-trades working specifically with the material; new equipment being developed to manufacture, store and apply this insulation; and a new construction method which enclosed the

insulation between cement block on the inside of the wall and exterior sheathing on the outside of the wall.[1]

Although polyurethane is only beginning to be recognized as an alternative type of insolation, its development dates back to 1930 in Germany when Otto Bayer used it to reinforce fighter plane wings. The North American home building industry adopted this product in 1950. In Canada, by 1985, 17,400 metric tonnes of it were used and an estimated 25,700 tonnes/year of it are expected to be sold by 1995 (Demilic 1993, 1)

3.4.3 THE COST OF INNOVATION

The cost of developing an innovative product is a barrier which hinders the diffusion of innovation. Costs can run in the millions of dollars, excluding small entrepreneurs from the market. The costs of commercializing a product increase disproportionately as the product nears the launching stage. This is the period in which innovators will likely have spent most of their funds (Figure 3.10) The commercialization cost of innovation thereby acts to inhibit innovators from realizing their invention and significantly slows down the diffusion process by forcing the innovator to find alternative modes of financing

[1]Enclosing the insulation between cement block from the inside of the wall and exterior sheathing (preferably in the form of brick) from the outside prevents the insulation from igniting in the event of fire. If the insulation catches on fire, the cement block on the inside of the wall prevents most of the fumes from entering the house

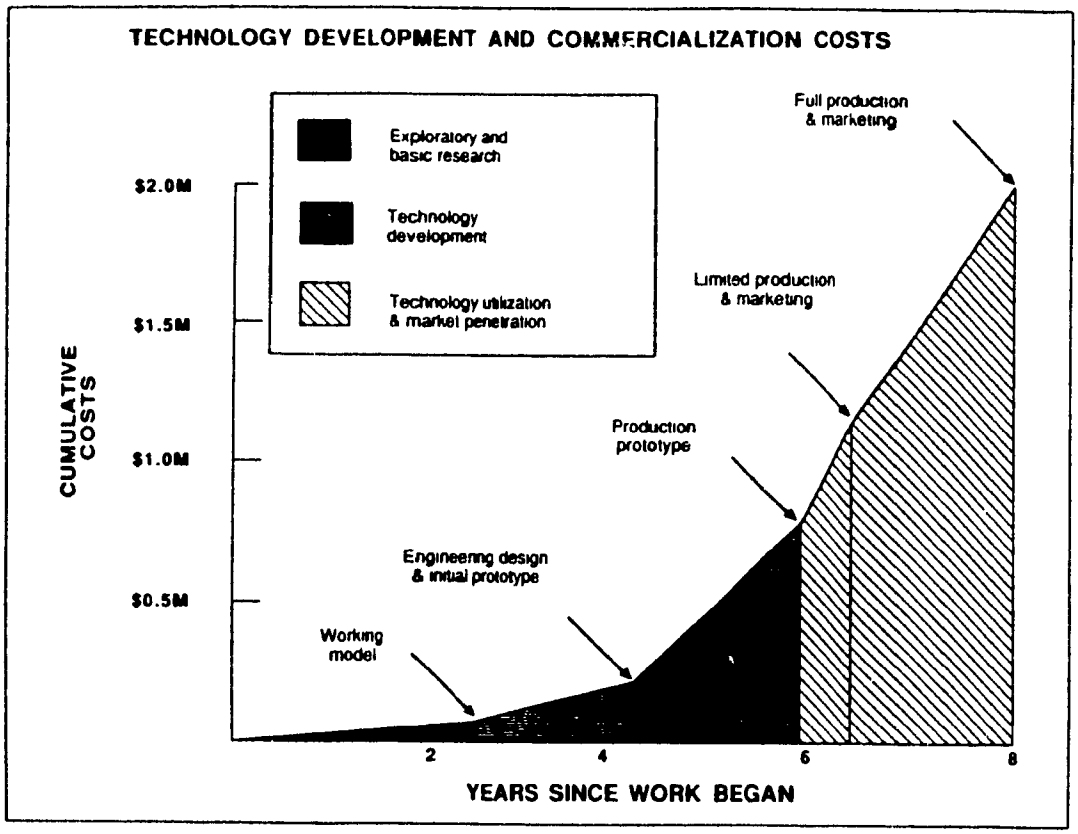

Figure 3.10: Technology Development And Commercialization Costs (Source: Brown 1990)

In conclusion, the manufacturer's organizational structure can be said to enhance the diffusion of innovation. Due to the manufacturer's large size and the intense competition it faces from other manufacturers, innovation is a means to achieving a competitive edge. A buyer who understands the production process of the manufacturer can enhance diffusion by working within the manufacturer's operational framework.

Since most manufacturers must be large enough to absorb the overhead costs of production, there appears to be great potential for innovation in the home building industry. Its size gives the manufacturer the ability to absorb the costs of innovation. However, the

enormous costs involved in the commercialization of innovation, due to the complexity of the process, can also act as a barrier to the diffusion of innovation.

In the following sections the author will examine the diffusion of innovation in the home building firm and sub-contracting firm.

3.5 THE HOME BUILDING FIRM

The home building firm is the most important player involved in the adoption of innovation. Its complex structure and operational practices have tremendous influence upon the employment of innovation The next section sets out to examine its role.

3.5.1 FACTORS INFLUENCING THE ADOPTION OF INNOVATION IN THE HOME BUILDING FIRM

In this section the author attempts to demonstrate the dominant factors influencing the adoption of innovation. (Quite certainly, many other factors exist.)

3.5.1.1 THE SIZE OF THE TYPICAL FIRM

Due to the cyclical nature of the home building industry, the typical home building firm is small, consisting of fewer than five employees. Its size makes it economically unfeasible to inquire into innovations In addition, as expressed by Friedman (1991, 5), "Small firms are financially more vulnerable and tend not to assume the risks that are associated with new products or methods " Moreover, they cannot afford the technical personnel nor the space and facilities necessary for R&D

Nevertheless, innovation in the form of "re-innovation" occurs on the construction site. Products are adopted to overcome specific daily problems As a report by the NAHB suggests (E 1991, 21):

> Most innovations consist of practical line extensions of existing products and processes and results from solutions to practical problems in the field, or "re-invention" or adoption of existing technologies applied to specific problems.

3.5.1.2 THE BUILDER/DEVELOPER

Builders/developers, as illustrated in Figure 2.4, run most aspects of their firms. Given the large number of tasks, they have little time for frivolous matters. Their main concerns involve ensuring the smooth operation of the firm, and keeping projects rolling with as few interruptions to the process as possible. Builders/developers have little time or energy to investigate innovative products

In order for an innovation to be attractive, it must be simple to understand. Undoubtedly, long technical pamphlets are not read by such builders/developers. The best approach for an innovator wishing to sell an innovation to a builder/developer is to illustrate the product and its functions through coloured photographs and diagrams on one concisely written page accompanied by a small sample of the product. Furthermore, the presentation should illustrate the market demand for the product as well as demonstrate how it reduces materials costs and construction complexity

3.5.1.3 MANAGEMENT INTENSITY OF THE FIRM

Home building firms operate "lean" by having a small number of employees who act as generalists, performing various tasks. Employees have little time on their hands to keep up with technological developments, due to their preoccupation with solving short-term problems (CMHB C 1989, 24). Only innovations which can help employees to perform their specific functions will be adopted Explicitly, an innovator will have better results if he addresses directly the builder/developer who is responsible for the entire operation.

3.5.1.4 THE ARCHITECT AND THE DESIGNER AS PROMOTERS OF INNOVATION

Typically, most home builders do not use architectural services Average home building firms build under ten homes per year, often building one at a time, making it very difficult for them to afford architectural fees Consequently, many architects find that it is not profitable for them to work for a small home builder, because the hours they spend designing a single house far outweigh the economic return on such work

The builder's/developer's goal is to sell what the market demands Their understanding of what the market demands is obtained by examining what other builders/developers are selling, this frequently results in the imitation or copying of successful designs For example, Group Marcotte of Quebec, in 1991, sold 87 "Grow Homes" (designed by Friedman and Rybczynski, of McGill University) Since then, numerous builders/developers have copied the "Grow Home" concept, building them throughout Quebec. Since architects cannot duplicate other architects' work, designers who work for less and have no qualms about imitating others' work have designed many of these replications. Clearly, as Friedman (1991, 6) states:

> This has brought about the creation of specialized "house designers"....who operate outside the formal professional structure of architecture and who are often not registered architects. They charge much below the recommended rates for a single plan that is later used numerous times in different projects, and they do not follow common practices of project follow up.

The builder/developer runs the firm and construction process with complete control Therefore, as Friedman states, "many architectural firms do not participate in housing design because of their inability to secure sufficient control over design" (Friedman 1991,6)

The architect, then, has little influence on the introduction of innovation. Although the designer may have slightly more influence on the introduction of innovation to home building firms, the builder/developer still calls the shots and makes the decisions.

3.5.1.5 THE HOME BUILDING FIRM'S CLOSED SYSTEM MODE OF OPERATION

The home building firm's "closed system" mode of operation limits the type of innovations which can feasibly work within this framework (See Figure 2.10). Since the construction site functions as an extremely efficient assembly line, wherein every trade and worker knows exactly what his function is, innovation must operate within this framework. Any attempt to introduce an innovation which alters this unique form of equilibrium will not be accepted by the industry because it would bring the entire process to a halt (Friedman 1987). For example, a prefabricated I Joist is applied the same way as a regular joist. A worker using this new material does not have to undertake any relearning to use it, yet the material offers many advantages such as its ability to span greater distances and its light weight Undoubtedly, this product works within the industry's "closed system" mode of operation

If the new product creates a new sub-trade industry which manufactures and installs the product, removing the need for a previous sub-trade, then it may be accepted. An innovator must bear in mind that the further away an innovation strays from normal practice in the industry, the less of a chance it has of being accepted (See Figure 3.11).

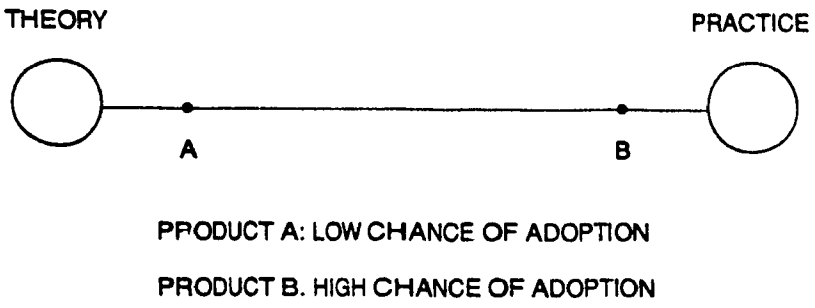

Figure 3.11: The Adoption Of Innovation (Source: Friedman 1993)

3.5.1.6 FRAGMENTATION

The home building industry is extremely fragmented. Frequently over 90% of a firm's work will be subcontracted to specialists in a particular field of construction (I&S Construction 1993). This leads to many smaller firms working at separate tasks to finish a project. Because these firms do not communicate with each other but only with the builder/developer and his foreman, an innovation cannot span two sub-trades (NAHB 1991, 24). A new wall system which required a new form of electrical wiring would have a difficult time getting adopted because it demands that the electrical trade change its work methods.

3.6: FACTORS INFLUENCING THE ADOPTION OF INNOVATION IN THE SUB-CONTRACTING FIRM

The organizational structure of the sub-contracting firm is similar to the home building firm, but smaller. The above factors therefore apply to the sub-contractors. Nonetheless, a further factor can be added.

It is commonly believed that sub-contractors are reluctant to adopt innovation because they would like to increase their prices rather than decrease them by using innovative products. Perry Bigelow, a builder, suggests, "You can't depend on subs to bring you innovative systems. They want to increase costs, not decrease them" (Jones 1992, 172). This notion is incorrect. Sub-contractors give bids on jobs to the builder/developer. The builder/developer hires the sub-contractor with the lowest bid, providing that he is competent. Undoubtedly, it is in the sub-contractor's interest to adopt innovation which will reduce his costs Consequently, the sub-contractor can influence the adoption of innovation in his particular trade.

In the following section the author will examine the diffusion of two innovations, roof trusses and drywall, into the home building industry, in order to comprehend the diffusion process and to demonstrate the influences which the key players had on their adoption.

3.7: THE ADOPTION OF TWO PRODUCTS BY THE HOME BUILDING FIRM

3.7.1 THE PREFABRICATED ROOF TRUSS

Prior to the adoption of prefabricated roof trusses, home builders used a joist and rafter system to support the roof. A series of joists were laid horizontally and nailed together, resting on the exterior and interior load-bearing walls. Then sloping "members," rafters, were nailed to the joists and nailed together, preventing them from spreading due to snow load Indeed, roof construction was an extremely complicated and timely procedure

requiring skilled carpenters. This was of little concern to home builders prior to the Second World War because there was no shortage of wood or labour (CMHC F 1989, 11)

The postwar period created shortages of materials and labour. Combined with the shortage of housing, home builders were forced to meet these challenges by becoming more efficient. Responding to this environment, the necessary "pull" for innovation existed, resulting in the creation of the prefabricated roof truss.

The development by manufacturers of the truss to its final form was a lengthy process. Initially the truss was held together by bolts. Later, a series of metal connectors such as split rings, shear plates, cast iron spike grids, and punched metal plates were used in building the truss. In 1953 "Gri-P-Late," a metal plate with triangular teeth, serving as a connection between wood membranes, was developed by Carol Sanford, enhancing the assembly of the truss. Its drawback was that it required nails to stay in place. Finally, in 1955 "Gang-Nail" was developed by J. Calvin Jureit. Its function was identical to "Gri-P-Late," however it was of thicker gauge metal, had larger teeth and was pressed into the wood through a hydraulic press, eliminating the need for nails. After 15 years of development, the truss was ready for mass production (CMHC F 1989, 13).

Initially the government, with its concern for safety, acted as a gatekeeper to the diffusion of the truss. In 1954 CMHC declared that the truss did not meet the building code standards, and suggested a traditional engineering design which rendered the truss uneconomical. After which, NRC and CMHC set out to perform numerous tests on truss systems which revealed problems of failure from snow loading. By 1956 they devised standards whereby trusses had to carry two times the normal snow load for a minimum of

24 hours without collapsing. Finally, in 1962 NRC published these standards in the building code (CMHC F 1989, 14).

Clearly, in the case of the truss, government's safety concerns required extensive testing of the truss, which slowed its diffusion process; however, this resulted in a far superior product Furthermore, having NRC approval on the new roofing system gave it the credibility which was necessary to convince the home building firm to adopt it.

Home building firms adopted the truss in the 1950s with enthusiasm since it reduced construction costs. This was achieved by: reducing by 50% the amount of wood used in constructing a roof, the ability of the truss to span the entire width of houses, the reduction in costs from not having to build load-bearing partition framing, and by enclosing buildings more quickly, thereby reducing labour costs and protecting the building from weather and vandalism (CMHC F 1989, 12).

The introduction of the truss created a new manufacturing industry which calculated the size of trusses necessary for a house's roof. As a result, the need for specialized roofing carpenters was eliminated by the use of framing carpenters who were given directions from truss manufacturers for installing trusses. With the creation of a new manufacturing industry, the truss was able to fit within the home builder's "closed system" method of operation Furthermore, the builder saw this as advantageous because it was one less responsibility on his shoulders in the building process.

The story of the truss's diffusion into the home building industry exhibits how it evolved due to market pull. Manufacturers of the truss spent over ten years perfecting it to its final state. The government rightfully slowed down the diffusion process through its rigorous testing procedures and insistence on safety first. The truss was adopted by home

building firms because it had the relative advantage of being less expensive and easier to install than joist and rafter construction. Moreover, its ability to work within the home builders "closed system" mode of operation enhanced its diffusion.

3.7.2 DRYWALL

Drywall is a nonflammable wall system made out of gypsum It was invented in the United States around 1910 by the U.S. Gypsum Company as a direct substitute for plaster and lath wall construction. Prior to the Second World War, drywall's market penetration was low. To encourage its use, drywall companies recommended the use of a plaster skin coat over the drywall to give it a more traditional look The postwar construction boom created the pull necessary for drywall to be in wide demand. The shortage of skilled plasterers and the need to reduce housing costs furthered its demand (CMHC B 1989, 54)

Drywall's diffusion was a lengthy process Initially many problems existed such as nail popping and poor edge quality CMHC's insistence on a one-year home warranty led to numerous recalls by builders in order to fix drywall which had nails protruding through the paint or excessive cracking at joints By 1960 Black & Decker and the drywall companies solved the problem by using self-tapping screws which were applied with an electric screw gun. Tape for joints along with premixed joint compound was introduced, giving drywall a better finish. By the late 1960's, after 50 years of existence, drywall was used in 95% of all jobs (CMHC B 1989 56).

The postwar home building firm adopted drywall with enthusiasm because it reduced construction cost by reducing labour and increasing the speed of construction. Undoubtedly, it fit within the postwar assembly line process of construction Drywall offered the builder a competitive advantage by being a better product than the low-quality

plaster work resulting from the shortage of skilled plasterers in the postwar period. Finally, drywall was easily integrated into the home builder's "closed system" mode of operation due to the creation of a new plaster-man trade.

The diffusion of drywall into the marketplace was a prolonged process. Manufacturers of drywall spent approximately 40 years improving the product before it was acceptable Government legislation requiring builders to guarantee their work pushed drywall manufacturers to improve the product. Nevertheless, the pull for efficiency created by the postwar period along with drywall's ability to work within the home builder's structure are the factors most responsible for its successful diffusion.

3.8 SUMMARY AND CONCLUSIONS

We have seen that the parameters effecting the adoption of innovation in the home building industry are complex and that they reach far beyond the home building firm. An understanding of these parameters is essential in order to determine the factors influencing the acceptance or rejection of innovative ideas by builders/developers. To conclude:

* The diffusion of innovation is a complex process which results in social change and encounters obstacles at every level of its path.

* The diffusion processes of innovation occur with an innovation being communicated through certain channels to members of a particular social system over a period of time.

* There must be market pull in order for the diffusion of innovation to occur.

* Many barriers to the diffusion process exist which hinder the process. These must be understood prior to launching an innovation.

* Adopters of innovation consider its relative advantage, compatibility, complexity, triability, and communicability prior to adopting it. An innovation which offers greater relative advantage, compatibility, triability, observability, and simplicity will be adopted more readily.

* Government, through its various agencies, laws, evaluation processes, and administrative processes can act as a gatekeeper which enhances or slows the diffusion of innovations.

* The manufacturers act as the driving force behind the diffusion of innovation

* The diffusion of innovation is a costly and lengthy process, causing most manufactures to be large in size and to have high overhead expenditures. Their large size enables them to absorb the costs and risks involved in the diffusion of innovation; nevertheless this can also be a barrier to smaller manufacturers

* Manufacturers face fierce competition, therefore innovation can give them a competitive edge in a difficult industry

* The small size of home building firms makes R&D unfeasible and limits the risk that can be taken on innovations.

* The builder/developer, rather than his employees, should be directly approached when attempting to introduce an innovation. It is best to demonstrate one's product to him in the simplest possible fashion.

* The architect and the designer have limited influence in the diffusion of innovation to home building firms.

* An innovation must work within the home building firm's "closed system" of operation.

* Innovation is a means for the home building firm to reduce materials cost, simplify the construction process, and gain a competitive advantage.

* Because the industry is highly fragmented, an innovation must not span two sub-trades.

* It is in the sub-contractor's interest to adopt innovations which will reduce his costs.

* The sub-contractor has influence on the adoption of innovation in his particular trade.

* The diffusion and adoption of the prefabricated roof truss and drywall illustrate the need to understand the role of the key players involved in the adoption and diffusion of innovation in the home building industry.

