PRODUCT-PLANT ASSIGNMENT IN

NORTH AMERICAN AUTOMOBILE ASSEMBLY

by

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CHAPTER I

INTRODUCTION

Large modern industrial corporations, which dominate key sectors of western industrial economies, are generally characterized by membership in at least one oligopolistic industry and the presence of multiplant and multilocational operations (Eichner, 1980, 19). The major firms in an oligopoly engage generally in forms of non-price competition, frequently involving a strategy of product differentiation. A firm dominant in one industry group usually also manufactures a broad range of product lines in which the number of distinct items seldom remains fixed because the design and physical attributes are upgraded or altered routinely as part of competitive strategy. As the large corporation operates several production facilities simultaneously, so it frequently has to deal with the important question: In which plants should particular products be made? This study concerns the changing geography of product-line assignment in a group of large multiplant enterprises which form a differentiated oligopoly. Its focus is on the final assembly segment of the principal North American automobile firms. Interest in the topic was inspired by concern for the widespread geographic impact of decisions made by these key corporations. "When Detroit sneezes, America catches a cold"--is an apt adage and vivid portrayal of the extraordinary impact the automobile industry has upon the United States, and, one might add, upon Canada. Currently throughout the North American continent, a palpable reminder of the industry's importance is the numerous reports of unscheduled plant layoffs and closures, which have captured headline news and created widespread consternation. Such unfortunate occurences have recently affected literally hundreds of workers at a single plant, thousands in a community and tens of thousands in a state, province or country. The scale at which an otherwise active labour force is coerced into involuntary idleness is generally most serious during a recessionary period, when the majority of plants are unable to avoid taking such action. However, even during poor economic conditions, the seriousness of layoffs among individual plants within a corporate system is rather more complex and is seldom dispersed equitably (Clark, 1976). For instance, while production is now being curtailed and workers are being retrenched at plants producing large cars, those producing small, fuel-efficient vehicles are operating at peak capacity to meet an unprecedented demand for these cars. Besides seasonal plant closures and layoffs during the annual shutdown for retooling and model changeover it does appear that unscheduled closures, production slowdowns and labour force reductions are intimately associated with the type(s) of vehicles made at a plant.

A striking example of this causal link between product and plant employment is the recent developments at the American Motors Corporation (AMC) Brampton, Ontario, facility. During the summer of 1978 the company converted its only Canadian plant from passenger cars to four-wheel-drive Jeep assembly. Although the change meant the indefinite layoff of approximately 300 workers, this decision was generally well received by the community because sales of recreational vehicles, the market niche in which Jeeps competed, was expected to be on the verge of a boom. However, by 1980, what was to be a promising future for the plant failed to materialize. It was reported that

> "for the first time in its 20-year history, the American Motors facility . . . is operating as a one-shift operation because of the lack of demand for Jeeps. That is, when it's operating at all . . . . This week, 560 of the plants 730 workers were laid off . . . . This is the third production shutdown since last November . . . . All told, since the Jeep conversion plans were announced, employment at AMC has declined from 1,200 workers to 730" (Brampton Guardian, April 7, 1980, 14).

Sales of AMC passenger cars both in Canada and the U.S. were, nevertheless, reaching record proportions during this period. To quote the Guardian:

> "The bitter result for Brampton, therefore, is that AMC's decision two years ago to switch all of its passenger car manufacturing to its Kenosha, Wisconsin plant and leave only the CJ Jeeps for Brampton has proved to be the worst possible decision for this city".

Brampton, its hopes and dreams shattered, is merely one example out of perhaps several different auto assembly communities which have shared similar experiences on all too many previous occasions and which will continue to live with the prospect that such experiences will occur again. It may seem surprising, therefore, that there has been no major effort to document and explain the assignment of certain car lines to particular assembly plants, given the economic-geographic environments and nature of circumstances surrounding change in plant product portfolios. A better grasp of corporate strategies and revealed behaviour involving product-plant assignment and change may prove timely, therefore, in an era when the space economy of many developed countries is heavily affected by the operating decisions of giant multiproduct, multiplant corporations.

Scope and Objectives

This thesis argues that in conditions where a variety of factors including scale economies, for example, in research, production, marketing and distribution, have contributed to the development of an oligopolistic structure in which competition is primarily on the basis of dynamic product differentiation there is a need for frequent corporate locational assignment decisions. In some cases, the assignments will involve setting up new plants and/or closing old ones. But insofar as the expected return on investment does not warrant establishing a new plant, corporations will assign and reassign products between their existing set of plants comprising their corporate geographic system, in a continuous process of adjustment to shifting revealed and expected conditions; constrained perhaps by the legacy of past assignments and plant infrastructure, and thereby generate a distinctive but perhaps rapidly changing internal corporate product geography. For individual communities which host a company plant, as our Brampton example indicates, the stakes in such product assignment may be high, though not readily predictable.

A number of key questions form the basis of this study. What are the geographic influences on, and consequences of, such product differentiation strategies? How frequent are product-assignment decisions and on what basis are decisions made? Is there a distinct corporate core and periphery? Is there a relationship between product-mix and location, product age and location and product volume and location? What is the evolution and basis of plant locational inertia and turnover and product locational inertia and turnover?

The study focuses on North American auto assembly mainly from the 1965 model year to the 1978 model year, a period in which there were some significant changes, especially from a Canadian viewpoint. Although the auto industry plays a major role in both the U.S. and Canadian economies, there has been little documentation on the spatial strategy in assigning models. A point of some pertinence is whether the assignments to Canadian plants are significantly different to those for American plants, particularly since the signing of the Auto Pact between Canada and the United States. Is it the case that Canadian plants are in some sense discriminated against, perhaps by being allocated older models, which show little basis for significant growth, as opposed to largely new designs, a strategy found to prevail, for instance, in the major appliance industries (Crookell, 1970)?

To the author's knowledge, no other study has attempted to document and analyse product-plant locational assignment and change along the lines of the approach attempted here. It is felt that the relevance of this approach has become increasingly important to our grasp of manufacturing geography in a situation where giant enterprises dominate our industrial economies and their strategies for assigning products and functions are of major importance to communities, regions and countries.

It is also pertinent to note that while, increasingly, government agencies have become involved in the industrial location process, either by providing direct financial incentives to situate at particular locations or restricting locational choice through regulation or landuse planning, recently they have shown particular concern over what lines should be produced in individual plants, and some governments have even sought to encourage foreign-owned branch plants to pursue a "global product mandate" strategy which effectively gives a subsidiary responsibilities to develop and produce a product for world markets (Financial Post, March 31, 1979; May 19, 1979, 1 & 4).