Now that the author has explained the diffusion and adoption process of innovation, and the key players involved, we must examine the specific factors influencing the adoption or rejection of innovation by home building firms. The author will approach this subject in the following chapter by establishing evaluation criteria which influence a builder's/developer's decision on technology.

CHAPTER FOUR

FORMING EVALUATION CRITERIA

4.0 INTRODUCTION

The subsequent chapters will address the main research question of the thesis by identifying the specific factors which influence the acceptance or rejection of innovative products by builders/developers. Unlike in Chapters Two and Three, where the author demonstrated why a builder/developer buys a "hammer," the following chapters will illustrate why a builder/developer buys a "particular hammer" The discussion, that is, moves from the general to the specific

This chapter stipulates a set of evaluation criteria obtained through a literature review and a scientific evaluation procedure, which will enable the author to record and analyze the data in the subsequent chapters.

4.1 CRITERIA FOR EVALUATION

After a review of the literature, and having contributed his own insight, the author has developed a set of factors which influence builders'/developers' decisions on technology (See Figure 4.1). In the following section the author sets out to explain these factors and to justify their importance as evaluation criteria. It is important to understand that certain factors were gathered from reading studies and, where possible, specific references will be cited.

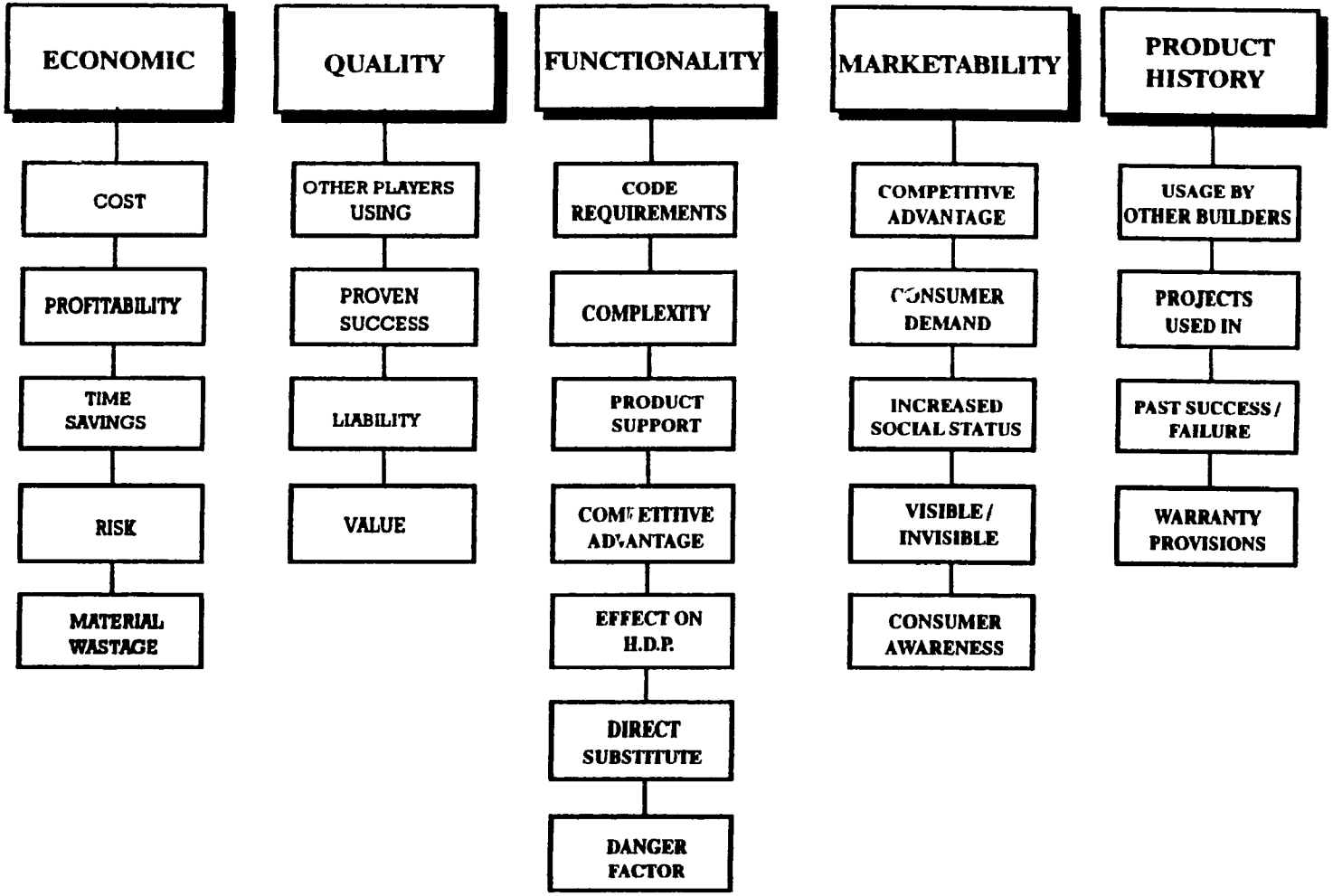

Figure 4.1: Evaluation Criteria

4.1.1 ECONOMIC

Economic factors influencing a builder's/developer's decision on technology can be divided into several sub-factors consisting of Cost, Profitability, Time Savings, Risk, and Material Wastage. All of the sub-factors influence a builder's/developer's decision from a financial perspective.

COST refers to the actual price paid to use a particular product This price is dependent upon the cost of labour to install the product, the materials needed, rental charges for special equipment needed for installation, and the cost of transporting the product from the factory to the construction site. Builders/developers will also be interested in knowing whether a product has a low first cost of usage, low operating cost, and whether the product encourages early payback from its usage (NAHB E 1991, 30). Finally, in using cost as a criterion, the replacement cost of using one product over another is incorporated into the real cost of a product (NAHB E 1991, 101)

PROFITABILITY[1] refers to how a product affects the builder's/developer's profit rate. The builder/developer examines the net return of a product to see whether the product is economically viable (NAHB E 1991, 30) Furthermore, the financial gain from choosing one product over another becomes an important criterion for builders/developers in determining a product's profitability (NAHB E 1991, 29).

TIME SAVINGS refers to the time which is saved by using a particular product Products which save builders/developers time allow them to maintain their tight

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[1]Some builders/developers consider cost and profitability as one criterion However it is important to bear in mind that cost refers to the real price paid for a particular product whereas profitability deals with the financial gain from choosing one product over another

construction schedules, which is very important in areas which have short construction seasons (Charney 1971). Moreover, time savings may be important to builders/developers when one considers that they are paying interest on funds borrowed to build (Friedman 1993). This consideration becomes especially vital when builders are using bridge financing (see Chapter Two) and are only given money upon completion of a house.

RISK refers to the financial danger of using a particular product, especially if it should fail and need to be replaced. The economic vulnerability of the typical home building firm, as illustrated in Chapter Two, may certainly lead builders/developers to assess the risk involved in using any new product (SHQ 1988, 22).

MATERIAL WASTAGE increases the cost of construction. A product which encourages material wastage may be frowned upon by builders/developers.

4.1.2 QUALITY

The quality of an innovative product may influence a builder's/developer's decision to adopt or reject it. A product's quality can be assessed by looking at other players who use it, its proven success, and its value. Furthermore, the quality of a product is important to builders/developers since they are liable for their work up to five years after its completion.

OTHER PLAYERS USING IT refers to the other builders using a particular product. A builder's/developer's decision to adopt or reject an innovative product may be influenced by his colleague's use of the product. Some may ask other builders/developers if they are satisfied with a certain product.

PROVEN SUCCESS refers to whether a product was proven to work properly by builders/developers. This may affect other builders'/developers' perception of the quality of a particular product (NAHB C 1989, 81).

LIABILITY refers to the legal requirement that builders/developers must guarantee the home for five years against any defects. They will opt not to use products which might fail within this time period (CMHC B 1989, 32).

VALUE refers to whether an innovative product improves or increases the quality of the product which it is replacing. It can also be used to determine whether a product is the best in a particular price range, as well as its value and utility (CMHC K 1992, 11).

4.1.3 FUNCTIONALITY

The functionality of a product is determined by the product's ability to function within the operational structure of the home building industry (NAHB C 1989, 27). Functionality, as illustrated by Rogers (1983), and Goldberg (NAHB E 1991), can be broken down into seven sub-factors consisting of: Code Requirements, Complexity, Product Support, Competitive Advantage, Effect On Home Delivery Process, Direct Substitute, and Danger Factor.

CODE REQUIREMENTS oblige builders/developers by law to use only products which meet specified standards. Since the given standards are minimum standards, a builder/developer can choose between products which meet the code requirements or exceed them. Therefore, a builder/developer may be influenced by the code requirements or standards when examining the engineering efficiency of a product (SHQ 1988, 19-22).

COMPLEXITY refers to how complicated a product is to use. Does the product ease or increase the difficulty of assembling a house? When adopting a new product,

builders/developers may investigate whether they will have to retrain workers to use the product. The simplicity of the product therefore plays an important role. A builder/developer may also want to know if the product is more convenient to use or not, and if the product increases productivity and efficiency of construction (Rogers 1983, 15).

PRODUCT SUPPORT refers to the distributor's strength, technical literature on the product, and access to the products. A builder/developer may want to know if the distributors are financially secure and if they have trained technical staff who are able to help with questions related to the product's installation (NAHB E 1991, 26). Technical literature may be important to builders/developers since it can be used to understand further the use of a product and can be passed on to the final consumer. Builders/developers may also be concerned about the accessibility of the product. They might want to ensure that the product can be consistently delivered on time and that the distributor carries sufficient stock (CMHC B 1989, 35).

COMPETITIVE ADVANTAGE refers to the advantage that a product gives a builder/developer from a construction viewpoint. Due to the competitive nature of the home building industry, it is essential for builders/developers to obtain opportunities to compete effectively (NAHB C 1989, 77).

EFFECT ON THE HOME DELIVERY PROCESS refers to how a product affects a builder's/developer's method of construction. A product may be examined to determine if it works within the "team-like" operation of home building firms, and if the product will encounter resistance from the sub-trades. Builders/developers may weigh the effects that a product has on the home delivery process very carefully prior to adopting it (Friedman 1991, 2-7).

DIRECT SUBSTITUTE refers to whether or not a product is a direct replacement for an existing product. An innovative product which is superior to an existing product and which is installed using the same method may influence a builder's/developer's decision to use it (Friedman 1993).

DANGER FACTOR refers to how dangerous a product is to use. A product which is very dangerous for workers to install or for the buyer of the house may influence a builder's/developer's decision to use it. For example, builders/developers prefer not to use aluminum wiring because faulty connections can cause fires, placing the buyer in danger (CMHC B 1989, 62).

4.1.4 MARKETABILITY

The marketability of a product can have significant influence on a builder's/developer's decision to adopt or reject the product. This category can be divided into five sub-categories consisting of Competitive Advantage, Consumer Demand, Increased Social Status, Visible/Invisible Innovations, and Consumer Awareness.

COMPETITIVE ADVANTAGE is the advantage which a product gives a builder/developer from a market viewpoint. A builder/developer who uses a product which is perceived as being superior by consumers will gain a competitive advantage. It is in the builder's interest to examine this sub-factor when looking at new products (NAHB C 1989,8).

CONSUMER DEMAND refers either to the demand or to the resistance to a particular product by the consumer. A builder/developer may evaluate this demand or resistance prior to using a product (CMHC B 1989, 81).

INCREASED SOCIAL STATUS is achieved by a builder/developer using a product which is perceived as being far superior or as "state of the art" by other builders/developers and consumers. This criterion can be important to builders/developers, since by using such products they might improve their reputation in the industry and amongst consumers (NAHB E 1991, 30).

VISIBLE/INVISIBLE INNOVATIONS refers to whether the product can be seen by the purchaser of the house or whether it is invisible and hidden behind closed walls and ceilings. If a product can not be detected by the consumer, a builder/developer may not choose to use it (Rogers 1983).

CONSUMER AWARENESS refers to whether consumers have heard about a product. Their awareness might influence a builder's/developer's decision to adopt the product (CMHC B 1989, 44).

4.1.5 PRODUCT HISTORY

When builders/developers encounter a new product, they may want to know its track record. If they themselves are familiar with the product, they may know how the product has performed in the past. Thus a product's past history can play an important role in a their decision to use it. When examining the product's history, a builder/developer may look at four sub-categories: Usage by Other Builders, Projects Used In, Past Success/Failure, and Warranty Provisions (Jones 1992).

USAGE BY OTHER BUILDERS refers to anyone else who has used the product in the past. This may be very important to those wishing to adopt a product, since it has been already tested in the field.

PROJECTS USED IN refers to the type and scale of projects in which a product was used. This category can be a form of reference for the product to a builder/developer.

PAST SUCCESS/FAILURE may be important to builders/developers in order to determine a product's track record.

WARRANTY PROVISIONS refers to how well a manufacturer has honoured its commitment to the consumer. Builders/developers may prefer to deal with companies who guarantee their products (Friedman 1991, 9).

4.2 FORMING AN EVALUATION PROCEDURE

4.2.1 THE SURVEY

From the outset of this report, the key factor differentiating this research paper from past studies is that it considers factors of concern to builders/developers. An attempt was made to understand the industry in order to appreciate the diffusion of innovation to home building firms. The author interviewed builders/developers so that he might evaluate the validity of the above criteria used in adopting and rejecting innovative products.

Twelve builders/developers were chosen to be interviewed (Appendix A). They were randomly selected and, in the author's view, represent a cross-section of builders/developers in the Montreal-Ottawa region. The range in company size varied from those building an average of three homes to 350 homes per year. It was imperative to verify the validity of the above criteria by presenting them to builders/developers. Only by meeting with the subjects of this study, by listening to their criteria for adopting innovation, and by hearing

their opinions on the factors' importance could a reasonable understanding of the diffusion of innovation into the industry be achieved.

4.2.2 THE PRODUCTS CHOSEN

Thirty innovative products were chosen from NAHB's five major systems of the house (Figure 4.2). These products are profiled in Appendix B. The author gained familiarity with the products, at home and at trade shows, in research reports and in periodicals on innovation, by meeting with researchers, builders and salesmen, and through work experience in the industry. An attempt was made to choose products which had been documented in research reports, in order to gain greater insight into their diffusion. Consequently, some products may have been on the market for up to ten years. Other products were chosen for their degree of inventiveness, technical literature, cooperation from the manufacturer or distributor, and potential interest to readers of this report.

Brochures, technical information, and the cost for each product were placed in a binder which was divided into the five categories mentioned above. This allowed builders/developers to look at each product in an organized manner.

MAJOR SYSTEM	SUBSYSTEM	COMPONENTS
Foundation	General Basement/Crawl Space Slab Footing	
Structural Frame and Enclosure	Load Bearing and Non-Bearing Structure	Walls, Floors, Cladding, Partitions, Weather Barriers, Columns, Beams, Counters, Stairs, Ceilings, Insulation
	Roof And Chimney	Roof Trusses, Soffits, Guttering
	Openings	Windows, Doors
Plumbing and Sanitary	Pipes Fixtures	Toilets, Sinks Showers, Etc.
Heating, Ventilation and Air Conditioning (HVAC)	Heating and Cooling	Furnace, Compressors, Heatpump, Water Heater, Fireplace, and other Heating
	Ventilation	Fans, Ducts
Energy Supporting Systems	Electricity Gas Solar	Appliances, Wiring, Lighting, Meters, Pipes, Appliances

Figure 4.2: Functional Classification Of The House (Source: NAHB D 1989)

4.2.3 THE MATRIX

A matrix was designed to assist in collecting information on the importance of the evaluation criteria. The purpose of the matrix was to see which evaluation criteria were important for each product by each builder/developer being interviewed. They were also given the opportunity to add any missing factors. Columns were provided for the purpose of ranking in importance the five principal evaluation criteria and their sub-factors. Additionally, the matrix was designed to determine where builders/developers heard of each product, whether they had used it, and whether they liked each product (Appendix C).

4.2.4 INTERVIEW PROCEDURE

Twelve builders/developers were interviewed for approximately one to two hours each. All interviews were taped with the permission of the interviewee. Interview guidelines were established, as illustrated in Appendix D.

First, questions regarding the builder's/developer's firm were asked in order to attain a brief company profile. Then they were given a binder containing the thirty innovative products, enabling them to examine each product separately. The author proceeded to ask about their awareness and appreciation of the product. Finally, the builder/developer was asked which factors and sub-factors were important for each product in his decision to adopt or reject them, and ticks were placed in appropriate boxes illustrating a factor's importance. Builders/developers were permitted to add or eliminate factors to and from the matrix.

4.2.5 DATA ANALYSIS PROCEDURE

While this report is not a conclusive statistical analysis, several trends can be inferred from statistics. Therefore it was necessary to use statistical averages in order to

interpret the builders'/developers' views. This particular exercise is helpful since it is important to study what the builders/developers have to say, in order to ascertain their opinions on the validity of the evaluation criteria. Figures drawn from the data must be viewed within this context.

A summary table of all responses can be found in Appendix E. First, a ranking of importance for the five main factors and sub-factors was established by tabulating the number of ticks which each factor obtained and then by dividing this number by the total possible number of ticks in order to calculate a percentage. The factors were then placed in the appropriate order. The same was done for each sub-factor. The results indicate the importance of the evaluation criteria to the average builder interviewed.

A summary of the number of ticks which each product received in each sub-factor was tallied and placed in the summary table. By doing this, the author was able to summarize views on individual products in order to compare them with the views of conventional research. The awareness categories, usage, and like/dislike categories were evaluated in the same fashion Percentages were calculated for the awareness categories to clarify which were more important.

The author studied the results and compared them to research by other scholars. Clearly, these results are very helpful in understanding the opinions and the evaluation procedure of a sample of builders/developers in the industry.

All tapes of interviews were listened to, and important points were transcribed on paper. This information was then compared with other research on the subject. By compiling the various forms of data obtained from the interviews, i.e., through the summary table and tapes, the author was able to draw certain conclusions.

4.3 SUMMARY AND CONCLUSIONS

In studying the adoption of innovation in the North American home building industry, there is a need to look beyond the general reasons for the diffusion of innovation By attempting to determine the specific factors leading builders/developers to adopt or reject innovative products, this process of diffusion can be genuinely understood. To conclude:

* Evaluation criteria leading builders/developers to adopt or reject innovative products have been established.

* It is imperative to interview builders/developers in order to test the evaluation criteria.

* While this is not a conclusive statistical analysis, certain inferences can be drawn from apparent trends.

The following chapter reveals how the builders/developers responded in the interview to the factors comprising the evaluation criteria.

CHAPTER FIVE

BUILDER'S/DEVELOPER'S INSIGHT ON EVALUATION FACTORS

5.0 INTRODUCTION

> Men in general judge by their eyes rather than by their hands: because everyone is in a position to watch, few are in a position to come in close touch with you. Everyone sees what you appear to be, few experience what you really are.
> (Machiavelli 1981, 101)

The present chapter illustrates the builders'/developers' views, collected in the interview process, on the factors comprising the evaluation criteria. Each of the five main factors will be examined in the following order: Economic, Quality, Functionality, Marketability, Product History; and principal sub-factors will be discussed. An attempt will be made to illustrate where the author's findings differ from those of research in the field. Examples of products (outlined in Appendix B) demonstrating these differences will be provided.

The builders/developers quoted in the following pages will be referred to by a letter code in order to preserve their privacy. (The order of the letter coding does not correspond to the order of the builders/developers listed in Appendix A.)

5.1 ECONOMIC

Previous studies maintain that economic factors are of paramount importance to builders/developers in deciding upon innovation. As illustrated by Goldberg (NAHB E 1991, 30), "Research clearly indicates that economic advantage is the most important factor in influencing an innovation's acceptance."