Plan of the Thesis

Chapter II reviews some related literature and discusses some conceptual issues regarding the nature, spatial form and basis of product change and product-mix in multiplant firms. It commences with a discussion of product differentiation and the distinction between static and dynamic product differentiation and market segmentation. This is followed by a discussion of the concepts relating to product-, plant- and firm-specific economies of scale. Patterns of product-mix in plants are identified and related to production economies of scale. The relationship between product-mix and plant location is discussed as also some elements of the structure of corporate task environments. Finally, some circumstances regarding plant product mandates are noted.

Chapter III introduces pertinent 'background' on the development of the North American automobile assembly industry. It traces briefly the development of the U.S. and Canadian industries from their beginnings to the mid-1960's. From 1965 until the present, the analysis focuses on the integrated North American auto industry and certain features of the Canada-U.S. Automotive Products Trade Agreement. A final section outlines the industry structure and market power of the Big Three and indicates some bases of corporate behaviour.

Chapter IV examines features of product differentiation in the auto industry. The discussion begins by outlining the various forms of differentiation and market segmentation and the strategic bases for these product policies. Next the reasons and characteristics associated with model and style changes and product turnover are revealed and analysed.

Chapter V describes the economies of auto assembly operations and the locational characteristics of plants. Initially, assembly line operations and the economic and technical factors facilitating or constraining plant-product mix are detailed. Next, arguments about the economies of scale of assembly plants in general and for different size of vehicles are noted. A third section describes the spatial organization of Big Three assembly plants and proposes a classification of plants based on four industry regions: industry core, outer core, inner periphery and outer periphery.

Using the concepts and relationships outlined, Chapter VI documents product-mix patterns in auto assembly plants in terms of car make, line and wheelbase dimensions. It analyses the changing patterns for each of the principal firms during a fourteen year period, the 1965-78 model years.

Contrasts in plant-product mix, first in different industry regions and second, in Canada and the U.S. are analysed in Chapter VII. The discussion seeks to evaluate the importance of the locational variable for plant product assignment strategies.

Product change occurring in plants constitutes the focus of Chapter VIII. The principal elements of the analysis are the pace of change and the circumstances that lead to alterations in plant-product mandates.

Finally, Chapter IX summarizes the major points revealed by the analyses and then briefly outlines several conclusions.

CHAPTER II

PRODUCT DIFFERENTIATION, SCALE ECONOMIES AND PRODUCT-PLANT ASSIGNMENT

This chapter discusses some key concepts in product-plant assignment and indicates recent arguments concerning the basis of multiplant corporate production and location strategies in differentiated oligopolies. A number of developments has led to a decrease in the utility of traditional industrial location theory (Hamilton, 1974, 5). Among these is the increasing scale, economic dominance and product diversity of major industrial corporations. As a result, over the past two decades a behavioural school of locational analysis has developed with a focus upon the situation of large enterprise. Most analyses have dealt with a number of major components including: the spatial evolution and configuration of giant enterprises (McNee, 1958, 1963, 1964, 1974; Håkanson, 1979); spatial implications of corporate growth policies (Chapman, 1974); firm infrastructure and product rationalization (Heal, 1974; Watts, 1974); contact systems (Tornqvist, 1970); and material and functional linkages (Britton, 1974, 1976). Other major areas of emphasis have concerned the location of internal corporate functions. Malecki (1979), for instance, has examined the location of corporate R & D facilities while others including Goddard (1968, 1971), Goodwin (1965), Westaway (1974a) and Pred (1974) have analysed the geography of corporate head offices and functions. Yet others have examined the regional impact of large corporations (Erickson, 1972, 1975; Westaway, 1974b; Krumme and Hayter, 1975; Parsons, 1971; Townroe, 1975; Britton and Gilmour, 1978). Corporate decision-making and locational behaviour have also been the major focus of several studies including those by Blackbourn (1974), Rees (1974, 1978) and Townroe (1974).

In general, however, analyses in enterprise geography have tended to ignore changes in the magnitude or character of activities at a given site even though changes at existing locations are as important as seeking new locations (Steed, 1968). There are indications that a high degree of locational inertia exists even amongst plants of older vintage because of the possibilities of output substitution (Auty, 1975). More importantly, in industries where plant product mix changes rather rapidly, firms may deliberately search for locations or establish plant intrastructure which possess a high degree of operational flexibility (Steed, 1971 a & b; Krumme, 1979), thereby increasing plant locational inertia. For the large multiproduct, multiplant company then, the exact location of their individual plants will perhaps not be seen as a very important management decision because it is possible to shuffle production between plants relatively easily (Townroe, 1969, 24).

Product Differentiation

It is commonly accepted that in oligopolistic industries, where price competition is largely eschewed, product differentiation constitutes the key competitive strategy for firms. Product differentiation, as a strategy,

> Is concerned with the bending of demand to the will of supply. It is an attempt to shift or to change the slope of the demand curve for the market offering of an individual supplier. . . . It results from the desire to establish a kind of equilibrium in the market by bringing about adjustment of market demand to supply conditions favourable to the seller (Smith, 1956, 5).

The success of this strategy depends on the consumer having some basis for establishing a preference between competing products (Caves, 1972, 18). Variations in preferences are in turn the result of a lack of homogeneity on the demand side because of different customs, desire for variety or exclusiveness or simply differences in user needs (Smith, 1956, 4). Product differentiation is achieved by the firm in four different ways: store or plant location, quality of service, physical differences and advertising or promotion (Scherer, 1970). First, the firm may select plant or store locations which are more convenient in terms of travel time and/or transportation costs than rival locations. Second, exceptional service and terms of guarantee differentiate one product from another. Third, a product usually has some distinguishing features which make the brand sold by one producer different from a competitor's. Further, behind the brand mark all sorts of differences may exist in terms of design, performance characteristics, material composition, and so on. Finally, products are differentiated in terms of the subjective image they impress on the consumers' mind through brand labelling, advertising or direct word-of-mouth sales promotion.

For a product which has gained national and indeed some degree of international acceptance, notable characteristics, aside from its brand label or logo, are its physical features including design, size, shape and performance which distinguish it from other competing items. A product's physical attributes may remain relatively stable or may be subject to frequent change. However, the period over which such attributes are 'frozen' or altered will depend upon the type of product, competitive climate, demand conditions and technological circumstances.

Static and Dynamic Differentiation

Most studies of product differentiation have focused on the static notion of physical product differentiation which:

> . . . is often considered to be of two broad types, style and quality, the former involving physical appearance and the latter based on measurable performance characteristics. The distinctions betweem them are not clearcut and may be blurred by differences in image or other subjective attributes, created or emphasized perhaps by promotional advertising designed to build consumer loyalties (Steed, 1978, 309-10).

The key emphasis, however, is the assumption that physical differences among competing products remain fixed and do not alter with time. This notion may be strongly influenced by several factors including the inflexibilities experienced at the production end. For instance, some firms which have committed themselves to a set of physical and subjective product attributes may find it difficult to escape that commitment sometimes until years have passed (Scherer, 1970, 324).

In reality, subjective and especially physical attributes seldom remain fixed despite obvious production inflexibilities. For most, if not all products, change is a rule rather than an exception. Products are not merely differentiated at a point in time but often from one year or season to the next, the exact length of the change cycle differing between products. If a product can be defined as a set of characteristics which in combination fulfill a function, or several functions in the case of complex products, a manufacturer competing on the basis of product differentiation will select

> . . . that combination of characteristics by which he expects to attract a positive preference by a large body of customers to ensure the product's viability. This is essentially a procedure of product definition which, under product differentiation, means that several definitions are possible at any one time. Given a changing market environment, the products offered have

> to be periodically redefined and updated. The faster the rate of environmental change the greater is the tendency for products to reflect only partially the actual buyer requirements, so enlarging the opportunity for product differentiation. New characteristics have to be added and old ones dropped . . . Thus a product policy becomes a dynamic process of differentiation by which firms periodically (or, in extreme cases continually) probe out the changing buyer requirements (Dorward, 1979, 215).

Dynamic product differentiation is the manifestation of several factors. It may represent an incremental innovation designed to improve product attributes which may include performance, cost, quality and design. As Utterback (1979, 53) notes:

> Incremental improvements in products . . . are not as dramatic as major product . . . innovations but they may be the most important type of innovation because of their short-run economic and competitive impact. Incremental innovations are stimulated by demands for reduced cost and improved quality as products become less differentiated and, therefore, more directly in competition with one another. While each step improvement in either cost of production or quality may be small, such changes are clearly focused and may add up over a period of time to very consequential gains.

Incremental innovation also occurs imperceptably through simplification and redesign of parts of the product. As product volume grows, the firm may demand special design of a greater proportion of the components it uses. Substitution of less costly or more prefinished materials for those in earlier designs may also occur.

Incremental innovations appear to be especially important in highly efficient and capital-intensive production processes involving large-scale plants used for the manufacture of one of a few standardized products. In this circumstance, innovation is constrained by past investments in both product design and production process technology. Small improvements applied continuously in both product and process can maintain the production unit's competitiveness and can lead to relatively swift and certain gains, which, because of large production volume, can have an immediate and important impact (Utterback, 1979, 53-4).

From a competitive viewpoint change appears to be an integral and necessary component of product policy. The analogy has often been made that "products, like people are subject to the same mysteries of birth, growth, maturity and death" (Andrews, 1975, 2). No branded product can be expected to hold a permanent franchise in the market place, and the lifetime sales of many products reveal a typical pattern of development known as the product life cycle. This cycle normally consists of four stages, product introduction or market development, growth, maturity and decline (Kotler, 1965; Levitt, 1965). Generally, the sales volume of a new product goes through a phase of slow growth (Introduction), followed by one of very rapid increase (Growth). At Maturity, sales begin to taper off and eventually decrease to signal the final stage, Decline. Product life cycles, however, represent a useful idealization rather than a rigid description of all production life histories (Patton, 1959). There is nothing fixed about the length of the cycle, the length of its various stages and indeed the classical configuration of the life cycle curve, an inverted 'U'. The rate of product degeneration, for instance, is governed by the rate of technical change, market acceptance and ease of competitive entry (Dean, 1950). For example, fashion clothing may have a life cycle of a year while that of commercial aircraft may last a decade or more. For some products, the life cycle curve may from the very onset be "infinitely descending" (Levitt, 1965, 82).

When new competing products entering the market are clearly superior, a firm wishing to remain competitive may be forced to adapt by upgrading its products, in the form of design, performance or quality improvements, in order to meet the challenge posed by competitors. In a mature industry where sales expansion is limited, a key strategy is to create a high degree of turnover in the ownership of products through planned obsolescence. Frequently, this entails a simple revamping and relaunching of an old product with a new formula or simply a new packaging. Such periodic updating strategies to create new products from old can lead to upward flips in the menacing declining life cycle curve for the individual product (Andrews, 1975, 6). The automotive industry is, unequivocally, the best example of this form of product strategy among North American manufacturing industries. Such policies may involve incorporating ideas orginating within the firm or 'adapting' them from rival companies, behaviour which is not unusual in oligopolistic industries.

Besides the producers themselves, governments have been playing an increasingly important role in affecting product change and development. Mounting awareness of, and concern for, the environment, health and safety have led the government through its various agencies to introduce legislation to alter the composition, design, quality and standards of both industrial and consumer products in order to meet new and more stringent standards. Perhaps one of the most visible and widely-known effects of government intervention of this form concerns the automotive industry's products (Abernathy, 1980; Hanson, 1980). Government regulations introduced since 1966 have greatly altered the size, shape, design and technology characteristics of modern automobiles.

Product Differentiation and Market Diversity

The market for a variety of products including refrigerators, cars and ovens, is often mistakenly assumed to be uniform or homogenous. Within specific product markets, however, demand tends to be characterized by a high degree of divergence and for the manufacturer, it may be more advantageous to accept divergent demand as a market characteristic and to adjust its product lines and marketing strategy accordingly rather than to regard the market as being strictly homogeneous. Generally, this requires a merchandising policy which accurately defines how a firm's products can satisfy the requirements of one or more distinguishable market segments. The strategy of product differentiation is thus formulated in the context of a segmented as opposed to a homogeneous market. Smith (1956) has argued that the act of recognizing or identifying heterogeneity within a market and formulating product policies for such a market, commonly referred to as market segmentation, constitutes a form of strategy in itself and there are indications that product differentiation and market segmentation are closely related, perhaps even inseparable.

Market segmentation is based upon characteristics on the demand side of the market and represents a rational and more precise adjustment of ~~product~~ and marketing effort to consumer or user requirements. According to economists, segmentation is disaggregative in its effects and tends to bring about recognition of several demand schedules where only one was recognized before. Successful application of market segmentation strategies tends to produce depth of market position in the segments that are effectively defined and penetrated. In essence, a producer who employs market segmentation strives to secure one or more wedge-shaped pieces of the market pie.

Smith (1956, 6) suggested many reasons why formal recognition of market segmentation as a strategy has emerged. One of the most important of these occurs when there is decrease in the size of the minimum efficient producing or manufacturing unit required in some product areas. American industry has also established the technical base for product diversity by gaining release from some of the rigidities imposed by earlier approaches to mass production. Hence, there is less need for generalization of markets in response to the necessity for long production runs of identical items.