Cost plays a critical role as an Economic factor. Duke's report entitled Local Building Codes and the Use of Cost Saving Methods (1988), discussed in the above NAHB report, suggests that "only the innovative methods that achieved the most substantial cost savings were adopted more frequently" (NAHB E 1991, 31).

In addition, as demonstrated in Charney's report (1971, 156-160), it is believed that the time savings achieved by a new product will significantly influence a builder's/developer's desire to use it. A product which speeds up the construction process will have a greater chance of being adopted.

Finally, researchers feel that financial "risk" is a crucial factor in a builder's/developer's decision-making process. As James F. Hickling Management Consultants explain (CMHC B 1989, 30): "Members of the low-rise residential construction industry have a low tolerance for risk. They will stay away from any innovation which carries a market risk, a competitive risk and **especially a financial risk**."

As opposed to what past studies convey about the importance of the Economic factor, the author has found, by interviewing builders/developers, that for certain builders/developers Economic factors are important in influencing the adoption of innovation whereas for others they are not.

For some builders/developers such as A, "Every decision made is affected by budget, not just what I can afford to spend but what my customers can afford to spend." He dislikes Corian, a cabinet countertop material, because its cost of $160 per linear foot is far too expensive for him and his customers. K who states that "cost and profitability are extremely important to us," and H who says that "my method of choosing products is by their price," would appear to agree with both builder A and with research on the topic.

Moreover, both builders/developers rejected the use of Corian because of its price even while acknowledging its superior quality.

However, C says that "our customers generally have a fortress mentality when it comes to housing. If a product is the best and most efficient to operate, I don't care how much it costs. Therefore we seldom look at economic factors." For him, Corian was rapidly adopted because of its superior quality and functionality. As well, it provides C with a market advantage because it is desired by his consumers. It should be noted that builder/developer C is an upscale custom home builder, and his clientele can afford more expensive products thereby allowing him to be less concerned with Economic factors. In addition, G who uses a marketing strategy in selling homes would appear to agree with builder/developer C, by stating that "if a product helps to sell a house I don't care about its cost." He uses polyurethane moulded millwork which costs $400 to $1000 per housing unit because it helps to promote the marketing of the house.

Builder/developer I has a different view with respect to Economic factors. He feels that "if a new product's price is within 5% of the currently used product's price, then cost is no longer a factor in adopting or rejecting it." Hence, for I, a 5% increase or reduction in the cost of construction will not affect his ability to sell homes or the profit which he expects. Nevertheless, the same builder does go on to say that "someone can bring me the greatest product in the world but if it is an expensive product and will add to the value, making my end product too costly, I will reject it very quickly." Therefore a product which will have tremendous impact on the cost of construction will not be accepted by I, unless he is willing to take a profit cut, because it will make his homes too expensive. For example, he rejects the use of Corian because it exceeds the 5% limit of increase in cost

and would make his final selling price of a home uncompetitive. However, he accepts the use of Open Joist 2000, a prefabricated joist, because it adds less than a 5% increase in his cost of construction, making it well worth the advantages it provides.

Time savings, as conveyed in past studies, are important for many builders/developers such as H and A, and unimportant for others like I. The importance of this criterion depends on the operational style of the firm in question. Time savings are crucial for builders/developers who operate on "hairline" schedules. A never used Sparlock, an interlocking cement block system used for common walls, but wants to because of the time he thinks it will save him in building them. Furthermore, a primary reason for H in adopting the prefabricated fireplace unit was the reduction in time which is gained from its use, in contrast to building a masonry fireplace. Nonetheless, builder/developer I feels that "time savings is only important in saving a trade." If a new product saves time by eliminating one of the many trades involved in construction, then it is worthwhile. He adopted the prefabricated fireplace unit because the company selling him the unit installs and guarantees it. Moreover, they are able to install the unit in a couple of hours, in contrast to the numerous days it takes to build a conventional fireplace. Therefore, by using the prefabricated fireplace unit, builder/developer I was able to eliminate the bricklayer trade specializing in fireplace construction and the metalworks trade who make the doors for the fireplace, resulting in the reduction of one trade. The fundamental difference here is that this new trade is responsible for its product and guarantees its work. Builder/developer I recognizes that time savings can be critical when working on a specific contract for a customer, but in most cases one should not be overly dependent on timing. He says:

> Timing is important but not the end-all. One week more or less is not the end of the world. In construction you are playing with weather and all kinds of elements, and if you are working on that kind of constraint (too tight of a schedule), you're doing something wrong.

Clearly, I's method of operation is different from his colleagues. He appears to be more organized and therefore less needy of shortcuts to deliver his product.

Although research suggests that builders/developers are reluctant to take risks in adopting or rejecting innovation, the author found that this was not always the case. Some builders/developers who agree, such as B, say that "we are very conservative and only use proven products that were used by others. I can't afford mistakes since they cost thousands of dollars." He rejects the use of Geothermique Thermopompe, a geothermal heating and cooling system, because the cost of replacing or fixing it, should it fail, would bankrupt him. In addition, C agrees, by expressing that he would use a certain product because "my grandfather used it and was never sued." He rejects the use of Excel, an exterior sheathing meant to eliminate the need for a housewrap, because in his region of construction plywood has always been used as an exterior sheathing and works effectively. Nevertheless, builder/developer I feels that "risk is not a main issue unless the product is so vital to the construction of a house." Therefore he rejects the Maytrab Building System, because it revolutionizes the way homes are built by changing the construction method from wood framing to metal framing. What remains clear is that each builder/developer has a different tolerance to risk, which affects how much risk they can afford. This is not simply determined by the size or wealth of the organization, since B and I are large firms. They are also acting on past experience and intuition, which differs from person to person.

To conclude, we have seen that the Economic factor, as an evaluation criterion, is not as important as suggested by past researchers to all builders/developers. Certain sub-factors are more important to some builders/developers than to others. The choice depends on the builder's/developer's method of operation and on his clientele.

5.2 QUALITY

Past studies by CMHC (B 1989) and NAHB (E 1991) propose that Quality is an important factor to builders/developers as an evaluation criterion when adopting innovations. Cordeau (1991, 16) suggests that builders/developers are believed to weigh strongly a product's quality prior to accepting it. Furthermore, innovators wishing to succeed "must offer a product which responds to the precise needs of the industry, which are impeccable quality, easy installation and less expensive than what's on the market." Goldberg and Shepard (NAHB C 1989, 14) agree and believe that "Quality related problems often cost the builder money. By eliminating these problems, the builder not only enhances quality, but achieves significant cost reductions."

Whether other players use an innovation or not is an important Quality factor, since "many builders prefer to follow rather than take the lead in adopting innovations" (NAHB C 1989, 27). Undoubtedly, builders/developers look to their peers prior to adopting innovations.

Further, it is believed by James F. Hickling Management Consultants that builders/developers examine the proven success of a product prior to adopting it. As they illustrate in their report (CMHC B 1989, 20), "Innovators normally play an important role,

they perform the economic, social and psychological risk assessment for the entire community. Because the low rise residential construction industry's community is generally localized, every innovation has to diffuse again and again in each microcosm."

Liability is considered by James F. Hickling Management Consultants as an important factor for builders/developers in the evaluation criteria. As they proclaim in the above report, "There exists a fear of liability which is perhaps one of the greatest deterrents to innovation in the industry" (CMHC B 1989, 21).

Finally, it is suggested that builders/developers address the value of a product in considering its adoption. Goldberg (NAHB E 1991, 98) believes that value is an important evaluation criterion because "firms often charge a premium price for a given product for enhanced engineering efficiency."

By interviewing builders/developers, the author has found that the above studies are in accordance with their views. Most builders/developers are concerned with the quality of a product. However, not all sub-factors are considered important to all builders/developers.

For example, some are not concerned with other players using a product. They appear to have more confidence in their own ability to discern if a product is feasible for them. A says that he is not concerned with whoever else is using a product. His view may be due to his hands-on experience at the construction site. He disliked the Open Joist 2000 product because he feels it is inferior to conventional joists. Nevertheless, nine out of the twelve builders/developers interviewed liked it. Others like B are interested in knowing who else is using a particular product and would only use products used successfully by others. For example, he likes Parallam which is an engineered factory-made wood beam, capable of larger-than-conventional spans and loading, because all other builders/developers he

knows have used it successfully. Moreover, out of the twelve builders interviewed, eleven were in favour of using it.

Most builders/developers think that proven success is an important evaluation criterion and feel that it is imperative to know if a product works as it is supposed to. As F explains, "When a product like Therma-Ray, a ceiling radiant heating system, exists for such a long time and it is not widely known nor advertised, then something is wrong with the product." As past research indicates, builders/developers are concerned with a product's proven success.

Most builders/developers express concern over liability, as an evaluation criterion, when assessing a product. C explains that "you tend to be conservative because of the large amount of dollars at stake and you don't want to use something which you suspect may cause problems." For this reason, he rejects the use of preserved wood foundations. In his view the liability which could ensue if the foundation fails is too high. Furthermore, builders/developers are concerned with long-term liability. As H states, "I have to guarantee the house and product for five years. I'm responsible for any new product used." This was one reason for his adoption of the prefabricated fireplace unit. As expressed above, the companies installing the units are liable. eliminating the liability of the builder/developer for faulty fireplaces. Nevertheless, some builders/developers, such as A, are not concerned with liability. He explains by saying that liability is not important to him because of the high quality of his work. In general, most builders/developers are concerned with liability, as demonstrated in past research work, because they might have difficulty in sustaining the financial losses which could ensue from defective products. Some builders/developers, however, such as A, were not worried because of the confidence they have in their product.

Goldberg (NAHB E 1991), suggests that builders/developers feel that value is an important factor in the evaluation criterion. They often chose products which have better value, as is the case with A who explains, "We use BP High Performance Sheathing because it is more solid than regular sheathing. When using regular sheathing you break half of them as opposed to High Performance Sheathing." Likewise, builder/developer I feels that value is an important criterion when examining products, since he is interested in knowing more about what a product gives him, and if it is better. He adopted the prefabricated shower unit because it is a far superior product than conventional showers built from ceramic tiles. A prefabricated shower unit lasts a life time while a ceramic shower starts to deteriorate after three years.

Undoubtedly, builders/developers agree with past research on the importance of Quality as an evaluation criteria, and most sub-factors are seen by them as being significant. This is best explained by builders'/developers' pride in their work and their concern for their reputations.

5.3 FUNCTIONALITY

Functionality, a factor used to evaluate a product's ability to function within the operational structure of the home building industry, is viewed by James F. Hickling Management Consultants as a crucial factor in the evaluation criteria. They feel that the functionality of an innovation is important to builders/developers because "functional innovations [Functionality] are the least disruptive. They occur naturally in the evolution of a product and they involve the use of a known product in a related field in the same

industry" (CMHC B 1989, 22). Functional innovations are ones which work within the operational structure of the home building firm.

Code requirements, a sub-factor of Functionality, are deemed of paramount importance in a builder's/developer's selection of products. As Jones explains in his article, "Roadblocks To Technology" (1992, 174):

> In the end the burden usually falls on the builder to get approval for an innovation that doesn't meet the code. The builder must prove that the new method satisfies performance standards by presenting test evidence collected at his own expense. Few can afford such an ordeal.

In addition, some think that builders/developers are concerned with the complexity of a product prior to its adoption. James F. Hickling Management Consultants believe that "product complexity or at least perceived complexity [by builders/developers] is a barrier to diffusion" (CMHC B 1989 45).

It is also believed that builders/developers consider product support as a significant evaluation criterion. Builders/developers want to ensure that the company producing a product is secure enough to support it financially and technically. As explained by James F. Hickling Management Consultants (CMHC B 1989, 45), "The strength of the company launching a product can influence the pace of adoption."

Goldberg and Shepard feel that builders/developers look at the competitive advantage of products prior to accepting them. A product which allows builders/developers to crush the competition will be welcomed (NAHB C 1989, 78).

The effect on home delivery process is considered, by Cordeau, as one of the most important sub-factors to builders/developers in the evaluation process. Builders/developers verify that any new innovation does not change their method of construction. As Cordeau

(1991, 16) explains, "The golden rule for an innovator is never look to change or revolutionize the structure of the home building industry."

Finally, James F. Hickling Management Consultants maintain that builders/developers examine a product to see if it is a direct substitute for an existing product. Builders/developers are fond of direct substitutes, because "direct substitute innovations maintain the essential characteristics of the previous product and add one or more comparative advantages either in terms of immediacy or magnitude of benefits" (CMHC B 1989, 23).

Through his interviews, the author has found the above researchers to be correct in suggesting the worthiness of Functionality as an evaluation criterion. Most of the sub-factors comprising Functionality are also viewed by builders/developers as being pertinent.

Code requirements is the only sub-factor which they ignored. This occurred not because of its lack of importance but because most builders/developers only look at products which meet the requirements. As A explains, "On'y products which have passed the required tests come through this door." This explains why very few builder/developers, as illustrated in the summary table, used this criterion when examining the products in this study. Therefore code requirement, as an evaluation factor, is not an issue to them.

Complexity, as indicated in research, is considered to be extremely important to builders/developers. Generally, most builders/developers interviewed are concerned with their ability to understand how a product functions and their men's ability to easily use and repair the product. C explains this point with reference to Smart House technology:

> Smart House technology is an attempt to sell us what we don't need. My concern is in making housing simple. What happens when something goes wrong? Who fixes it? You are

> adding an unnecessary layer of complexity, besides who wants your house to call you at work to tell you that it is broken!

Consequently, he chose to reject the use of Smart House technology because of its complexity.

Builders/developers are concerned with product support as an evaluation criterion. However, it certainly is not their most important measure. They feel that it is vital to know that a company is easy to deal with and able to deliver products on time. They especially favour companies which have strong technical assistance available to them. For example, L uses the Open Joist 2000 product because it comes with installation plans and company engineers made available for consultation on the construction site. Furthermore C, B, and I all felt the same way.

As indicated by past research, the effect on the home delivery process is a crucial sub-factor in the evaluation criteria. Builders/developers feel that it is important for a product to work within their method of construction. K explains that "in the act of building a house there are many people involved. It is a very complicated process. A material which overcomes a problem I have, technically or time-wise, and simplifies the construction process, will be closely examined." For this reason he wants to use Excel by BP. Excel is an exterior sheathing which eliminates the need for house wrap thus saving a step in the construction process. Furthermore, nine other builders interviewed also felt the same way.

Builders/developers agree with past research on the importance of direct substitute as an evaluation sub-factor. They believe that a product which is simply an improved version of an existing product will have a better chance of adoption. Hence, L is interested in knowing if a new product works and if it is installed in the same manner as the

preceding product. L wants to adopt the motion sensor light switch, aside from practical advantages, because it is installed connecting the same two wires as a standard light switch. Furthermore, C adopted the I Joist, a prefabricated wood joist, because it is installed in the same manner as a conventional joist. Using this product, carpenters do not have to relearn how to install joists.

Clearly, Functionality is an important evaluation criteria in the eyes of researchers and builders/developers. The only discrepancy in views came over the matter of code requirements. Builders/developers found this sub-factor irrelevant since they only look at code-approved products.

5.4 MARKETABILITY

Studies by CMHC and NAHB consider Marketability to be an important factor in a builder's/developer's evaluation criteria. They propose that due to the competitiveness of the home building industry, builders/developers look at the competitive advantage which a product gives over an alternative one, and they are more likely to adopt products which provide greater marketing advantages. Jones (1992, 174) explains this point by illustrating the actions of one builder/developer in Northern Iowa:

> Building in a depressed housing market eight years ago, Bill Eich decided to establish his company as the Energy Experts Of Northern Iowa. Besides beefing up insulation and upgrading windows, he installed controlled ventilation systems in all of his houses. Now more than half of the houses built in his country have controlled ventilation. [Bill Eich remarks:] "It doesn't have to take long for builders to adopt an innovation as long as someone is out there beating the bushes."

Once other builders saw the marketing advantages gained from using controlled ventilation systems, they quickly adopted them.

In addition, James F. Hickling Management Consultants (CMHC B 1989, 14) believe that consumer demand is important to builders/developers when adopting innovation, because builders/developers provide what the consumer yearns for and will use any product they desire. Clearly, "where the innovation is not supported by consumer demand and has no immediate or obvious significant comparative advantage to the builder or trades person, it has very little prospect of diffusion success" (CMHC B 1989, 44)

The majority of research reports do not dwell on increased social status as an evaluation criterion, however most feel that builders/developers use this as an evaluation criterion (NAHB E 1991, 30). Friedman (1993) believes that builders/developers are concerned with their social status in the industry and are interested in using products which improve their reputations.

Visible/invisible[1] factors are believed [Rogers (1983), Goldberg (NAHB E 1991), Shepard (NAHB C 1989), Friedman (1993), James F. Hickling Management Consultants, Duff & Poitras (1988)] to play an important role as an evaluation criterion to builders/developers, because visible products have a better chance of being adopted by them than invisible ones. James F. Hickling Management Consultants (CMHC B 1989, 23) believe that "invisible innovations are not supported by consumer demand and have no immediate or obvious significant comparative advantage in terms of cost, time saving or availability to the builder or trade person." On the other hand, visible innovations are seen

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[1]Visible innovations are ones which can be seen by the consumer, and invisible innovations are hidden from the consumer, often behind closed walls.

as the "hot buttons" which builders/developers use to entice customers into buying their homes.

Finally, Duff and Poitras (SHQ 1988, 22) believe that builders/developers use consumer awareness as an evaluation criterion and maintain that most consumers, because of their ignorance of innovation in the industry, make few demands on builders/developers to innovate. Consequently, they will examine whether the consumers have heard of a product prior to using it. The use of an unknown product can cause the buyer to be wary of the builder/developer.

Some builders/developers are strongly in favour of Marketability as an evaluation criteria while others are less enthusiastic. Those in favour of it feel that Marketability is an important evaluation criterion because their role today, as expressed by F, is "building people's lifestyles." Therefore they look at a product for its potential marketability. For example, builder/developer A says that "Open Joists 2000 means that customers can finish the basements themselves," since they can run all the services through them without drilling holes. However others, like J who is an engineer and a knowledgeable builder, do not evaluate products only in terms of their marketability. For example, he rejected the use of Panisox's Structural insulated Panels, a foam core sandwich panel system, because he felt that there would be numerous engineering problems with the product. He believed that cutting holes in the panel for windows would be very difficult. Moreover, he felt that the panels were not flexible enough to respond to changes in plans which occur on site.

Competitive advantage is seen by most builders/developers as an important evaluation criterion. As F explains, "It is always a question of marketing: what product will help you sell." Builders/developers must weigh the competitive advantage which a given

product will provide. For this reason, F likes the thermopompe which provides heating and cooling.

Some builders/developers feel that consumer demand is an important evaluation criterion, as research suggests, while others do not. It is important to F, because "a new product which is not known has to be sold to the consumer. Therefore you must consider this when you go for a new product." Consequently he did not adopt polybutylene water piping, a replacement for copper, until it was widely accepted in the industry. Others feel that the consumer does not care about what you are using and is only looking at the finished product. As builder/developer I explains, "They [the consumers] don't care about the type of insulation. They know if the floor squeaks, it's no good." Therefore, for I, consumer demand plays a less important role as an evaluation criterion, because most of his customers are not concerned with the actual details of a house.

Increased social status is considered important to some builders/developers and insignificant to others. L is concerned about his status in the industry. This may be due to his small size, in contrast to other builders/developers. However, A who is significantly larger and more successful than L is not concerned with what others think of him and is not interested in getting reviewed in building magazines.

Past research regarding visible/invisible factors as an evaluation criterion is largely in accordance with how builders/developers think. Innovations which can be detected by consumers can be used in marketing. Builders/developers do not preclude invisible innovations from being adopted. They believe that the overall quality of the house is important. For example, L uses concrete walls to separate semi-detached houses because he believes that although you can not see the blocks, they help to sell homes.