Product differentiation and market segmentation are often employed jointly but more commonly they are applied sequentially in response to changing market conditions. In one sense segmentation is a momentary or short term phenomenon in that effective use of this strategy may lead to more formal recognition of the reality of market segments through redefinition of the segments as individual markets, but redefinition may later give away to differentiation. The frequency of change of both physical product differentiation and market segments varies with different products. For some, clothing in particular, change may be momentary or short lived, but for others, such as aircraft, longer intervals separate change in product attributes and redefinitions of market segments.

Product Differentiation and Manufacturing Economies

For the individual firm, dynamic physical product differentiation and market segmentation imply having to produce a myriad of products with a wide range of individual specifications differing marginally on the one hand or substantially on the other. This may constitute a real challenge to the producer, particularly when he has to reconcile a firm's extensive and changing product line to certain production and distribution economies of scale to be obtained.

Economies of Scale

Economies of scale, commonly refer to the lowering in unit cost of products manufactured and sold in association with the operation of a large as opposed to small production, distribution and merchandising entity. The "entity" may consist of a production line, a plant, a complex of integrated plants or an aggregation of plants constituting a firm (Scherer, 1974, 16). Such economies are believed to exist when unit costs are found to be lower for larger entities. Further, there is speculation that expansion beyond some scale may not lead to additional cost savings. Diseconomies of scale may indeed prevail when an entity grows to a magnitude too large to be efficient. Often used in conjunction with economies of scale is the concept of the "minimum optimal scale" (MOS) or sometimes the "minimum efficient scale"(MES), conventionally defined as "that scale at which scale economy opportunities are first fully exhausted and the unit cost curve becomes horizontal . . ." (Scherer, 1974, 19).

Following extensive theoretical and empirical analysis, with most attention focused on plant economies of scale, recent studies have shown, the concept to be extremely complex. Economies may, for instance, exist at the product, multiproduct, plant, multiplant and firm levels, each interacting with the others, and being highly dependent on the economic-environmental context. Some comments on the form of economies of scale, and particularly their interaction with geographic factors follow.

Plant Economies of Scale

The existence of economies of scale in manufacturing plants, the basic production unit in secondary industries, is widely accepted. However, what constitutes the MOS plant for a given industry is partly a reflection of locational conditions. Geographic circumstances and spatial variations in factor costs within a given temporal context can alter the optimal plant size. When costs of product distribution and the spatial configuration of market areas are taken into account, the most suitable size may differ from that estimated to be 'ideal' from solely an engineering cost standpoint. A large scale plant serving a geographically extensive market area may be difficult to justify when transport costs per unit product are proportionally high. Other factors, such as spatial variations in wage rates, may influence the choice of technology and hence, ultimately, optimal plant size. Further, a favourable labour 'climate' may permit the working of multiple shifts and thus increase output through more intensive use of plant facilities. The importance of geographical factors is clearly emphasized by Scherer (1974, 20) who notes: "What is optimal in one region can be economically disastrous elsewhere". Other geographical influences affecting optimal plant scale variations, particularly between countries, include political, economic, legal and cultural differences (Scherer, et al., 1975).

Optimal plant size may also be affected by product mix. A given plant specializing in one homogenous product may be able to produce a much higher level of output than if it was producing several products. Though purely from a production cost standpoint, the former situation may be more efficient than the latter, both could conceivably be equally acceptable from a marketing or competitive viewpoint. Moreover, the optimal size may decrease over time depending on particular circumstances. In their international study of twelve industries, Scherer, et al. (1975) detected decreases in MOS outputs over time in weaving, shoemaking and antifriction bearings, because of increasing product line complexity and relocation to low-wage areas where limited labour supplies constrain plant size.

Product Economies of Scale

The manufacture of a specific product often involves fixed set-up costs, a cumulative increase in operative learning skills and productions engineering know-how as production-run length increases. The cost savings so derived are referred to as "product-specific" scale economies since they are closely aligned with individual product volume, not aggregate plant output.

The sources of product-specific scale economies are total output volume, output rate and length of production period. For large expected volumes and long standardized production runs, it is possible to cut costs by employing completely automated production techniques. Production on a job-shop basis, typical of small lot sizes can be substituted with straightline operations which involve the use of highly specialized machines executing highly disaggregated steps in the manufacturing process. Generally, during production involving high volumes and standardized products, cost saving through a high degree of automation is attainable with automatic work transfer devices, industrial robots and computers.

One of the major cost advantages of product specialization with large outputs over long production runs arises from the reduced expenses from fewer line changes, less resetting of machines and lower downtime costs which include wages paid to idle workers and loss of production. Recent studies on the higher production costs and lower efficiency of many Canadian manufacturing plants, vis-a-vis their American counterparts, have emphasized the lack of these product-specific economies (Scherer, et al., 1975; Daly, et al., 1968; Caves, 1975).

As production run length is extended, both workers and management become more familiar with operating techniques because by concentrating on narrow repetitive tasks over extended periods, workers are able to develop dexterity in carrying out intricate tasks, giving rise to 'learning by doing' economies. There may be advantages from less need for trial and error, elimination of material wastage, improvement in the quality and uniformity of output and higher productivity, all combining to reduce unit production costs. Further, as volume gets bigger, the law of large numbers tends to decrease the importance of random fluctuations in demand and production failure so that firms can manufacture closer to the expected demand and carry proportionately lower inventories of finished goods, material inputs and replacement parts for machinery.

At some critical volume production may become so specialized, automation and workers so efficient that further increases in volume may not lead to significant cost decreases. This volume is the product MES. Like plant MES, that for a specific product is a function of input costs--labour, capital, energy and raw materials--and is, hence, region or country specific (Lecraw, 1978, 4). Since changes occur in product specifications, design and inputs and process technology, product MES also no doubt shifts over time. Further, production economies of scale for a single product may be exhausted at volumes either above or below the MES plant required to produce it, a feature of scale economies which may have implications for product specialization or diversity at the individual plant level.

Firm Economies of Scale

Besides those that are product or plant related, scale economies may exist at the level of the firm as well. A major difficulty in assessing the economies of scale at this level has been correct determination of whether size economies derive from the firm's desire to be efficient or from the exercise of market power which is not necessarily related to the efficiency factor. Granted that there are "pecuniary" economies of scale due to the exercise of market power in the factor and product markets, studies have also suggested the presence of some true economies of scale due to production capabilities and other non-production oriented activities.