Visible/invisible factors are important to builders/developers as an evaluation criterion, even though they may have different views on the nature of their importance.

Lastly, consumer awareness serves as an important evaluation criterion to builders/developers. Some feel that consumers are ignorant about innovation and that one must be careful not to scare the consumer with new products. Nonetheless, other builders/developers think differently. J says that he uses Tyvek, a housewrap, as a marketing ploy because of consumers' familiarity with it.

Explicitly, Marketability is not important to all builders/developers. Its importance is dependent upon the operational method of a home building firm. Those who see themselves as promoters rely more heavily on Marketability as an evaluation criterion.

5.5 PRODUCT HISTORY

Research by CMHC and SHQ indicates that Product History is an important evaluation criterion. Usage by other builders, projects used in, past success/failure, and warranty provisions all influence a builder's/developer's decision when adopting an innovation.

Builders/developers look at their colleagues' past experiences when they are considering adopting a product. Furthermore, they examine the type and location of the projects in which a given product was used, and they try to determine if the product was implemented successfully. CMHC recognizes the importance of the above factors and explains that they must provide builders/developers with this vital information. In one research report, they suggested that "the risk aversion of builders and other low-rise

residential construction industry participants indicates the usefulness of including up-to-date diffusion-related information, who is using what, where, and their experience" (CMHC B 1989, 46).

Other studies tend to agree that builders/developers look at the above evaluation criteria prior to adopting innovation. Duff and Poitras (SHQ 1988, 13) further explain this point by maintaining that "technological development only becomes accepted in Quebec once they have been developed and tested elsewhere, particularly in the United States..."

Through interviewing builders/developers, the author has found that some are concerned with Product History and others are not. G feels that it is very important to him because he knows very little about construction. Consequently, he rejected the use of Excel Board, an exterior sheathing to which stucco can be directly applied without using metal lathing, because he wanted to know about the product's history in Quebec. Builder/developer I is an engineer and is not concerned with a product's history. Being an engineer, he is capable of choosing products by examining their technical specifications. Because of his understanding of construction, he does not have to rely on a product's history as an evaluation criterion. As a result, by looking at the technical specifications for V Joist, a prefabricated joist, he was able to decide that the product was not suitable for his needs.

Builders/developers express greater concern over the sub-factor, projects used in, as opposed to the other sub-factor, usage by other builders. They feel that the location in which a product had been used is crucial in their evaluation process. F explains that "many new products achieve success in hot climates which are different from ours, and when you bring them to Quebec, because of climatic differences, they fail." He was sceptical of Excel

Board, speculating that the stucco would eventually crack in our climate from not having a metal lathe backing.

Past success/failure is an important factor for builders/developers. I, who claims that Product History is not an important evaluation criterion for him, feels that this sub-factor is important for certain products. He explains his views with reference to prefabricated fireplaces. "I buy fireplaces based on reputation. I don't shop because I want to know that it will be safe." As well, H thinks that this factor is important because "you have long-term problems in products which appear after ten years. Therefore a product without a proven ten-year track record has a lesser chance of being adopted."

In conclusion, Product History is used by builders/developers as an evaluation criterion, however its importance depends on their past experience in the industry, as well as on the products being examined.

5.6 SUMMARY AND CONCLUSIONS

This chapter has attempted to illustrate builders'/developers' views on the evaluation criteria by interviewing them in order to experience and convey their ideas firsthand. To conclude:

* Although research put forth by NAHB and CMHC stipulates that Economic factors are of paramount importance to builders/developers as an evaluation criterion, not all builders/developers agreed with researchers. It was judged as being more important for certain builders/developers such as A, K, H than for others like C.

* Builders/developers were in agreement with the views of Cordeau (1991), Goldberg (NAHB E 1991) and Shepard (NAHB B 1989) on the importance of Quality as an evaluation criterion. However, there were some disagreements over the pertinence of sub-factors: other players using it, and liability.

* Builders/developers and researchers both feel that Functionality is a significant evaluation criterion. Nonetheless, those who only use code-approved products did not find it necessary to look at code requirements (a sub-factor) when evaluating products.

* Although research institutions like CMHC and NAHB believe that Marketability is an important factor in the evaluation criteria, some builders/developers agree and others disagree. A and F use marketable products like Open Joist 2000 to help sell homes. J, who disagreed, felt that customers do not look at the details of homes but at the overall package. Often, builders'/developers' opinion on the importance of Marketability was linked directly to their approach to selling homes.

* Product History was used by most interviewees as an evaluation criterion. However, its relevance depended on the builder/developer and the product being examined. Generally, those who had a less technical background in construction were more interested in a product's history.

Now that we have examined the builders'/developers' views and researchers' views on the evaluation criteria, the author will draw specific conclusions in the following, final chapter on the diffusion of innovation in North American home building firms.

CHAPTER SIX

BUILDER'S/DEVELOPER'S EVALUATIVE PROCESS FOR INNOVATIVE PRODUCTS

6.0 INTRODUCTION

The following constitutes the final chapter of this report, and it is divided into four sections. The first section presents a simplistic model which builders/developers use in adopting innovation. The second section illustrates how, in order to understand truly builders'/developers' decisions on technology, we must break away from simplistic models and go one step further in our analysis. The third section discusses the issue of conservatism vis-à-vis builders/developers. Finally, the fourth section provides recommendations to companies attempting to diffuse innovation in home building firms.

6.1 THE SIMPLISTIC DECISION-MAKING MODEL

Through interviewing builders/developers the author has developed a simplistic decision-making model, as depicted in Figure 6.1, to illustrate their adoption process.

This model was achieved by ranking the responses of builders/developers, when shown different products, to the importance of the five main factors and sub-factors of the evaluation criteria. A detailed numeric description can be found in the summary table in appendix E. It is imperative to understand that the simplistic model reveals the average builder's/developer's ranking of the importance of the factors in the evaluation criteria.

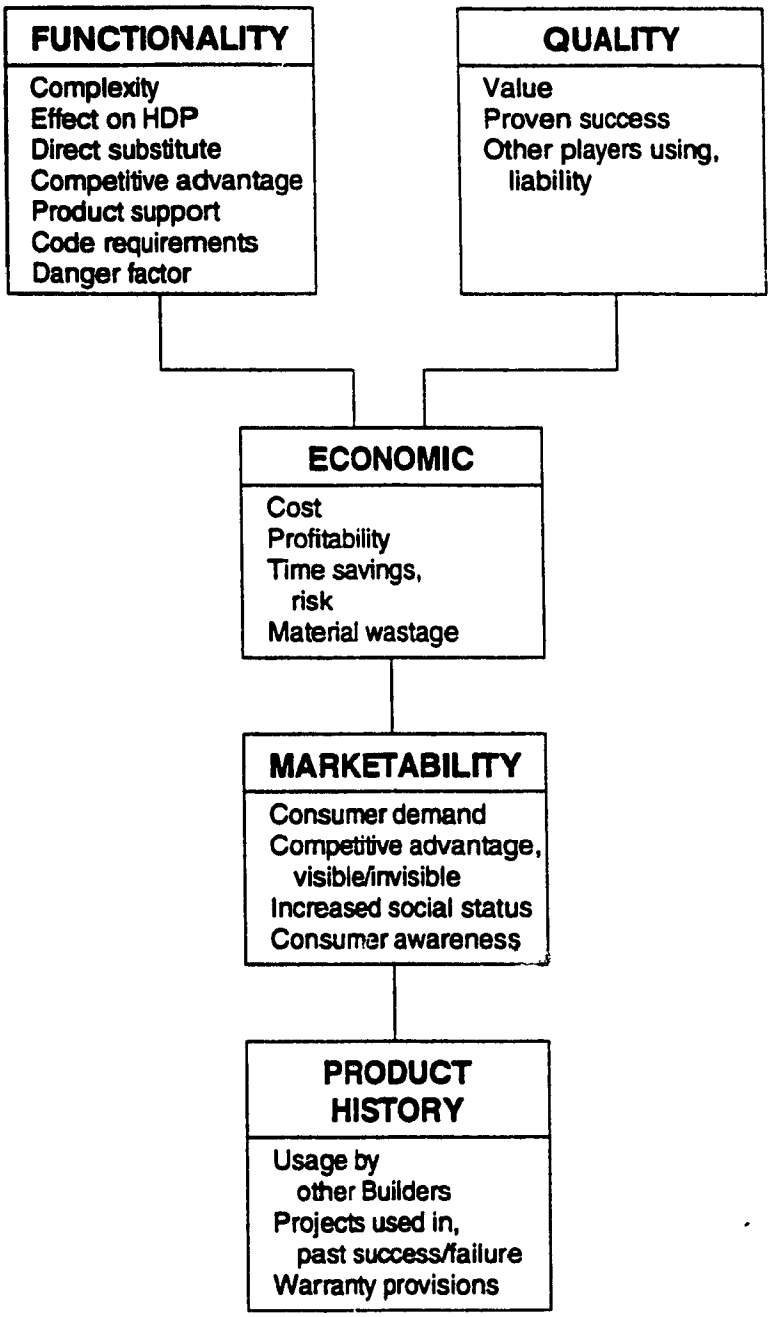

Figure 6.1: The Simplistic Model

This model enables us to appreciate in basic terms the steps which builders/developers go through when deciding upon innovation. To understand fully their decision-making process it is necessary to move beyond simple models.

6.2 BREAKING AWAY FROM SIMPLICITY

> Probably the most important fundamental that is being ignored today is staying close to the customer to satisfy his needs and anticipate his wants. In too many companies the customer has become a bloody nuisance whose unpredictable behaviour damages carefully made strategic plans, whose activities mess up computer operations, and who stubbornly insists that purchased products should work.
>
> (Lew Young, Editor-in-Chief, Business Week, Peters & Waterman 1982, 156)

If one views the builder/developer as the customer, one can surely appreciate the above paragraph. Too many research reports (cited in this report) and companies attempting to diffuse innovation in the home building industry do so from an elementary understanding of builders/developers. Their use of simplistic models to illustrate the builders'/developers' decision-making process fails to guarantee a product's diffusion, because of the models' rudimentary nature.

By interviewing builders/developers and by listening to their views, it became clear that they are not a homogeneous group. There is no single type of training for builders/developers, and consequently they have different backgrounds. For example, builder/developer A graduated with a Bachelor Of Science degree and then went on to work in the garment industry. He proceeded to open his own fish retail business and then became a builder/developer. I has a university degree in Civil Engineering, and L started out as a

carpenter. Because they are different, they adopt and reject products for different reasons. These reasons are directly related to their dissimilar backgrounds. As C explains, "I evaluate each product in a specific context. For example, I evaluate Therma-Ray panels in the context of what I know about Eswa panels and concerns I have about how people live in houses. Therefore, you are always associating your decision to adopt with past experiences. Hence, you get different contexts in which you place materials to evaluate."

As illustrated in Figure 6.2, the particular method of adopting innovation depends on the builder/developer, his background and experience in the industry, the project on which he is working, and the product itself. Because numerous factors influence a builder's/developer's decision-making, no model depicting this process can be used to guarantee the successful diffusion of an innovation. Each one has his own method and his own model for adopting innovation. As F explains, "There is no rule for choosing products, no method for our adoption of innovation. You cannot say, `Follow this list and products will be accepted.' Certain factors are important at different times. What is important is to keep your ears and mind open." It is evident, however, that all factors in the evaluation criteria are important to different builders/developers at different times.

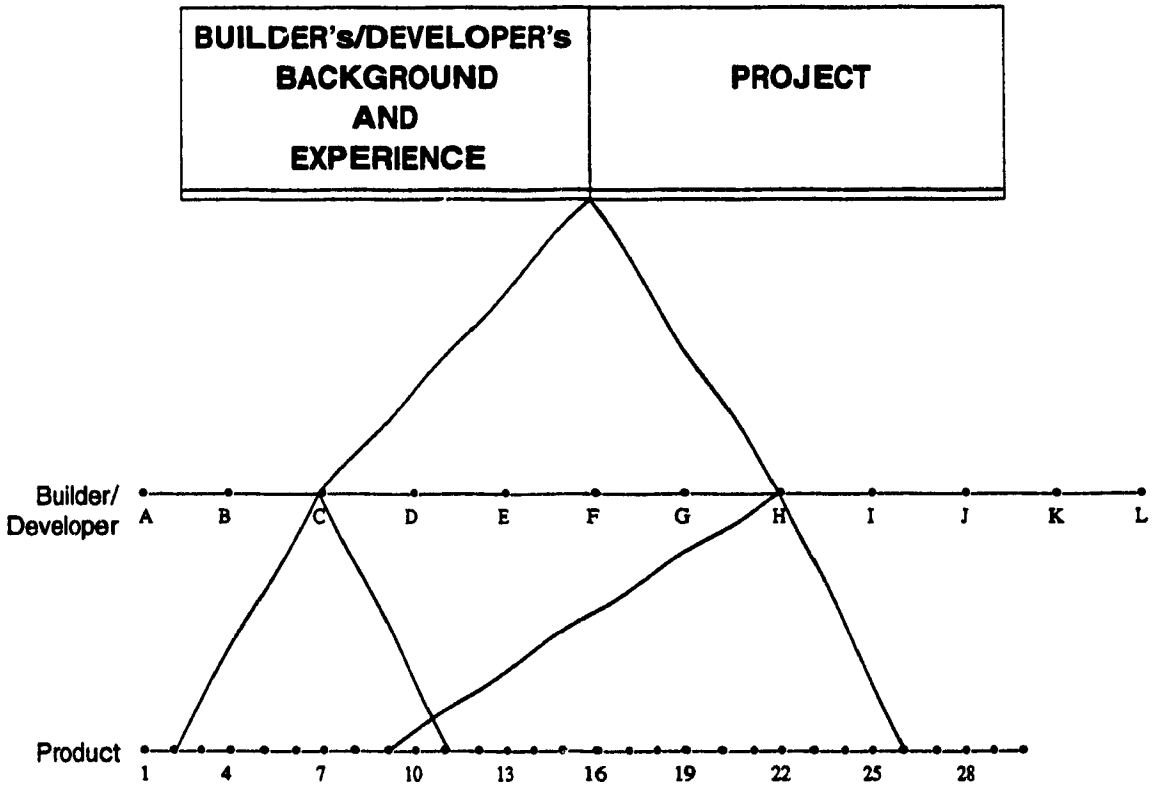

Figure 6.2: Builder's/Developer's Evaluative Process For Innovation (Source: After Friedman 1993)

6.3 THE CONSERVATIVE NATURE OF BUILDERS/DEVELOPERS

Charney (1971), Goldberg & Shepard (NAHB C 1989), James F. Hickling Management Consultants (CMHC B 1989), Duff & Poitras (SHQ 1988), all view builders/developers as being conservative and reluctant to take risks in trying new products.

The author believes that builders/developers are conservative when adopting innovation, but in a positive sense. In order to understand this point, let us recognize the plain meaning of being "conservative." As defined in the Concise Oxford Dictionary (1991), one is conservative when being moderate or cautious. President Lincoln in his address at Cooper Union in New York in 1860 defined conservatism as "adherence to the old and tried, against the new and untried" (Bartlet 1982, 520).

The conservative nature of builders/developers can be equated with wise consumerism. They understand their industry. They know which products will help them to build and sell homes and so they choose accordingly.

They are reluctant to select products which do not give them clear-cut advantages. For example, certain products are rejected because they are perceived to be too difficult to use regardless of their engineering superiority. Other products have no consumer demand, while some are financially "too" risky. Therefore, builders/developers reject products which cause rather than eliminate problems. Critics who suggest that builders/developers are reluctant to try new products do not recognize that most of the time the products being rejected do not fit their methods of operation or goals.

To conclude, builders'/developers' conservative nature allows them "to survive" in a difficult industry. They act as wise and cautious consumers and are wary of products which potentially spell disaster.

6.4 RECOMMENDATIONS TO INNOVATORS

In conclusion, although no model indicating a builder's/developer's decision-making process can be established to guarantee the successful diffusion of an innovation, certain guidelines can be followed. The following section recommends to innovators principles which should be considered prior to launching an innovation. They by no means guarantee that a product will be accepted by builders/developers.

ONE Innovation is a means of keeping the home building industry efficient, productive, and competitive. Innovations which enhance these goals will have an increased likelihood of being adopted. For example, drywall was eventually accepted by builders/developers as a replacement for plaster and mesh wall construction because it met these criteria.

TWO It is essential to understand the "mindset" of builders/developers prior to launching an innovation. They are a unique group of visionaries who command enough ambition and perseverance to succeed. When an innovation enables them to succeed, these entrepreneurs embrace it as a tool of development. Their entrepreneurial spirit must be understood by innovators because it can aid them in diffusing innovation.

THREE The organizational structure of the home building firm influences the types of innovations which will be accepted. The typical firm is very small and has under five employees. Overhead costs are kept to a minimum in order to withstand periods of economic slowdown. Most home building firms do not have the capital to invest in expensive and risky innovations. This was a principal reason why eleven out of twelve builders/developers, interviewed in this report, rejected preserved wood foundations.

FOUR Builders/developers run all aspects of their firms and make the final decisions. They should be approached directly with any new product. However, one must keep in mind that they do not have time to read lengthy brochures or to learn about highly complicated products. Simple products with readable brochures have a better chance of being examined.

FIVE

Since the Second World War, the construction site has evolved into a highly efficient "assembly line" process of construction. Downtime and delays are unacceptable because of their enormous costs. Profit margins in housing today are small, running between 9%-12%. It is essential that builders/developers construct homes rapidly and efficiently. An innovation which requires workers to relearn their job breaks down this efficient system. Consequently, it will have less chance of being adopted. Eight out of the twelve builders interviewed liked the I Joist product because it is cut and installed in the same manner as a conventional joist and, therefore, does not hamper the construction process.

SIX

Home building firms use the services of designers and architects. Neither, however, has much influence on builders'/developers' decisions on technology. Innovators must take this into consideration when targeting their advertisements. Furthermore, the designers, as a group, are often ignored in advertisements, but they should be targeted since many builders/developers do use their services.

SEVEN

Sub-trades are an under-utilized avenue to diffuse innovation into the home building industry. They have a tremendous influence on builders'/developers' decisions to innovate and will frequently recommend products in their particular trade. They consider products which decrease their material costs and increase their efficiency. For example, eight out of the twelve builders/developers interviewed accepted the use of Polybutylene piping based on their plumbers' recommendations. Therefore, innovations which relate directly to specific sub-trades should be targeted at them.

EIGHT

Sub-contracting firms are smaller than home building firms and less able to afford expensive equipment costs. Therefore, innovations which require sub-contractors to invest in expensive tools will take longer to be adopted. Manufacturers should attempt to provide special financing or to give certain tools, required to use a product, to the sub-contractors. For example, in the case of Polybutylene piping, some plumbing sub-contractors have not adopted it because it costs approximately $800 for the pliers necessary to install it. The manufacturer of Polybutylene pipes could provide promotional deals to sub-contractors, such as discounts on these tools.

NINE Most of the work on the construction site is done by sub-contractors. Often, as expressed by builder/developer K, 40 sub-trades work in the construction of one house. They communicate directly to the builder/developer and not between themselves. Therefore, an innovation should not span trades. A product like Panisox, a structural insulated panel, which requires carpenters and electricians to work together in order to ensure that the electrical work is done properly, can cause coordination problems on the construction site.

TEN The diffusion of innovation results in social change and, therefore, is a complicated and lengthy process. An innovator must be prepared to withstand the years it takes for products to diffuse. Furthermore, the diffusion of innovation is a process of evolution rather than revolution, so overnight success stories are rare. Corian, a counter surface, was invented in the early 1970's by Dupont. By 1987 it had only achieved a 2% market penetration.