Important non-production activities include research and development, management, finance, operation and accounting control, advertising distribution and risk-taking. Much of the evidence for the existence of scale economies relating to the above sources is reviewed by Scherer (1974) and Lecraw (1978). Notable is the uncertainty that still surrounds the concept.. Empirical evidence tends to be industry or even firm specific and more general pronouncements on the existence of non-production scale economies must be accepted with some caution.

Of particular interest to our current analysis is the presence of production and distribution scale economies. Large industrial firms, frequently are suppliers of multiple, differentiated product lines, and multiplant operators as well. These two features probably combine to allow firms to realize certain economies of scale. Scherer, et al. (1975) note that a multiplant firm may be able to lower its total unit costs by balancing transportation costs with product and plant scale economies. Fewer plants operating at the most efficient scale, usually imply lower production costs but higher transportation costs as products from these plants are sold over larger market areas. When products tend to have significant unit transport costs, production in several smaller, regional plants may enable the firm to minimize average total costs per unit. Another source of scale economies is in coordinated multiplant investment staging to replace obsolete plant equipment or to serve growing demand. A firm which operates multiple plants because moderately high transport costs induce regional decentralization of production has the advantage of being able to coordinate plant investments on an interregional basis. In essence, it can expand one regional plant at a time; each new capacity investment can be used to meet growing demand in adjoining regional markets as well, until all plants are expanded to serve their respective, expanded markets. However, investment staging will require expensive cross-shipments of goods until all plants have been expanded. Manne (1967) has shown that when unit transport costs are not prohibitive and in the presence of appropriate competitive conditions, a multiregion investment staging strategy can sharply reduce the average level of excess capacity and make it possible to construct plants or plant additions of considerably larger scale.

The multiplant firm, unlike single plant rivals, possesses certain advantages especially in the production of multiple product lines.

First, it has opportunities to allocate the manufacture of individual product lines to plants so as to reap product-specific scale economies. For example, some plants can specialize in single high volume lines while low demand items are centralized to gain maximum product specific scale economies, an allocation pattern expected in industries with low transport cost compared to product value. Alternatively, firms may choose a pattern of allocation that enables production closer to optimal plant scale and which would facilitate investment staging and the bringing of large blocks of capacity into line. This involves producing more than one product, some at MES and others below MES at separate regional plants. Multiplant firms will thus tend to have a higher level of plant capacity utilization and therefore lower costs. Scherer, et al. (1975), termed this form of allocation "optimal (geographically) unbalanced specialization".

Notwithstanding historical circumstances (that is, acquisitions or mergers) that lead large firms to have several plants, there may be real scale economies that accrue to multiplant operations. These multiplant economies of scale are generally realized, "when and to the extent competitive market processes break down"--that is in oligopolistic situations where product competition is more important than the role of prices and interdependence based on maintaining stable market shares is not uncommon (Scherer, 1974, 40). An example of such economies may indeed be the flexibility multiplant producers have in producing products in plants located near consumers thus reducing delivery times, a form of product differentiation strategy noted earlier.

<u>Product and Plant Manufacturing Assignment</u>

While large industrial corporations produce a wide range of differentiated products, often in multiple plants, it is usually the case the number of distinct product lines exceeds the existing number of plants. How then are individual products allocated for production purposes to individual plants?

Analyses of multiproduct and multiplant manufacturing and distribution problems have usually been a major focus of Operations Research. Although numerous models and algorithms have been developed, the emphasis with few exceptions, has not been upon the allocation of differentiated product lines to a relatively stable system of plants. Among the exceptions is the work of Dillon (1956), who proposed a simplified technique dealing with the production allocation of several differentiated goods among a set of plants and the distribution of these goods to several markets in order to meet a set of inventory and profit objectives of the firm and ultimately to determine the closure of some plants or the addition of new capacity. According to Dillon, the key to solving the problem of geographic distribution of production in multiplant operations, which is a complex non-linear programming problem, is by considering only those plants, products and consumers who account for the preponderance of business. Further, by incorporating only discrete levels of output, and not allowing for potential scale economies in production, and by eliminating all but one transportation link between each plant and each consumer, he found his previously complex problem could be simplified considerably and solved by manual computation.

Another exception is the analysis by Folie and Tiffin (1976), which is similar in several respects to that by Dillon, and leads to the development of a mathematical solution to production allocation and distribution problems encountered by an Australian firm producing a variety of potato chips for domestic and export markets. The problem involved examining the distribution of nine varieties of potato chips sold under two brand names, from eight factories, to satisfy demand in each of the four Eastern States of Australia. An optimizing algorithm was developed to determine which factory manufactures which product and to which warehouse the products are delivered in order to minimize overall production and distribution costs and yet satisfy the demands in each market area. An important factor was the firm's policy to offer a total range of chips to the consumer, even though the production facilities in each region did not always have the capacity to manufacture the full product range.

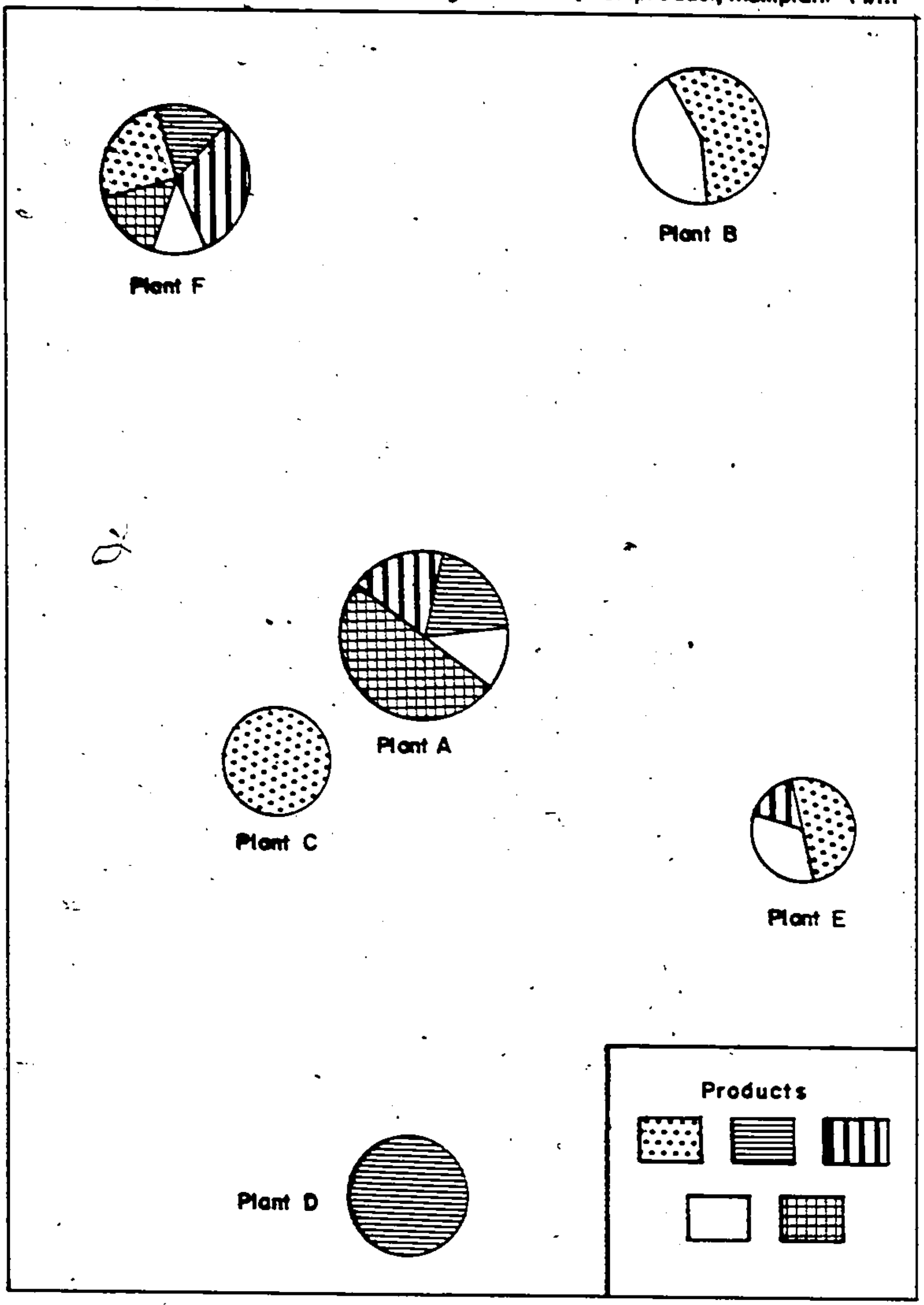
These studies were designed for a rather specific purpose, formulation of optimization models for decision-making and strategy implementation given a narrow set of internal and external corporate environmental constraints. Viewed in this context, they are important contributions. Further, they stress certain features of the product-plant assignment strategy: the importance of regional demand characteristics in determining the product responsibilities of plants, and the rather varied effects different corporate objectives may have, ultimately, on product-plant assignment patterns. As with other exercises in Operations Research, however, they have concentrated upon mathematical solutions to relatively highly simplified situations, a factor which inevitably circumscribes their utility. For the more complex situations of the real world, however, companies must frequently resort to intuition and rule-of-thumb methods.

Patterns and Rationale

At some specific time period, individual plants may reveal one of the following product portfolios: single line, full-line or multiple line (See Magee, 1968; Scherer, et al., 1975). For a hypothetical firm consisting of six plants and five product lines, plant product assignment may take the form illustrated in Figure 1. Plants C and D each have a single product line; A, B and E are multiple line plants, while F is a full-line facility. For the single-line plants, product specialization may indeed be a strategy to secure product-specific scale economies, in particular long, uninterrupted production runs which could benefit further by cost saving 'straightline' techniques, higher level of labour efficiency and quality control and economies of massed reserves. Other factors that may encourage specialization are product-specific MES that exceed plant MES, and insignificant transport cost per unit product value, which enables production to be centralized and shipped to distant regional markets.

At full-line plants, all product lines marketed by the firm are made under one factory roof. This pattern may be evident when product specific economies of scale are shorter than plant specific scale economies, finished product transportation costs are high, manufacturing location is not tied to material or energy and markets are geographically dispersed. Not infrequently, such plants may include those assigned particular geographic territories. From a marketing perspective, there are advantages in producing all items at each plant. When only some items are supplied directly at each plant location, difficulties in supplying customers may arise. Such difficulties may include higher

Figure 1: Hypothetical Product Assignment in a Multiproduct, Multiplant Firm



transport costs due to extensive cross-shipments of low volume items, customers receiving orders in separate shipments from different production points and delays in shipments because of different transport modes used for the movement of dissimilar items (Magee, 1968, 251).

Full-line plants may suffer from certain diseconomies particularly when individual product lines fail to exhaust their respective product-specific scale economies. Scherer, et al. (1975) who derived several comparisons based on estimates utilizing construed but realistic cases, and allowing for plant closures, was able to demonstrate that generally, full-line production was less efficient compared to a situation in which some plants specialize in specific products while others produce multiple lines. While the extent of absolute or extensive diversification may be less evident in domestic plants, it may not necessarily be so for the multinational branch plants. The frequent references to foreign-owned branch plants in Canada being miniature replicas of their parent firms is highly suggestive of this situation. The high level of diversity in product-mix in foreign-owned branch plants is commonly attributed to the protective tariff which prohibits imports and sustains costly domestic production.

Although there are reasons leading firms to assign a single line or complete line of products to their respective plants, there also exist reasons to manufacture only a partial line at some plants. Frequently, there are specific constraints on the products that can be assigned to a certain plant; plant equipment may be capable of producing only a narrow range of products which require related production processes or common material inputs (Ullmann and Gluck, 1969, 1; Salveson, 1956, 232-3). In addition, multiproduct mandates can benefit from joint economies of production based on the common use of some fixed factor such as a machine or a processing factor subject to capacity limitations (Dan⌀, 1966, 165). For example, if two products are manufactured by two different processes, and if these processes have to share the services of the plant's fixed equipment, these same processes cannot be considered separately. This type of interdependency is particularly important in multiproduct plants where several products are processed wholly or in part by the same machines.

The third factor favouring multiline plants concerns the lack of uniformity in the demand for individual products. A large proportion of a firm's total sales is usually accounted for by relatively few product lines while a small part of sales comes from the majority of product lines. One common rule-of-thumb to describe this is the "80-20" rule; about eighty per cent of demand is accounted for by the twenty per cent of the relevant items (Magee, 1968, 71 & 74). Generally, then, there are two types of products in a firm's product portfolio, low- and high-volume varieties, the manufacture of which are sometimes separated; the separation of low- and high-volume product and concentration of the latter in one or a few plants can yield the type of product-specific economies examined earlier. Magee (1968, 254), also notes:

> Some companies have found it desirable not only to concentrate production of low-volume items but even to set up separate production or assembly facilities for these items within the few locations where their production may be concentrated. In this way, these firms eliminate the problems and confusion of handling the very large number of low-volume items from the main production operations. A separated "small-volume shop" may be set up with skilled personnel having the range of training needed to produce a wide variety of products. The shop can be equipped with machinery that can be flexibly operated and utilized efficiently in producing a wide variety of products, even though such equipment may not be as efficient to employ in the manufacture of higher-volume items. The problems of handling paper work

and supervising the variety of orders in progress can also be simplified where these are concentrated in a small area rather than dispersed throughout a sizeable plant.