ELEVEN The diffusion of innovation is part of a process of technology push and market pull. There must be a need for a particular product in order for it to succeed. The diffusion of the prefabricated roof truss, as illustrated in Chapter Three, succeeded in the postwar period because there was a need for a more efficient roof construction system which would reduce labour input and materials. At the same time, truss companies were promoting their products.

TWELVE Innovators must work with organizations which act as gatekeepers to the diffusion of innovation. They should be directly approached with products in order to ascertain their views. Government legislation prohibited the use of electrical outlets in bathrooms with the exception of the safety razor outlet. This led companies like Leviton to invent Ground Fault Circuit Interrupter outlets which were safe to use near water. It won governmental approval which gave it a tremendous advantage in the market. Companies like Kohler could benefit by using this strategy. They could try to get government legislation to require the use of their water efficient "Lite" toilets.

THIRTEEN Innovation must be viewed in terms of the relative advantage it provides, its compatibility, its complexity, triability, and communicability. Products like Fypon Molded Millwork, a polyurethane moulding, has the relative advantage of lasting for life. It is compatible since it is applied in the same manner as a

normal moulding. It is very simple to use, and there is very little risk that the product will fail. Finally, the consumer is able to see it because of its visibility, which means it has a better chance of diffusing. Consequently, eight out of the twelve builders/developers interviewed liked the product.

FOURTEEN Builders/developers examine innovation in terms of economics, quality, functionality, marketability, and product history. The importance of each factor depends on the individual builder/developer, the product, and the project.

FIFTEEN Builders/developers may accept a product which is more expensive than the product it is replacing if the new product provides desirable advantages. For example, L chose to use Excel, an exterior sheathing, which is more expensive than conventional sheathing, because it eliminates the need for a house-wrap and therefore saves a step in construction. Moreover, it is a sturdier material than regular sheathing and keeps the framing of a house straighter.

SIXTEEN Innovators must comprehend that although certain new products are less expensive than currently-used products, sub-trades do not always pass on the savings to the builder/developer. Plumbers have not reduced their fees by using Polybutylene piping, and they will charge builders/developers more if they want copper piping.

SEVENTEEN Innovators must bear in mind that simplistic models illustrating the decision-making process of builders/developers can only serve as very basic models and must not be used for more than a general understanding of the subject.

EIGHTEEN Builders/developers are not a homogeneous group. They come from diverse backgrounds and have different experiences. Innovators must never presume that all builders/developers will examine a product identically.

NINETEEN As illustrated in the summary table (Appendix E), Home Shows are not successful at diffusing innovation to builders/developers. They must be restructured if they are to be used successfully for this purpose.

TWENTY Salesmen were the most frequent source, according to the builders/developers interviewed, of the diffusion of innovation. Innovators should consider this when launching a product.

TWENTY ONE Builders/developers read more than is commonly believed. As was made clear in the interviews, media served as the second most important source of hearing about innovations. Therefore, advertisements should be directed towards them and kept brief.

TWENTY TWO Material suppliers are a forgotten source of innovation diffusion. Builders/developers are always in contact with them: ordering materials, getting prices, and even asking for advice on materials. They can therefore be promoters of new products. Furthermore, many suppliers have their salesmen visit sites to ensure that materials are being installed correctly and to explain to workers how to use new products.

The diffusion of innovation into the home building industry is a complex and difficult process. It requires innovators with patience, perseverance, and open minds. As Schon suggests (Peters & Waterman 1982. 200):

> The new idea either finds a champion or dies...No ordinary involvement with a new idea provides the energy required to cope with the indifference and resistance that major technological change provokes...Champions of new inventions display persistence and courage of heroic quality.

By understanding the home building industry and the diffusion process, this task can be made easier. There are no guarantees of success to innovators, but once builders/developers are satisfied with a product they are reluctant to replace it. The financial gains of success make the attempt to diffuse an innovation definitely worthwhile.

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APPENDIX A

COMPANY PROFILES OF BUILDERS/DEVELOPERS INTERVIEWED

COMPANY:	Alabec Construction Ltée
ADDRESS:	2155 rue Guy Montréal, Québec H3H 2R9
TEL:	(514) 937-9327
FAX:	(514) 937-8632
DATE OF INTERVIEW:	August 14, 1993
TIME:	10:00
PERSON INTERVIEWED:	Joe Levine, ing.
AGE:	n/a
POSITION:	President
YEAR FIRM ESTABLISHED:	1979
MAIN AREA OF WORK:	Residential, Office, and Hotel Construction
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 450 10-100
PRICE RANGE OF UNITS($):	45 000 - 400 000
LOCATION(S) OF CONSTRUCTION:	Lasalle, Laval, Ste-Agathe
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	10 Most 4 0
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	n/a

COMPANY:	Anobid Construction Corporation
ADDRESS:	3901 Jean Talon ouest Suite 305 Ville Mont Royal, Québec H3R 2G4
TEL:	(514) 733-5106
FAX:	(514) 341-0058
DATE OF INTERVIEW:	August 13, 1993
TIME:	13:00
PERSON INTERVIEWED:	José A. Martinez DiBona, Ing. M.B.A.
AGE:	39
POSITION:	President
YEAR FIRM ESTABLISHED:	1986
MAIN AREA OF WORK:	Residential, General Contracting, Construction Management
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 30 15-20
PRICE RANGE OF UNITS($):	85 000 - 95 000
LOCATION(S) OF CONSTRUCTION:	Laval
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	3 3 0 0
FIRM'S OVERHEAD($):	150 000
AVERAGE SALES PER YEAR($):	1-2 million

COMPANY:	Dara Construction Ltée
ADDRESS:	245 Victoria Suite 100 Westmount, Québec H3Z 2M6
TEL:	(514) 932-4191
FAX:	(514) 932-6931
DATE OF INTERVIEW:	August 12, 1993
TIME:	14:00
PERSON INTERVIEWED:	Alex Turner, Bsc.
AGE:	39
POSITION:	Share Holder & Project Manager
NAME & AGE OF PRESIDENT:	Bill Kahane, 67
YEAR FIRM ESTABLISHED:	1988
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 120 50-80
PRICE RANGE OF UNITS($):	90 000 - 130 000
LOCATION(S) OF CONSTRUCTION:	Boisbriand, St. Constant, Ville St-Pierre, Pierrefonds
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	5 3 3 2
FIRM'S OVERHEAD($):	10 000
AVERAGE SALES PER YEAR($):	1.5 million

COMPANY:	Drerup Armstrong
ADDRESS:	P.O. Box 130 Carp, Ontario K0A 1L0
TEL:	(613) 836-1494
FAX:	(613) 831-2730
DATE OF INTERVIEW:	August 23, 1993
TIME:	09:30
PERSON INTERVIEWED:	Jeff Armstrong, M.Arch
AGE:	38
POSITION:	President
YEAR FIRM ESTABLISHED:	1985
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 15 3-5
PRICE RANGE OF UNITS($):	250 000 - 750 000
LOCATION(S) OF CONSTRUCTION:	West End Ottawa, Ottawa
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	2 0 1 0
FIRM'S OVERHEAD($):	50 000
AVERAGE SALES PER YEAR($):	2-3 million

COMPANY:	Duvo Construction Ltée
ADDRESS:	4084 rue de la Seine App. 2 Chomedey, Québec H7W 2S3
TEL:	(514) 681-2159
FAX:	(514) 681-3206
DATE OF INTERVIEW:	August 17, 1993
TIME:	14:00
PERSON INTERVIEWED:	E.K. Voland
AGE:	62
POSITION:	President
YEAR FIRM ESTABLISHED:	1985
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 1000 20-100
PRICE RANGE OF UNITS($):	60 000 - 90 000
LOCATION(S) OF CONSTRUCTION:	Laval, Lasalle
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	5 2 0 1
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	1.8-9 million

COMPANY:	Le Group Génix
ADDRESS:	175 ch. Bates Suite 200 Ville Mont-Royal, Québec H3S 1A1
TEL:	(514) 737-4800
FAX:	(514) 737-4671
DATE OF INTERVIEW:	August 19, 1993
TIME:	15:00
PERSON INTERVIEWED:	Gary Garbarino
AGE:	n/a
POSITION:	President
YEAR FIRM ESTABLISHED:	1979
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 1200 200
PRICE RANGE OF UNITS($):	80 000 - 90 000
LOCATION(S) OF CONSTRUCTION:	St-Bruno, Brossard, Anjou, Fabreville, Two Mountains, Dollard
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	15 4 16
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	5-25 million

COMPANY:	G.K.M. Construction
ADDRESS:	555 Notre-Dame Ville Le Gardeur, Québec J5Z 3B5
TEL:	(514) 582-2256
DATE OF INTERVIEW:	August 11, 1993
TIME:	09:00
PERSON INTERVIEWED:	Gilles Boisvert
AGE:	57
POSITION:	President
YEAR FIRM ESTABLISHED:	1968
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 1200 bungalows, 20 apartment buildings, 10 shopping centres 10-50 bungalows
PRICE RANGE OF UNITS($):	80 000 - 150 000
LOCATION(S) OF CONSTRUCTION:	Le Gardeur
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	1 0 0 0
FIRM'S OVERHEAD($):	40 000
AVERAGE SALES PER YEAR($):	1.8 million

COMPANY:	Les Habitations St-Jacques
ADDRESS:	112 St-Paul ouest Bureau 500 Montréal, Québec H2Y 1Z3
TEL:	(514) 849-2772
FAX:	(514) 849-1715
DATE OF INTERVIEW:	August 24, 1993
TIME:	09:00
PERSON INTERVIEWED:	Robert Varin Peter Cosentini
AGE:	42
	37
POSITION:	Principal Share Holder Vice President
YEAR FIRM ESTABLISHED:	1983
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 1200 100-350
PRICE RANGE OF UNITS($):	89 000 - 150 000
LOCATION(S) OF CONSTRUCTION:	Montreal
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	3-8 3 2
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	12-15 million

COMPANY:	Les Constructeurs I & S
ADDRESS:	1550 de Maisonneuve ouest Suite 1111 Montréal, Québec H3G 1N2
TEL:	(514) 934-0734
FAX:	(514) 934-3909
DATE OF INTERVIEW:	August 13, 1993
TIME:	08:30
PERSON INTERVIEWED:	Jonathan Sigler, Eng.
AGE:	37
POSITION:	Project Director, Vice President Construction
NAME & AGE OF PRESIDENT:	David Sigler, 63
YEAR FIRM ESTABLISHED:	1981
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 6000 100-150
PRICE RANGE OF UNITS($):	79 000 - 300 000
LOCATION(S) OF CONSTRUCTION:	St Bruno, La Prairie, Laval
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	20 2.5 3.5 5 note: remainder in sales and marketing
FIRM'S OVERHEAD($):	750 000
AVERAGE SALES PER YEAR($):	12 million

COMPANY:	Les Immeubles L'équerre Inc.
ADDRESS:	2775 boul. des Oiseaux Laval, Québec H7L 4S9
TEL:	(514) 628-3737
DATE OF INTERVIEW:	August 18, 1993
TIME:	14:00
PERSON INTERVIEWED:	André P. Charbonneau
AGE:	62
POSITION:	Vice President
YEAR FIRM ESTABLISHED:	1975
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 5000 200
PRICE RANGE OF UNITS($):	79 000 - 250 000
LOCATION(S) OF CONSTRUCTION:	Laval, Pierrefonds
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **Iii) Number Employed in On-site Labour:**	2 2
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	2-15 million

COMPANY:	Groupe Marcotte
ADDRESS:	1339 Notre-Dame St-Sulpice, Québec JOK 3J0
TEL:	(514) 640-4192
FAX:	(514) 640 5612
DATE OF INTERVIEW:	August 20, 1993
TIME:	09:30
PERSON INTERVIEWED:	Léo Marcotte
AGE:	46
POSITION:	President
YEAR FIRM ESTABLISHED:	1965
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 3000 30-260
PRICE RANGE OF UNITS($):	80 000 - 100 000
LOCATION(S) OF CONSTRUCTION:	Pointe aux Trembles
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	5 4 1
FIRM'S OVERHEAD($):	n/a
AVERAGE SALES PER YEAR($):	7-12 million

COMPANY:	Groupe Immobillier Prével Inc.
ADDRESS:	7391 boul. St-Michel Montréal, Québec H2A 3A1
TEL:	(514) 374-8640
FAX:	(514) 374-8303
DATE OF INTERVIEW:	August 16, 1993
TIME:	15:00
PERSON INTERVIEWED:	Jacques Vincent
AGE:	43
POSITION:	President
YEAR FIRM ESTABLISHED:	1980
MAIN AREA OF WORK:	Residential
NUMBER OF UNITS BUILT: **Since Establishment of Company:** **Per Year:**	 1800 200
PRICE RANGE OF UNITS($):	110 000 - 175 000
LOCATION(S) OF CONSTRUCTION:	Lachine, Anjou, Pierrefonds, Le Gardeur, Repentigny
TOTAL NUMBER OF EMPLOYEES: **i) Number Employed in Administration:** **ii) Number of Office Staff:** **iii) Number Employed in On-site Labour:**	30 3 5 6
FIRM'S OVERHEAD($):	1 million
AVERAGE SALES PER YEAR($):	20 million

APPENDIX B

PRODUCTS USED IN THE STUDY

Product:
Pressure Treated Wood Foundation

Manufacturer/ Distributor:
National Forest Products Association
1619 Massachusetts Ave. N.W.
Washington D.C., U.S.A.
20036

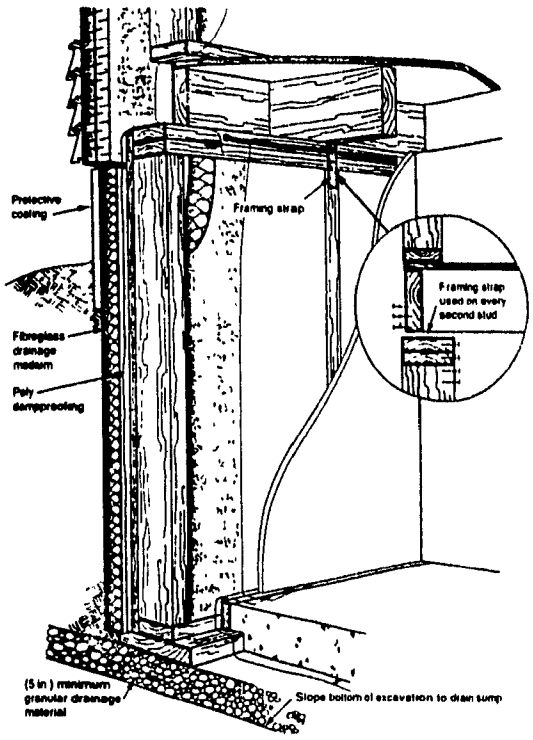
Tel. (202) 797-5800

Cost:
N/A

Use:
Foundation

Description:
This product eliminates the use of poured concrete or block foundations. Its principal advantages are it is easier to install and gives a warmer and drier feel to basements than a conventional foundation, it can be prefabricated, and wall heights are not restricted by the height of concrete wall forms.

Technical Data:
A builder/developer must follow rigorous guidelines when installing this product in order for it to be durable. An engineer must certify that the foundation meets requirements set out in the National Building Code (1990), section 9.15.3. Furthermore it must not exceed a soil bearing pressure of 75 kPa.



Product:
Insulock

Manufacturer/ Distributor:
Insulock Ontario
1400 Highgate Rd. #203
Ottawa, Ontario
K2C 2Y6

Tel. (613) 829-2176
Fax. (613) 829-7766

Cost:
$3.00/Block

Use:
Foundation

Description:
The Insulock Block is the form in which concrete and steel rods are added giving structural strength. The block is manufactured from polyurethane foam, is interlocking, self-aligning and requires no mortar. It is intended for use in single and multiple family dwellings, industrial and commercial, farm and utility buildings. Above and below grade applications.

Technical Data:
Material: Polyurethane Foam, closed cell, rigid, compressed to two pounds per cubic foot density.
Size: 20*20*40 cm (8"wide * 8"high * 16"long)
Weight: Approximately 340grams (3/4 pound)
Flame spread: Classification 45
Smoke density. 450 or less (per Resin Manufacturer's specifications)
Thermal resistance: 3.884 (M^2C/W -Equivalent to R-22
Compressive strength: 123 kPa
Tensile strength: 202 kPa
Flexural strength: 548.6 kPa
Shear strength: 155 kPa
Water vapour permeance: 70.5 $Ng/Pa.s.m^2$
Dimensional stability: 29°C 0.180% 70°C 100% RH 3.013% 100%3.790%
Water absorption: 2.0%
Weatherability: Subject only to ultraviolet degradation
Freeze/Thaw: Passes requirements of ASTM C67 Section 8

Product:
Sparlock

Manufacturer/Distributor:
Produits Sparbeton Ltee
C.P. 89, N.D.G.
Montreal, Quebec
H4A 3P4

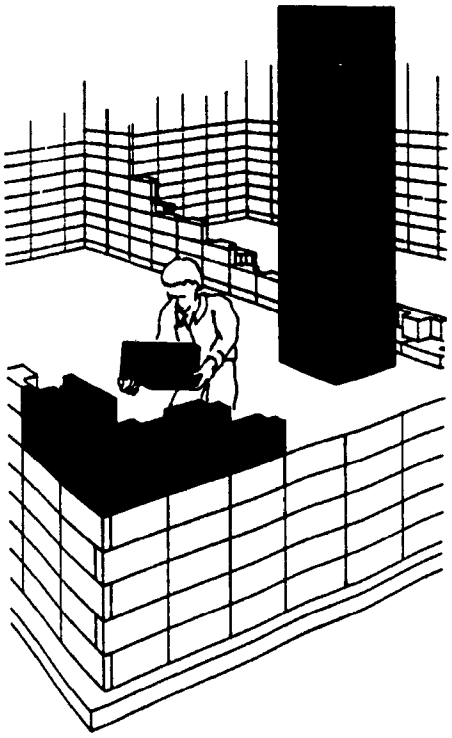
Tel. (514) 640-5192
Fax. (514) 640-5195

Cost:
$1.10/Block delivered
$0.40/Block installation

Use:
Foundation

Description:
Sparlock is an interconnecting block which eliminates the need for mortar. It is intended for building basements and foundations, fire walls and separations, party walls, sound barriers, piers and columns. It is quicker and cleaner to assemble than conventional blocks.

Technical Data:
Width of wall system: 200 mm (7-7/8")
Weight of stretcher unit: 12.3 kg (27 lbs)
Number of units per m^2: 25
Number of units per ft^2: 2.325
Mass (kg)
Air Dry: 11.07
Oven Dry: 10.86
Saturated moisture content: 6.7%
Compressive strength for net area (MPa): 24.1
Splitting tensile strength (MPa): 3.99
Fire rating: meets requirements of ASTM E119 and CAN4-S101 standards
Acoustical rating: Sparlock wall with no insulation = 52 FSTC



Product:
Open Joist 2000

Manufacturer/Distributor:
Open Joist Inc./ Toiture Mauricienne Inc.
1970 Rte St-Maurice Nord
St-Marthe du Cap-de-la-Madeleine, Quebec
G8T 7V8

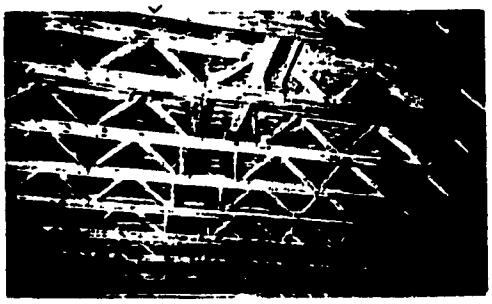
Tel. (514) 328-1612 and (819) 374-8784

Cost:
15' joist = $22.65 ($1.51/LF)
18' joist = $41.58 ($2.31/LF)

Use:
Structural Frame And Enclosure

Description:
Open Joist 2000 is a prefabricated joist which allows services, (plumbing/ventilation/electrical), to pass through it and is capable of larger spans than conventional joists.