The general concentration of low-volume items can be readily demonstrated. Given the volume of demand for a product, the cost of production (including cost of setups, paper work and holding inventories) and distribution costs, Magee (1968, 252-4) derived the optimum number of locations in which production should occur as follows:

$$n_i = \frac{k_2}{k_1} \sqrt{V_i}$$

where n_i (the optimum number of locations for the manufacture of the i_{th} product) is proportional to the square root of the volume of demand for the item in question (V_i). The constant of proportionality is a ratio of the constant k_2, characteristics of transportation costs, to the constant k_1, characteristics of the cost of ordering processing, setup and holding stock at each location. It is noteworthy that as the cost of transportation is reduced relatively, the indicated optimum number of locations tends to fall in proportion. However, it is evident that volume plays an important role in relation to how many plants a product can economically be assigned for manufacture.

Besides the factors directly associated with scale economies, there may indeed be other variables that influence plant product portfolios, including the desire to avoid excessive risks. For instance, besides its U.S. plants, IBM's worldwide product assignment strategy since the late 1950's saw individual plants specializing in a narrow range of computer products and components (Harman, 1971; Hu, 1973). The company perceived this strategy as a means of discouraging nationalization or expropriation because all non-U.S. plants were designed to be highly interdependent of each other for supplies and parts. In contrast, Ford's European operations embarked upon a dual-sourcing policy for its various car lines, following the disruptions in supplies caused by strikes particularly in the United Kingdom (Hu, 1973). These examples, clearly illustrate the rather important factor of specific corporate strategies or policies which may, under given circumstances, have a substantial impact upon product plant assignment.

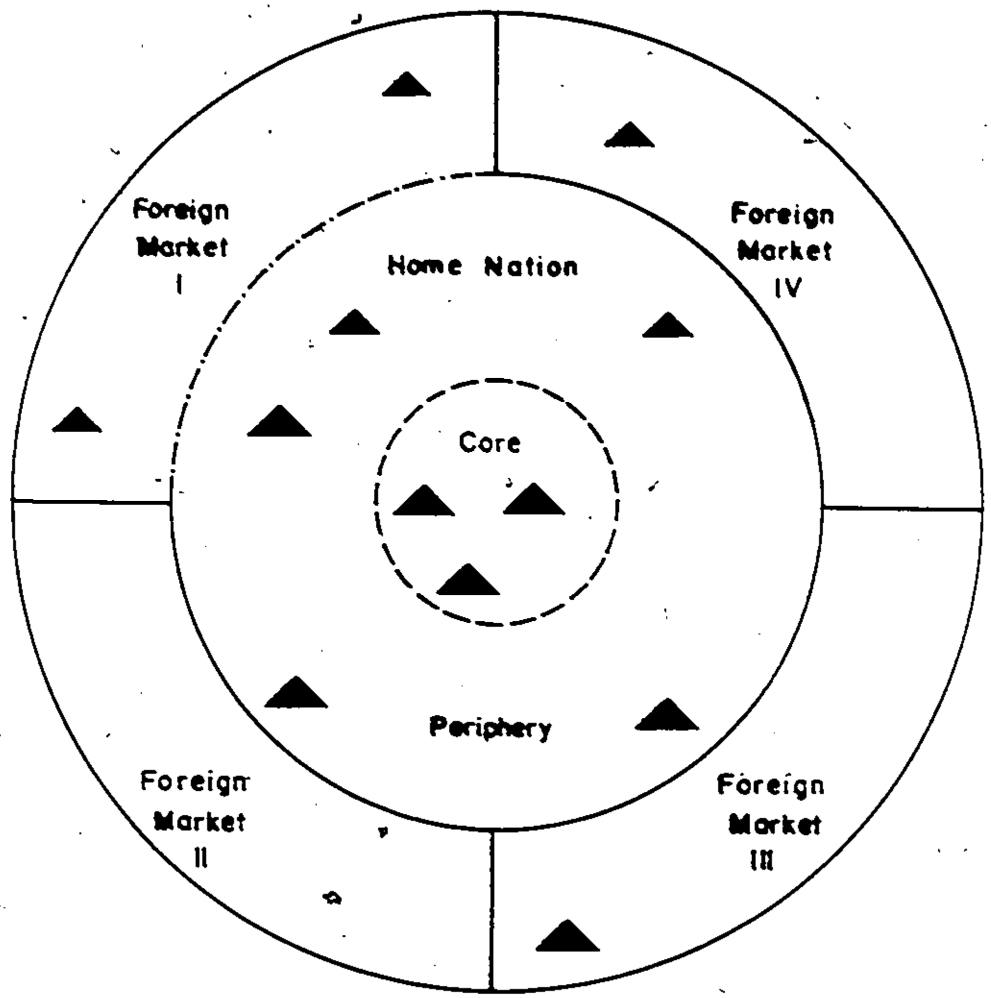
The role of another factor, corporate organizational structure in product-plant assignment, has been noted briefly by Watts (1974). He suggests that a structure based on geographical or product divisions is less amenable to production rationalization on a firmwide basis than one which is functionally oriented. Each division with a certain degree of autonomy and control of its plants may be reluctant to concede parts of its production capacity to make products of another division, especially if individual divisions are treated as independent profit centres. One that is functionally structured is generally better equipped to rationalize activities along several product lines and regions. Hu (1973) also observed that Ford's product sourcing policies were not satisfactorily attained until an appropriate corporate administrative structure was established to facilitate the planning necessary for coordinating the various production activities of plants located in different countries.

Product Mix and Plant Location

Thus far, little reference to the specific role of geographic attributes in plant-product mix has been made. Considerable attention has been focussed upon the location of the single-product firm but industrial location literature has paid rather scant attention to multiple product location analysis (Beyers and Krumme, 1974). A first step in the analysis of the spatial features of product-plant assignment is an explanation of plant location and spatial organization in the context of multiplant firms. This is important because plants operated by giant multilocational enterprises are non-independent entities. Each unit functions in the context of certain economic and geographic roles within a larger system of plants. As such, plant locational attributes must necessarily be defined in terms of the corporate spatial system and not from the standpoint of the traditional single-plant firm (See for example Chapman, 1974).