Technical Data:
Approved by CNBC 12118-R
Fully open webbed
Fabricated with: kiln dried wood, waterproof glue and a camber
Reinforced support points by design; Adjustable on site
Assembly plan by engineer supplied
Requires continuous cross bridging
Maximum deflection = L/360



Product:
I Joist

Manufacturer/ Distributor:
Truss Joist MacMillan
6363 Transcanada Autoroute
St. Laurent, Quebec
H4T 1Z9

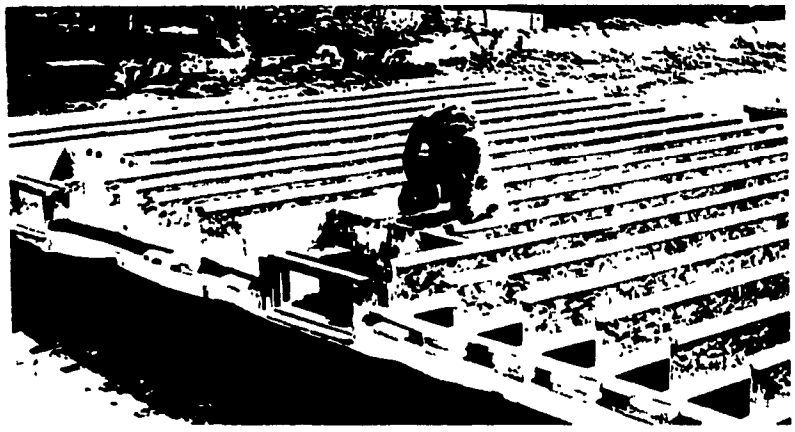
Tel. (514) 744-0576
Fax. (514) 744-8146

Cost:
15' joist = $28.50 ($1.90/LF)
18' joist = $36.00 ($2.00/LF)

Use:
Structural Frame And Enclosure

Description:
The I Joist is a prefabricated joist which eliminates floor squeaking and is capable of larger spans than conventional joists.
It can carry the same load-or more-than a conventional joist, with as little as 50% less wood fibre. Knockouts of 1 1/2" are provided every 12" for services.

Technical Data: (For TJI 25)
Depth: 9 1/2"
Flange material. MicroLam lumber (1 3/4"wide * 1 1/2"thick)
Web material: 3/8" structural I plywood or other approved material
Weight: 1.9-2.0 lbs/ft
Profiles: parallel and tapered
Total Load on 15' joist = 104 PLF



Product:
V-Joist

Manufacturer/ Distributor:
Les Systemes V-joist Inc.
30 Des Frenes
Bromont, Quebec
J0E 1L0

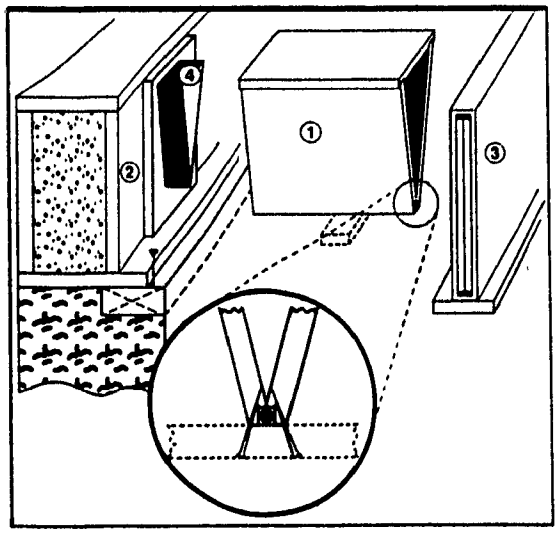
Tel. (514) 534-4031
Fax. (514) 534-4032

Cost:
15' joist = $30.00 ($2.00/LF)
18' joist = $36.00 ($2.00/LF)

Use:
Structural Frame And Enclosure

Description:
V-Joist is a prefabricated joist made from aspanite and reinforced with fibreglass. Its V shape allows it to be extremely stable, reducing vibrations and eliminating the need for using Croix de St-Andres for support.

Technical Data:
Aspanite thickness, sides = 7/16"
Aspanite thickness, top = 3/4"
Joint glue = polyester resin
Fibreglass shaft at bottom of V
Load for 15' joist. 9.50" depth, at 19" spacing = 144.5 PLF; 65 4 LPL



Product:
Maytrab Building System

Manufacturer/ Distributor:
SBM Inc.
2815, des Quatre-Bourgeois
Ste-Foy, Quebec
G1V 1X8

Tel. (418) 652-7555
Fax. (418) 652-1604

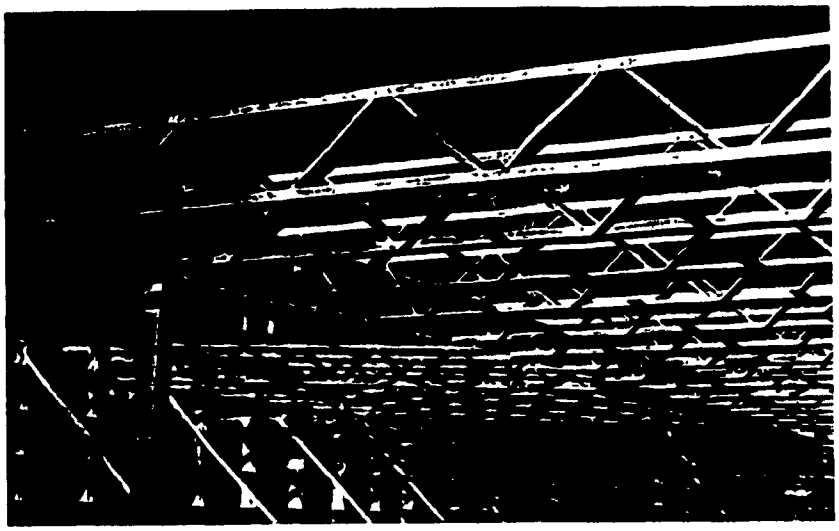
Paris, Head Office
Tel. 40-70-95-26
Fax. 47-23-35-30

Cost:
N/A

Use:
Structural Frame And Enclosure

Description:
A Metal framing system which comes in standard panels semi or completely finished. It does not limit design, and reduces construction time by 30%.

Technical Data
Robotized fabrication
Light weight
Fire Resistant
Pre-Punched service facilities
Seismic proof
Termite proof
Easy installation



Product:
Parallam

Manufacturer/ Distributor:
Truss Joist MacMillan
6363 Trans Canada Autoroute
St. Laurent, Quebec
H4T 1Z9

Tel. (514) 744-0576
Fax. (514) 744-8146

Cost:
15' 1 3/4"*9 1/2" = $90.00 ($6.00/LF)

Use:
Structural Frame And Enclosure

Description:
Engineered wood beam capable of spanning up to 66 feet

Technical Data:
(Beam 14' 1 3/4"*9 1/2")
Maximum load with LDF of 1.00 = 184 PLF
Maximum live load limited by deflection of L/360 = 126 PLF
Required bearing length at each end of the beam = 1.5"

Product:
Pan-isox Structural Panels

Manufacturer/ Distributor:
Iso-Sand Inc.
620 rue Kempf
Grandby, Quebec

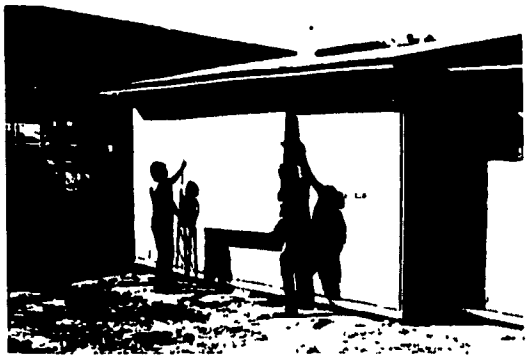
Tel. (514) 375-0085
Fax. (514) 375-9718

Cost:
panel 4'*8'*4 1/2"thick, R30 = $3.25/ft^2

Use:
Structural Frame And Enclosure

Description:
A foam core sandwich panel intended to eliminate the use of 2*6 framing. Panels are structural, insulated, and allow for rapid construction.

Technical Data:
Load bearing capacity for 1.220/2.440 mm panel: 21.700 kgs.
Outer layers of panel: fibrewood board OSB 6.35-11.10 mm thick or cement fibrewood board 8-40 mm thick
Filling: polyisocyanurate foam RSI 1.46 per 25 mm
Standard Panel Size: 4'*8', 4'*9'
Maximum length 20 feet



Product:
Escafor

Manufacturer/ Distributor:
Les Systems V-Joist Inc.
30 Des Frenes
Bromont, Quebec
J0E 1L0

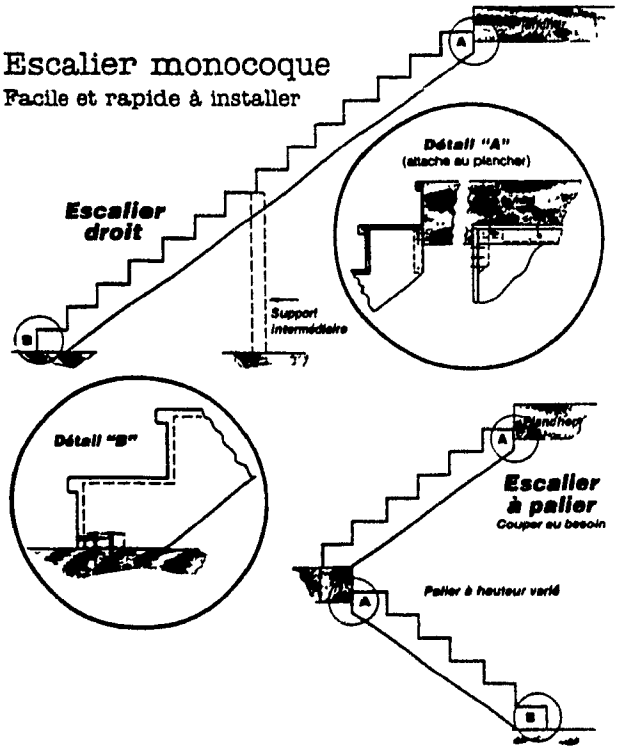
Tel. (514) 534-4031
Fax. (514) 534-4032

Cost:
$450.00 not installed

Usage:
Structural Frame And Enclosure

Description
A prefabricated staircase unit. Stairs are available in finished or non finished wood.

Technical Data
Easier and quicker to install than building a conventional staircase



Product:
Corian

Manufacturer/ Distributor:
DuPont Canada Inc
P.O. Box 2200
Mississauga, Ontario
L5M 2J4

Tel. (416) 821-5858

Cost:
$160.00/LF installed (10 year warranty)

Usage:
Structural Frame And Enclosure

Description:
Corian is a solid surface countertop material which requires minimal care to maintain its original beauty It is highly resistant to impact damage and staining. Because of its solid composition damage can usually be repaired.

Technical Data:
Composition: Natural minerals & high performance acrylic
Tensile strength: 6000 psi
Tensile Modulus: $1.5*10^6$ psi
Elongation: 0.4%
Hardness: 94 Rockwell "M" Scale
56 Barcol Impressor
Thermal Expansion $3.02 * 10^{-5}$
Boiling water surface resistance: No visible change
High temperature resistance (500°F): No change
Impact resistance: 14" slab - 36" drop; 1/2 lb. ball; No Fracture
Water absorbtion 3/4" sheet: 24 hours = 0.04

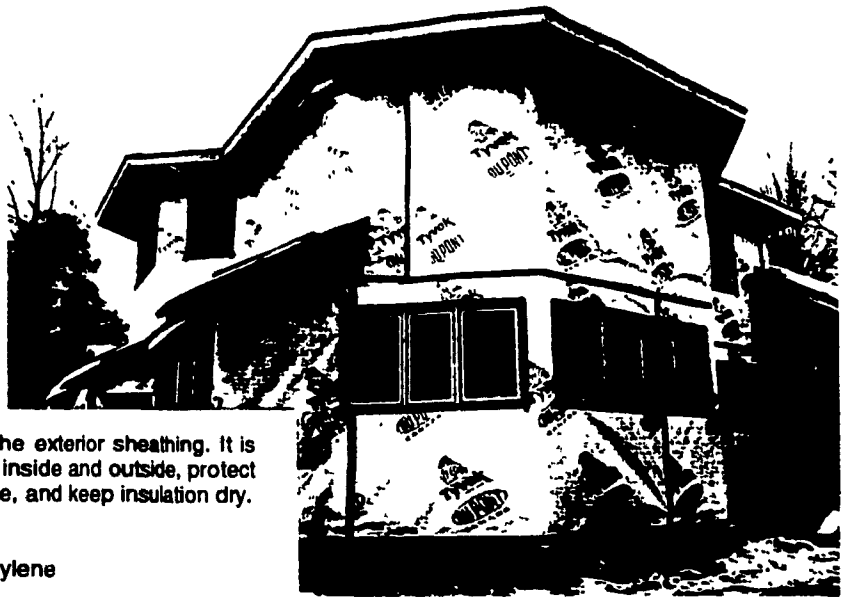
Product:
Tyvek Housewrap

Manufacturer/ Distributor
DuPont Canada Inc.
P.O. Box 2300
Mississauga, Ontario
L5M 2J4

Tel. (416) 821-5259

Cost:
Role 9'*195' (1755ft²) = $160.00

Use:
Structural Frame And Enclosure



Description:
Tyvek Housewrap is applied over the exterior sheathing. It is intended to stop air leaks from both inside and outside, protect against dry rot and masonry damage, and keep insulation dry.

Technical Data:
Material: 100% high density polyethylene
Tensile strength: 5.0 N/mm
Water vapour permeance: 4883 Ng/Pa.s.m², 84.6 PERMS (US)
Water resistance: 130 cm of water
Air permeance: 0.175 l/sec.m²
Resistance to UV exposure: 120 days under Florida sun
Flame spread: 0 - ASTM-E84-89a
Smoke developed value: 25 - ASTM-E84-89a

Product:
Glasclad

Manufacturer/ Distributor:
Fibreglass Canada Inc.
1875- 52nd Avenue
Lachine, Quebec
H8T 2Y1

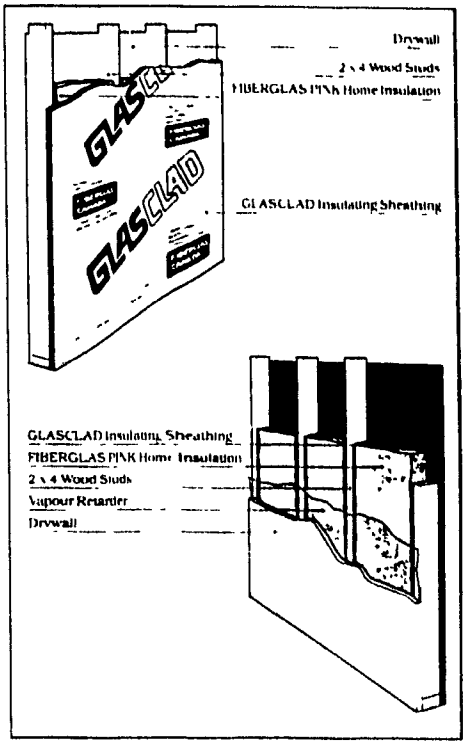
Tel. (514) 636-4800

Cost:
4'*8' or 4'*9'
1"thick = $355.00/1000 ft^2
1 1/2"thick = $490.00/1000 ft^2

Use:
Structural Frame And Enclosure

Description:
Glasclad is a non-structural rigid insulating exterior sheathing meant to replace conventional sheathing. Its exterior surface has Tyvek thus eliminating the need for a housewrap.

Technical Data:
Composition: Resin bonded glass fibres with Tyvek film on exterior
Water vapour permeability: Min. 1723 metric perms (30 perms)
Water absorbtion: 0.2% by volume; 96 hours at 49°C and 95% R.H.; No capillary action
Impact Resistance: 241J (178 ft.lbs)
Co-efficient of linear thermal expansion: $9*10^{-6}$ m/m/°C for temperature change of 27°C; length change 0.04% or 1 mm
Thermal properties: 1" thickness = R4.4; 1 1/2" thickness = R6.7



Product:
Wallmate

Manufacturer/ Distributor:
Dow Chemical Canada Inc.
1 Westmount Square
Suite 300
Westmount, Quebec
H3Z 2P9

Tel. (514) 934-8700

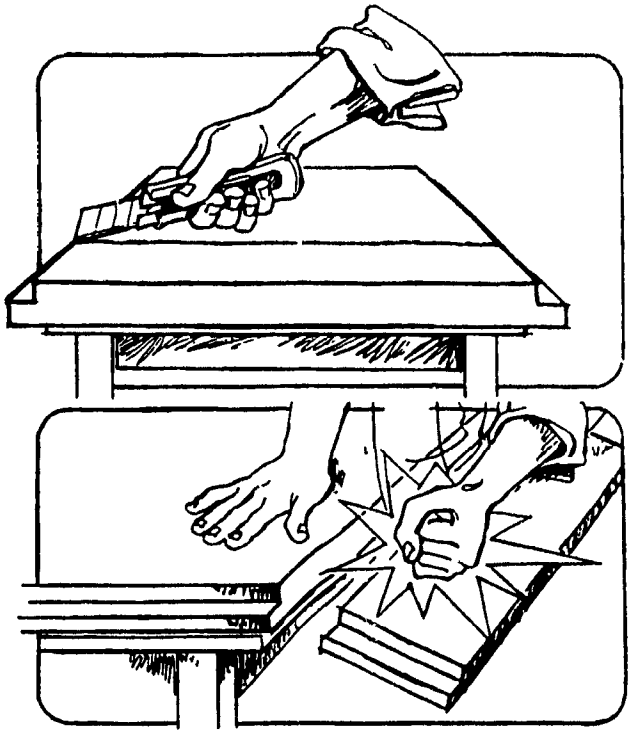
Cost:
$360.00 per thousand board feet

Use:
Structural Frame And Enclosure

Description:
Wallmate is a styrofoam insulation designed to insulate basement walls from the interior. It is applied to the masonry and the slotted feature accepts wood nailing strips.

Technical Data:
Board size: 2'*8'
Minimum compressive strength 16psi
Thermal Properties:

3/4" = R3.75	1" = R5
1 1/2" = R7.5	2" = R10
2 1/2" = R12.5	3" = R15



Product:
Excel Board

Manufacturer/ Distributor:
Daritek Inc
P.O. Box 434
Monn Heights, Quebec
J0R 1H0

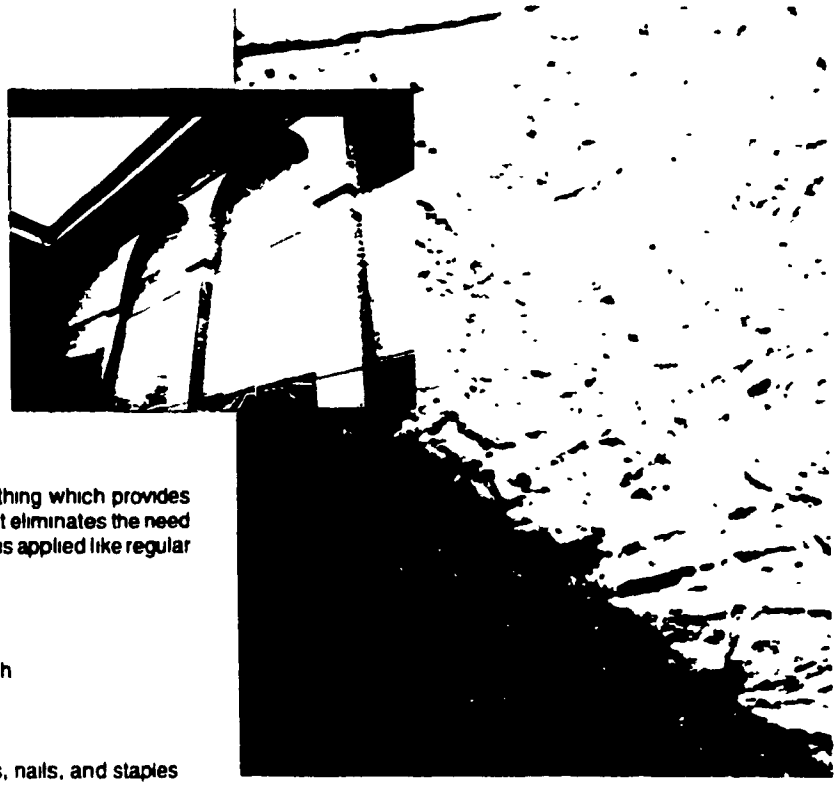
Tel. (514) 226-7968
Fax. (514) 226-7256

Cost:
4'*8' 3/4" = $1.30/ft^2

Use:
Structural frame And Enclosure

Description:
Excel Board is a rigid exterior sheathing which provides a base for polymer modified stucco. It eliminates the need for metal lath or fibreglass mesh and is applied like regular sheathing.

Technical Data:
Weight: 4'*8' panel = 20 pounds
Strength and impact resistance: High
Moisture resistance: No absorbtion
Thermal properties R4.0
Density. 10 pounds per cubic foot
Mechanically fastened using screws, nails, and staples



Product:
Excel

Manufacturer/ Distributor:
BPCO Inc.
0240 St. Patrick St.
LaSalle, Quebec
H8R 1R9

Tel. (514) 364-0125

Cost:
$340.00-$400 00/1000 ft^2

Use:
Structural Frame And Enclosure

Description:
Excel is an exterior sheathing which eliminates the need for a housewrap. It is applied like a regular sheathing, except joints are either taped or covered with 1"*3" wood strips.

Technical Data:
(based on 1/2" thickness)
Density: 18.0 lb/ft^3
Air permeability
0.09 max. l/s m^2 @ 75 Pa
Water vapour permeability:
5.0 min perm
Transverse load at rupture:
17.0 lb
Compression strength at 25% deformation: 71.0 lb/in^2
Racking strength: 412 lb
Impact strength (1/4" deformation): 6.5 ft
Nail pull-through: 88.0 lb
Linear expansion: 0.25%
Thermal resistance: R1.45
Water absorbtion: 5.0%-6.5%

Product:
Fypon Molded Millwork

Manufacturer/ Distributor:
Fypon Molded Millwork
22 West Pennsylvania Ave.
Stewartstown, PA
17363, U.S.A.

Tel. 1 (800) 537-5349
Fax. (717) 993-3782

Cost:
$200.00- $500.00 (US) for front door millwork

Use:
Structural Frame And Enclosure

Description:
Fypon Molded Millwork is made from a high density polymer and is intended to replace wood mouldings. Contrasted to wood, it will not rot.

Technical Data:
Density: Comparable to kiln dried white pine millwork. Skin density is greater.
Ultra violet: Millwork not affected by UV rays when properly coated
Moisture resistance: Non water absorbing
Fire rating: Fypon parts can be made from Fibreglass Reinforced Gypson (FRG) or fire rated polymer.
Solvent resistance: Fypon is solvent resistant
Odour/Gas: Releases no gasses and is odour free
Vermin and fungus resistance: Fypon is vermin and fungus resistant
Insulation: Has a greater insulation value than wood mouldings

Product:
Highpoint Roof Vent System (series 3)

Manufacturer/ Distributor:
Alcor Roofing
9475 Pascal-Gagnon
St-Leonard, Quebec
H1P 1Z4

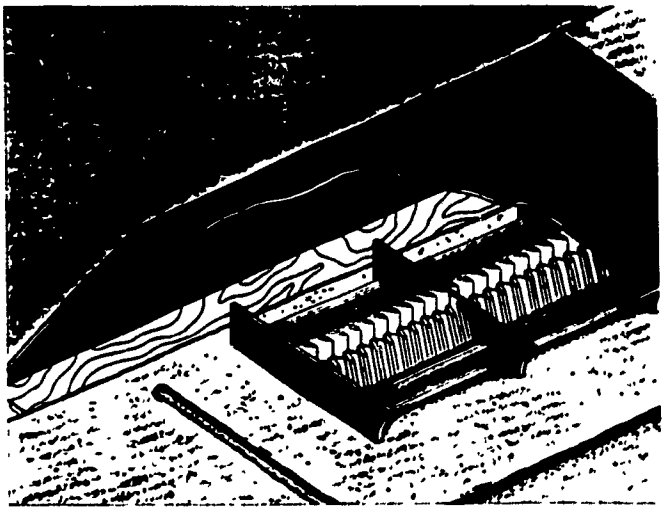
Tel. (514) 325-1260
Fax. (514) 325-9952

Cost:
$4.00/LF

Use:
Structural Frame And Enclosure

Description:
Highpoint Roof Vents are shingle-over ridge vents designed to run the entire length of the ridge. They provide increased ridge ventilation reducing heat and moisture build-up, resulting in longer shingle life, improved insulation effectiveness and reduced structural deterioration.

Technical Data:
Profile: 5/8" shingle-over ridge vent
Ventilation: 13 square inches per lineal foot of net free ventilation area
Widths: 9" and 11 5/8" widths
Composition: Durable UV stabilized polypropylene
Conforms to roof pitches 3/12 through 16/12



Product:
Woodruf

Manufacturer/ Distributor:
Alcor Roofing
9475 Pascal-Gagnon
St-Leonard, Quebec
H1P 1Z4

Tel. (514) 325-1260
Fax. (514) 325-9952

Cost:
$1.10/ft^2

Use:
Structural Frame And Enclosure

Description:
Woodruf is a wood based roofing shingle that captures the look of cedar. The shingles are denser and more durable than wood. They stand up to hail, high winds heavy rains and temperature extremes.

Technical Data:
Weather in colour naturally
Deep rugged texturing
Moisture resistant at 180^{0}F
25 year warranty

Product:
Fin-All

Manufacturer/ Distributor:
International Exteriors Ltd.
5611 St-Francois Rd.
St-Laurent, Quebec
H4S 1W6

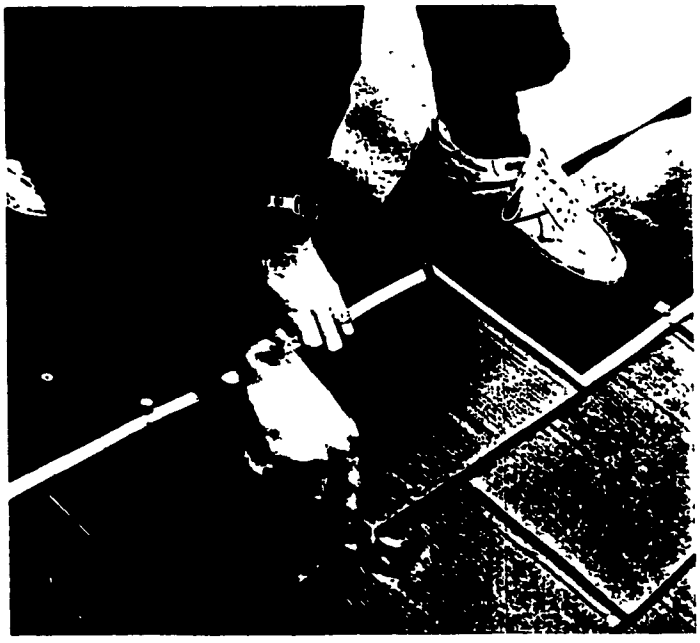
Tel. (514) 333-0300
Fax. (514) 333-6904

Cost:
$4.25-$6.95/ft^2 installed

Use:
Structural Frame And Enclosure

Description:
Fin-All is an interlocking aluminum shingle roofing system. Each shingle is embossed with a wood-grain texture, coated with superalurite, and applied under heat to provide a durable surface.

Technical Data:
Weight: 7.58 oz.(.214 kg) per unit
10 Colours Offered
Will adapt to any roofline
50 year warranty



Product:
Polybutylene Piping

Manufacturer/ Distributor:
Bow
5700 Cote de Liesse
Montreal, Quebec
H4T 1B1

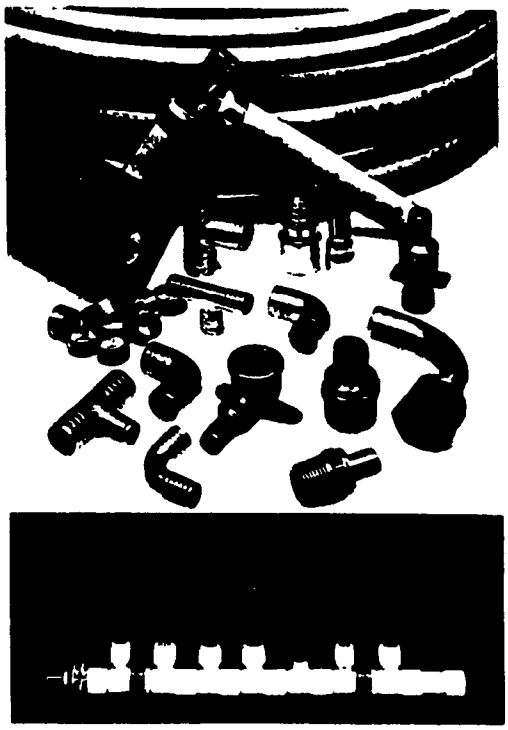
Tel. (514) 735-5671
Fax. (514) 735-8636

Cost:
$0.35-$0.45/LF

Use:
Plumbing And Sanitary

Description:
Polybutylene piping is a flexible piping system meant to replace copper. It is quicker and easier to install than copper piping.

Technical Data:
Pipe is chemically inert
Freeze resistant
Noiseless, eliminates water hammering
Reduces heat loss and eliminates condensation
light weight 47 lbs/1000 ft
Flexible
Reduces use of 80% of elbow fittings
Eliminates use of torch
Faster to install because joints are crimped using special pliers
Uses copper joints
Life span of 50 years



Product:
Kohler "Lite" Toilets

Manufacturer/ Distributor:
Nelco Inc.
7245 Ouest Rue St. Jacques
Montreal, Quebec
H4B 1V3

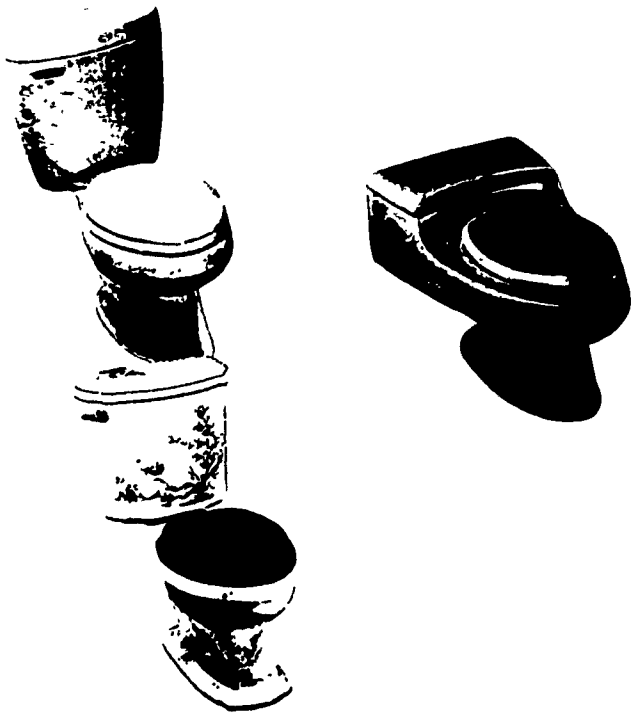
Tel. (514) 481-5614

Cost:
$251.00-$815.00

Use:
Plumbing And Sanitary

Description:
Kohler "Lite" toilets reduce the amount of water required to flush the toilet to 1.5 gallons without hampering the flushing system.

Technical Data:
Kohler "Lite" toilets' 1.5 gallon flush saves 57% of the water consumed by a 3.5 gpf "water saving" toilets and 70% of the water consumed by standard 5 gpf toilets.



Product:
Prefabricated Shower Unit

Manufacturer/ Distributor:
MAAX
P.O. Box 1030
600, Cameron, Ste-Marie
Beauce, Quebec
G6E 3C2

Tel (418) 387-4155
Fax. (418) 387-3507

Cost:
$310.00-$716.00

Use:
Plumbing And Sanitary

Description:
One piece fibreglass shower unit

Technical Data:
The units have a pigmented gelcoat surface and are reinforced with resin, fibreglass, and other rigid support materials. The weight of the units vary from 40-100 pounds.

Product:
Therma-Ray

Manufacturer/ Distributor:
CanRay Inc.
255 Restigouche Rd.
Oromocto, New Brunswick

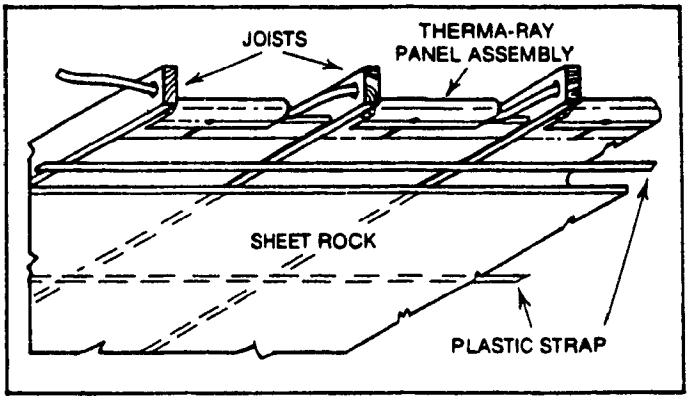
Tel. (506) 446-5100
Fax. (506) 446-6879

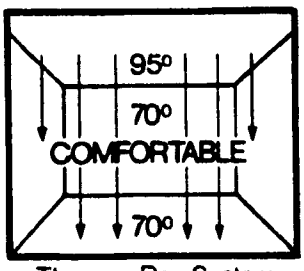
Cost:
$2.00/ft^2

Use:
Heating, Ventilation, and Air Conditioning

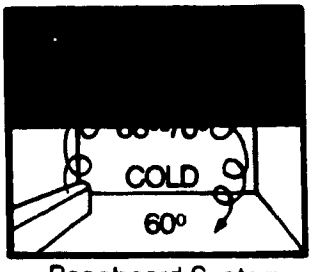
Description:
Therma-Ray is a radiant heat ceiling panel which is installed between the ceiling joists, below the insulation and above the finished ceiling The heat radiating from the ceiling warms the floor, furniture, and furnishings which in turn, warm the air.

Technical Data: (for 10"*9" panel)
Watts per panel: 160
Weight: 15 lbs
Maintenance free
Flexible installation





Therma-Ray System



Baseboard System

Product:
Prefabricated fireplace Unit

Manufacturer/ Distributor:
Foyer Securite
2125 rue Monterey
Laval, Quebec
H7L 3T6

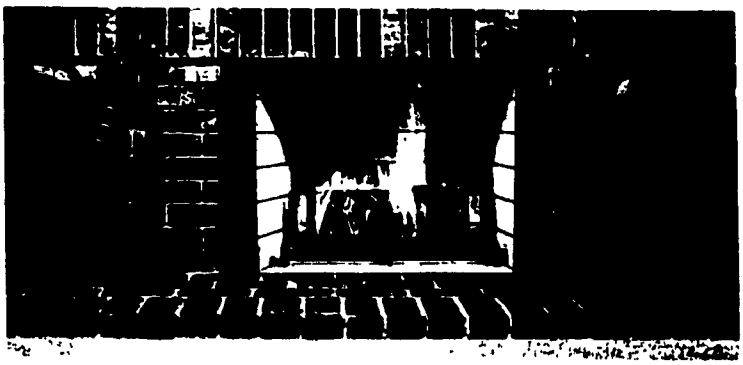
Tel. (514) 973-9999

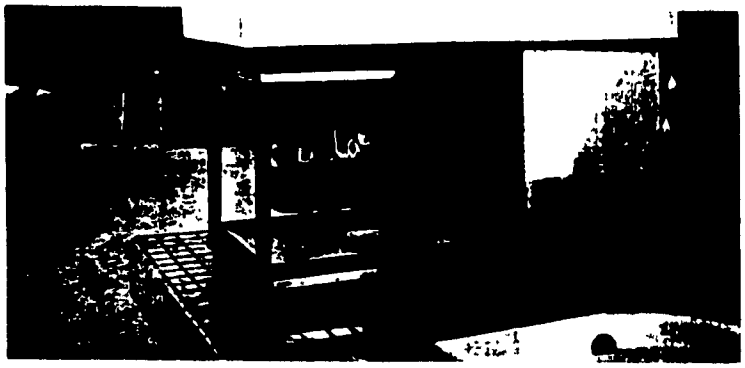
Cost:
$1200-$2000

Use:
Heating, Ventilation, And Air Conditioning

Description:
Prefabricated fireplace unit which is quicker to install than building a conventional fireplace and less expensive.

Technical Data:
Option of hot air fan available
Requires careful installation of chimney to prevent a fire from occurring





Product:
Thermopompe

Manufacturer/ Distributor:
Turcotte
690 Place Trans Canada
Longueuil, Quebec
J4P 1P2

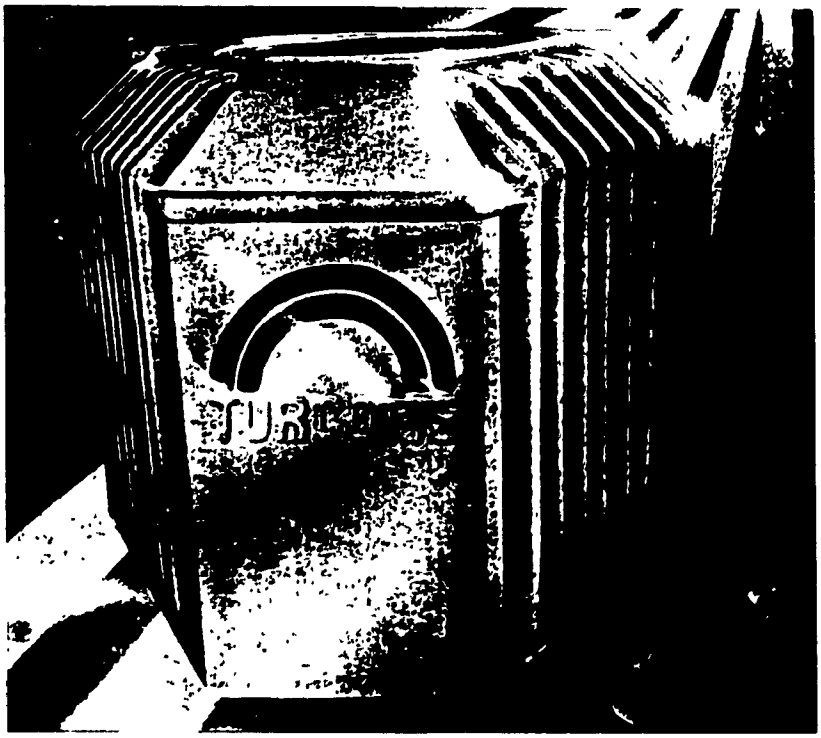
Tel. 527-4531

Cost:
$4000.00-$5000.00

Use:
Heating, Ventilation, and Air Conditioning

Description:
Thermopompes enable the home owner to have one unit which heats and cools.

Technical Data:
40% reduction in heating costs



Product:
Geothermic Thermopompe

Manufacturer/ Distributor:
Delta-Therm Ltee
5917, rue Mignault
Montreal, Quebec
H1M 1Y9

Tel. (514) 257-0561

Cost:
N/A

Use:
Heating, Ventilation, and Air Conditioning

Description:
The Geothermic Thermopompe uses sub-soil temperature as a means of heating and cooling a house. During winter the sub-soil temperature is warmer than the air temperature and in the summer it is colder than the air temperature. This allows for tremendous reductions in energy consumption.

Technical Data:
Piping circuits filled with liquid run through the soil either vertically or horizontally.
Geothermic Thermopompes allow for 65% reduction in heating costs, and 35% reduction in air conditioning costs.

Product:
Motion Sensor Switch

Manufacturer/ Distributor:
Leviton (Canada)
165 Hymus Blvd.
Pointe-Claire, Quebec
H9R 1G2

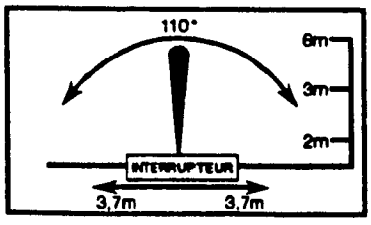
Tel. (514) 954-1840
Fax. (514) 954-1853

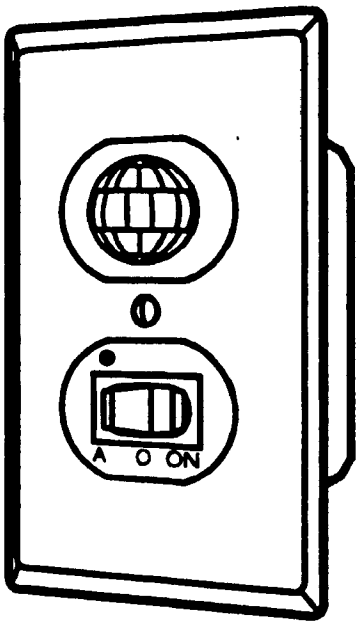
Cost:
$20.00

Use:
Energy Supporting Systems

Description:
The motion sensor switch uses passive infrared to detect motion, and automatically switches on a light which will remain lit for approximately 3 minutes after all motion ceases.

Technical Data:
Voltage: 120 V AC/CA 60 Hz
Wattage: 300 W max. incand.
Sensing coverage: 20'*12'
Sensing angle 110°
Photo-electric sensor prevents lights from turning on during the day.
Switch is heat sensitive and may stay on if located near a heat source.





Product:
Ground Fault Circuit Interrupters

Manufacturer/ Distributor:
Leviton (Canada)
165 Hymus Blvd.
Pointe-Claire, Quebec
H9R 1G2

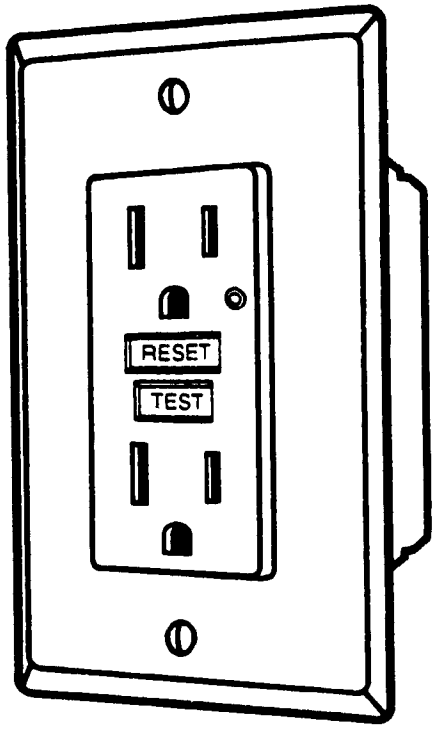
Tel. (514) 954-1840
Fax. (514) 954-1853

Cost:
$10.00

Use:
Energy Supporting Systems

Description:
Electrical outlet with sensitive circuit breaker making it safe to use in bathrooms, and outside.

Technical Data:
15 A 125 V at receptacle
Trip Threshold of 5 mA
Trip time of 0.025 seconds
Temperature tolerance level of -31°F to 158°F
1 1/8" deep body



Product:
Smart House Technology

Manufacturer/ Distributor:
Smart Lifestyles ltd.
8595 Fraser St.
Vancouver, BC
V5X 3Y1

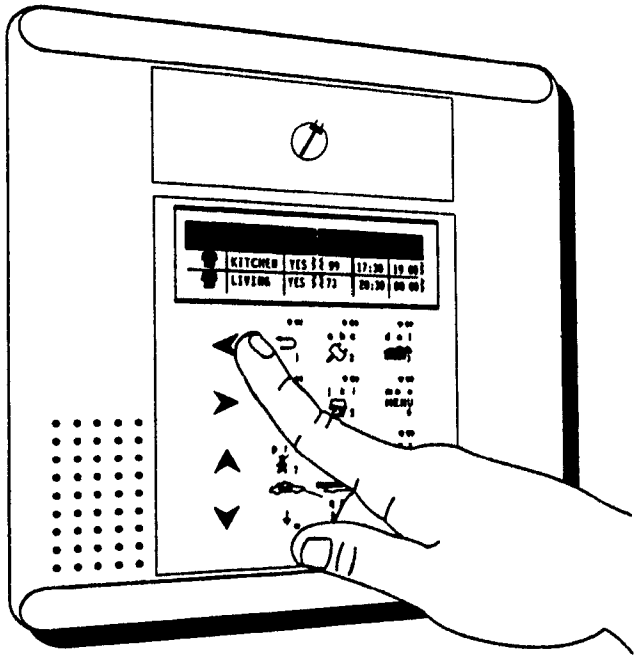
Tel. (604) 321-2355
Fax. (604) 322-6958

Cost:
N/A

Use:
Energy Supporting Systems

Description:
Smart House Technology provides an integrated, pre-designed wiring and control system for all electrical devices in the house.

Technical Data:
Computer regulated electrical system



APPENDIX C

THE MATRIX

Company:

Date:

FACTORS	AWARENESS NO LJ							ECONOMIC					QUALITY				FUNCTIONALITY							MARKETABILITY					PRODUCT HISTORY			
IMPORTANCE																																
SUB FACTORS	MEDIA	SALESMAN	TRADE	HOME SHOW	OTHER	IN USE (U) / NOT USED (N) / PAST USE (P)	LIKE (L) / DISLIKE (D)	COST	PROFITABILITY	TIME SAVINGS	RISK	MATERIAL WASTAGE	OTHER PLAYERS USING	PROVEN SUCCESS	LIABILITY	VALUE	CODE REQUIREMENTS	COMPLEXITY	PRODUCT SUPPORT	COMPETITIVE ADVANTAGE	EFFECT ON H.D.P.	DIRECT SUBSTITUTE	DANGER FACTOR	COMPETITIVE ADVANTAGE	CONSUMER DEMAND	INCREASED SOCIAL STATUS	VISIBLE / INVISIBLE	CONSUMER AWARENESS	USAGE BY OTHER BUILDERS	PROJECTS USED IN	PAST SUCCESS / FAILURE	WARRANTY PROVISIONS
IMPORTANCE																																
PRODUCTS:																																
A) FOUNDATION																																
PRESERVED WOOD																																
INSULOCK																																
SPARLOCK																																
B) STRUCTURAL FRAME AND ENCLOSURE																																
OPEN JOIST 2000																																
I JOIST																																
V JOIST																																
MAYTRAB BUILDING SYSTEM																																
PARALLAM																																
STRUCTURAL INSULATED PANEL (PANISOX)																																
ESCAFOR																																
CORIAN (DUPONT)																																
TYVEK HOUSEWRAP																																
GLASCLAD																																
WALL MATE																																

Company:
Date:

FACTORS								ECONOMIC						QUALITY					FUNCTIONALITY								MARKETABILITY						PRODUCT HISTORY					
IMPORTANCE	AWARENESS NO ⅃																																					
SUB FACTORS	MEDIA	SALESMAN	TRADE	HOME SHOW	OTHER	IN USE (U) / NOT USED (N) / PAST USE (P)	LIKE (L) / DISLIKE (D)	COST	PROFITABILITY	TIME SAVINGS	RISK	MATERIAL WASTAGE		OTHER PLAYERS USING	PROVEN SUCCESS	LIABILITY	VALUE		CODE REQUIREMENTS	COMPLEXITY	PRODUCT SUPPORT	COMPETITIVE ADVANTAGE	EFFECT ON H.D P.	DIRECT SUBSTITUTE	DANGER FACTOR		COMPETITIVE ADVANTAGE	CONSUMER DEMAND	INCREASED SOCIAL STATUS	VISIBLE / INVISIBLE	CONSUMER AWARENESS		USAGE BY OTHER BUILDERS	PROJECTS USED IN	PAST SUCCESS / FAILURE	WARRANTY PROVISIONS		
EXCEL BOARD																																						
EXCEL (BP)																																						
FYPON MOLDED MILLWORK																																						
HIGHPOINT ROOF VENT																																						
WOODRUF																																						
FIN-ALL																																						
C) PLUMBING AND SANITARY																																						
PB SUPPLY PIPE																																						
KOHLER LITE TOILETS																																						
PREFAB SHOWER																																						
D) HEATING, VENTILATION AND AIR CONDITIONING																																						
THERMA-RAY																																						
PREFAB FIREPLACE																																						
THERMOPOMPE (TURCOTTE)																																						
GEOTHERMIC THERMOPOMPE																																						
E) ENERGY SUPPORTING SYSTEMS																																						
MOTION SENSOR SWITCH																																						
GRND. FAULT CCT. INTERRUPTER																																						
SMART HOUSE TECHNOLOGY																																						

APPENDIX D

INTERVIEW GUIDELINES

INTERVIEW GUIDELINES

Date . . . . . Time . . . . . .

Person Interviewed . . . . . .

Position . . . . . .

Company . . . . . .

Name & age of president . . . . . .

PART A: COMPANY PROFILE

1) Year firm established . . . . . .

2) Main area of work . . . . . .

3) Number of units built since establishment of company . . . . . .

per year . . . . . .

4) Price Range Of Units . . . . . .

5) Location(s) Of Construction . . . . . .

6) Total Number Of Employees . . . . . .

i) Number Employed In Administration . . . . . .

ii) Number Of Office Staff . . . . . .

iii) Number Employed In On-Site Labour . . . . . .

7) Firm's Overhead . . . . . .

8) Average Sales Per Year . . . . . .

PART B: FACTORS OF DECISION ON TECHNOLOGY: THE PRODUCTS

1) Why would you or would you not use the following products? (with reference to the criteria on the matrix)

* give product description
* use
* rough cost
* history in industry

2) where did you hear of it?

APPENDIX E

SUMMARY TABLE

SUMMARY TABLE

FACTORS	AWARENESS NO ❑					IN USE	NOT USED	PAST USE	LIKE	DISLIKE	ECONOMIC					QUALITY				FUNCTIONALITY							MARKETABILITY					PRODUCT HISTORY				
IMPORTANCE																																			
SUB FACTORS	MEDIA	SALESMAN	TRADE	HOME SHOW	OTHER						COST	PROFITABILITY	TIME SAVINGS	RISK	MATERIAL WASTAGE	OTHER PLAYERS USING	PROVEN SUCCESS	LIABILITY	VALUE	CODE REQUIREMENTS	COMPLEXITY	PRODUCT SUPPORT	COMPETITIVE ADVANTAGE	EFFECT ON H.D.P.	DIRECT SUBSTITUTE	DANGER FACTOR	COMPETITIVE ADVANTAGE	CONSUMER DEMAND	INCREASED SOCIAL STATUS	VISIBLE / INVISIBLE	CONSUMER AWARENESS	USAGE BY OTHER BUILDERS	PROJECTS USED IN	PAST SUCCESS / FAILURE	WARRANTY PROVISIONS
IMPORTANCE	**2**	**1**	**3**	**4**	**4**						**1**	**2**	**3**	**3**	**4**	**3**	**2**	**3**	**1**	**6**	**1**	**5**	**4**	**2**	**3**	**7**	**2**	**1**	**3**	**2**	**4**	**1**	**2**	**2**	**3**
PRODUCTS:																																			
A) FOUNDATION																																			
PRESERVED WOOD	10	1	0	0	1	0	11	1	1	11	3	0	2	5	2	1	2	2	6	0	4	2	2	3	2	0	4	7	4	3	4	3	2	3	2
INSULOCK	5	0	0	0	1	0	11	1	1	11	6	3	3	4	2	1	2	2	2	1	8	3	4	8	5	1	3	4	3	2	3	6	6	6	5
SPARLOCK	2	5	0	0	1	3	7	2	7	5	9	7	5	2	1	0	1	1	9	0	6	2	3	7	6	0	3	2	3	1	0	1	1	1	0
B) STRUCTURAL FRAME AND ENCLOSURE																																			
OPEN JOIST 2000	5	9	0	2	2	6	2	4	9	3	3	1	4	0	0	2	3	1	8	1	9	5	7	7	6	0	1	1	0	2	1	1	1	1	1
I JOIST	5	9	0	2	2	4	5	3	4	8	4	3	0	0	0	1	4	0	8	0	8	6	5	6	6	0	0	1	0	1	1	0	0	0	0
V JOIST	0	0	0	1	1	0	12	0	1	11	5	5	0	0	0	1	2	1	4	0	9	5	3	7	2	0	0	0	0	0	0	5	5	4	4
MAYTRAB BUILDING SYSTEM	0	0	0	1	0	0	12	0	1	11	7	6	0	2	1	3	5	1	5	0	9	5	5	7	6	0	3	4	2	3	3	2	2	2	2
PARALLAM	3	5	2	0	2	3	5	4	11	1	4	3	3	0	0	2	5	1	9	0	9	6	5	9	9	3	3	2	3	5	2	1	1	1	1
STRUCTURAL INSULATED PANEL (PANISOX)	3	4	0	2	3	0	9	3	0	12	5	3	1	4	0	1	4	3	9	0	8	5	6	7	5	1	3	3	2	2	2	3	3	3	2
ESCAFOR	1	3	0	0	0	1	11	0	3	9	9	8	4	0	0	2	2	0	4	0	5	3	5	9	6	0	1	0	0	0	0	1	1	1	0
CORIAN (DUPONT)	6	5	0	0	1	2	6	4	1	11	10	9	0	0	0	2	2	0	2	2	3	3	4	4	3	1	0	0	0	0	0	0	0	0	0
TYVEK HOUSEWRAP	4	9	1	0	1	8	1	3	9	3	4	4	0	0	0	2	6	1	8	1	4	3	3	5	2	2	2	3	2	2	3	1	1	1	1
GLASCLAD	6	10	0	0	2	2	2	8	3	9	4	4	1	0	1	0	3	0	8	1	8	5	3	9	5	0	1	0	1	1	0	1	1	1	1
WALL MATE	6	11	0	0	3	6	0	6	5	7	2	1	0	1	0	0	5	2	8	1	9	1	3	7	5	0	0	0	0	0	0	1	1	1	1

FACTORS											ECONOMIC					QUALITY				FUNCTIONALITY							MARKETABILITY					PRODUCT HISTORY				
IMPORTANCE	AWARENESS NO ❑					IN USE	NOT USED	PAST USE	LIKE	DISLIKE	COST	PROFITABILITY	TIME SAVINGS	RISK	MATERIAL WASTAGE	OTHER PLAYERS USING	PROVEN SUCCESS	LIABILITY	VALUE	CODE REQUIREMENTS	COMPLEXITY	PRODUCT SUPPORT	COMPETITIVE ADVANTAGE	EFFECT ON H.D.P.	DIRECT SUBSTITUTE	DANGER FACTOR	COMPETITIVE ADVANTAGE	CONSUMER DEMAND	INCREASED SOCIAL STATUS	VISIBLE / INVISIBLE	CONSUMER AWARENESS	USAGE BY OTHER BUILDERS	PROJECTS USED IN	PAST SUCCESS / FAILURE	WARRANTY PROVISIONS	
SUB FACTORS	MEDIA	SALESMAN	TRADE	HOME SHOW	OTHER																														
EXCEL BOARD	1	2	0	1	0	0	12	0	1	11	10	10	0	2	0	1	2	1	4	0	2	1	2	2	2	1	1	1	1	1	0	5	3	4	2
EXCEL (BP)	0	6	0	0	1	1	11	0	9	3	8	7	1	0	0	1	4	1	9	1	8	4	5	9	6	2	1	1	2	2	1	1	1	1	1
FYPON MOLDED MILLWORK	4	3	3	3	1	4	5	3	8	4	3	3	0	0	0	3	4	1	9	1	4	1	4	3	2	0	6	3	6	6	1	1	0	0	0
HIGHPOINT ROOF VENT	6	5	1	0	0	2	7	3	6	6	5	5	0	0	0	1	7	1	9	0	5	1	1	3	3	0	0	0	0	0	0	3	3	3	3
WOODRUF	2	2	0	0	1	0	10	2	4	8	7	5	0	0	0	1	4	1	8	0	1	0	0	1	1	0	3	4	4	3	3	1	1	1	1
FIN-ALL	3	2	0	2	0	0	10	2	0	12	10	9	0	1	0	0	0	0	2	0	1	0	0	1	1	0	0	2	1	1	1	1	1	0	0
C) PLUMBING AND SANITARY																																			
PB SUPPLY PIPE	3	3	8	2	0	6	2	4	6	6	5	5	3	1	1	3	3	4	5	0	5	1	5	4	5	0	3	7	4	6	3	2	1	1	0
KOHLER LITE TOILETS	5	7	0	1	0	1	9	2	4	8	5	5	0	0	0	0	3	0	3	0	0	0	0	0	0	0	5	5	4	4	4	0	0	0	0
PREFAB SHOWER	7	8	0	2	0	12	0	0	12	0	10	7	4	4	1	6	8	7	12	5	12	8	11	11	11	0	5	4	4	4	4	0	0	0	0
D) HEATING, VENTILATION AND AIR CONDITIONING																																			
THERMA-RAY	4	2	1	2	1	1	5	6	3	9	7	6	0	0	1	2	4	2	5	0	4	4	2	3	2	0	1	0	0	1	0	0	0	1	0
PREFAB FIREPLACE	8	11	2	2	0	10	0	2	10	2	8	8	7	6	2	2	4	3	6	1	7	4	4	8	5	2	7	8	7	8	8	1	1	2	1
THERMOPOMPE (TURCOTTE)	11	9	3	3	3	3	4	5	5	7	7	6	0	0	0	2	5	3	7	0	2	0	0	1	1	0	3	3	2	3	2	0	0	0	0
GEOTHERMIC THERMOPOMPE	7	1	2	0	2	1	11	0	2	10	8	8	1	4	3	3	4	4	7	3	4	4	4	4	4	1	3	3	2	1	3	3	3	3	2
E) ENERGY SUPPORTING SYSTEMS																																			
MOTION SENSOR SWITCH	3	3	1	0	0	0	11	1	7	5	4	4	0	0	0	0	1	0	3	0	2	1	2	3	3	1	6	4	5	5	0	1	1	1	0
GRND FAULT CCT INTERRUPTER	7	10	5	0	0	12	0	0	12	0	1	1	0	0	0	1	6	3	10	6	4	2	2	2	2	0	3	3	3	3	3	2	2	2	1
SMART HOUSE TECHNOLOGY	9	5	2	4	1	0	11	1	0	12	10	9	1	2	0	1	2	1	1	2	6	2	3	4	3	1	1	4	1	1	1	3	3	3	1