Several studies by McNee (1958, 1963, 1964, 1974) and recently by Håkanson (1979) have led to some tentative statements regarding the structure and geography of large multifacility enterprises. Generally, there are three levels of plant location which collectively form the corporate environment, defined as the structural and spatial confines within which the firm functions (Figure 2). First, a 'core area' may be identified; it is often the region in which the enterprise was founded and in which early development and growth tends to be concentrated (McNee, 1974, 55). Further, it is the administrative focus of the firm, where the head office is located, and the location of the firm's older plants. The second major region is the 'periphery' which typically consists of newer plants, established to serve a growing regional market, perhaps to flee the 'diseconomies' of the core area. Collectively, these two areas comprise the national environment or 'home nation' of the enterprise. The third corporate region is the international environment which consists of different foreign markets differentiated according to varying

Figure 2: The National and International Corporate Environments



▲ Plant

—·— International boundary, trade impediments removed

——— International boundary with trade impediments

– – – – 'Industry region' boundary

Source: After Håkanson (1979)

levels of economic accessibility resulting from transportation costs, cultural differences, custom barriers or other trade impediments. Most foreign markets, II, III, IV in our figure, have trade barriers such as protective tariffs which are sufficient to encourage the establishment of branch plants which produce largely for those markets. In other markets (such as I) trade barriers may have been reduced or eliminated as with the case of common markets. Plants erected during a previous era, may still be operating, but only perhaps after having been rationalized.

The lack of significant emphasis on product location and the spatial variable has been striking amongst analyses of the multiplant, multiproduct firm, particularly with respect to the situation of firms with differentiated products. In fact it is only recently that two economists, Kennedy and Copes (1978), have provided a theoretical assessment of the effects of product differentiation upon production location of even the single plant firm. The producer of differentiated products, they argue, will show a tendency to situate at some centralized point of the market because the firm draws consumers located throughout the market area instead of a well defined geographic region as in the case of manufacturers of homogeneous items. Such locational behaviour is apparently influenced by a rather unique spatial consequence of product differentiation which is

> . . . a reduction in the friction of distance to the extent that the sales territories of the competing manufacturers will tend towards a complete overlap in national markets except in those cases where transport and distribution costs form a very high proportion of the value of output. . . . Within an environment of overlapping sales territories the firm strategy is no longer aimed at the total domination of its sales territories but at gaining a maximum, or at least a commercially viable market share (Dorward and Wise, 1978, 26).

Dorward and Wise (1978, 28) also note that:

> Given heterogeneous buyer requirements and the usual unequal spread of economic and social activities over the market, it seems more appropriate to expect those buyers with similar product requirements to be concentrated in areas where environmental opportunities and constraints are similar. Thus the market will be made up of geographical segments, each one containing a distinct grouping of demand characteristics.

This gives rise to the probability of suppliers offering products which appeal to groups of buyers rather near or at considerable distances from the plant. A study of the West German medium-size truck producers and particularly the spatial market characteristics by Dorward (1979) provided confirmation of this. The competitive process based on products themselves and the spatial variations in demand for individual products may have an impact upon where product supplies are sourced. However, particularly from the standpoint of the individual firm, these studies provide only limited insights into product-plant assignment and location largely because of the focus on product differentiation at the industry level, that is, between firms.

Product differentiation, it was noted, exists within firms as well. The recent study by Scherer, et al. (1975) has advanced both the theoretical and empirical considerations regarding the geography of multiplant operations making single-, and more importantly, differentiated-product lines. They provide key observations on plant product mix patterns, the role of economies of scale at the product, plant and firm levels in product assignment, the efficiency of different product-plant assignment strategies, product and plant numbers and, to a much more limited degree, the features of product and plant location.

One recurring observation of Scherer and his collaborators on the subject of plant-product mandates is the "centralized" production of low-volume items and decentralization of high-volume lines amongst several plants of a multiplant system. The key factors leading to such distribution patterns amongst the firms surveyed were apparently lot size economies which "tug centripetally" and high transportation costs in relation to product value which exert a pull toward geographic decentralization (Scherer, et al., 1975, 302). Centralization refers obviously to one or very few plants where low-volume lines are produced. Often these lines consist of specialized products which require special skills to cope with unique features, quality standards and frequent startups. They are generally produced in the core areas. High-volume items tend, however, to be produced in several plants located presumably in both the core and periphery. Whether within a national context core-oriented plants are more likely to reveal a high degree of product-mix compared to peripheral plants, because core-plants produce several low-volume lines, was not clarified by Scherer, et al. (1975). However, Magee's (1968) analysis, indicating that there may be advantages for a firm in operating multiple line regional plants, suggests that peripheral plants may not be less diversified compared to core area plants. And Scherer, et al., (1975) do indicate that a firm pursuing a full-line strategy in all its plants is not operating at a significant cost disadvantage compared to an unbalanced, geographic specialization strategy. According to Luttrell (1962), however, branch plants which are located at significant distances from the main factory or corporate headquarters tend to be larger, and self-contained and may duplicate all or part of the parent factory's product range or perhaps become the firm's exclusive source of certain product lines. Intermediate distance, semi-independent branches produce only parts of the firm's product activities.

If the Canadian experience is representative, it is probable that the product-mix at foreign branch plants is usually highly diversified, especially if the plants are fully protected by high tariffs designed for import replacement. With penalties on imports set deliberately high in some foreign markets, multinationals have little choice but to designate a full, if not a rather extensive product line to those foreign plants, if they wish to continue serving those markets. If, however, tariff protection is removed, it does not necessarily mean that foreign branch plants will be closed. The experience in such cases has been that some firms reduce the number of product lines and rationalize to obtain longer production runs, the extra volume being warranted if the plant's increased efficiency enables increased domestic market share or exports. In these circumstances, the product-mix of foreign plants may perhaps be indistinguishable from that of peripheral plants located in the home country.

Additional important insights into the practice of international product-plant assignment have been made by Valtz (1964), who investigated a U.S. multinational operating plant in several Western European countries and its decision to rationalize its production facilities and make each product in only one location. His study underscored some important variables in the rationalization process. Lower unit costs, the result of longer production runs of single products was the principal reason leading to a reallocation of product lines to plants. Besides these advantages, Valtz also indicated the role of certain pecunairy costs arising from the planned change, including factory retooling expenses, worker retraining, possibility of layoffs, the risks of extreme specialization, loss of established suppliers and the expense of modifying products to suit individual markets. However, although he identified the problems relating to product-plant assignment, he did not discuss the final assignment decisions, and hence did not reveal the locational features of assignment.

International rationalization may be the initiative of individual companies (Science Council of Canada, 1980), a corporate adaptive response to changed environmental circumstances. For instance, the formation of the European Economic Community prompted greater product specialization on a plant-by-plant basis to obtain product specific scale economies (Grubel, 1977, 80). However, freer trade, per se, may not be sufficient to trigger spontaneous product realignment. Delays in rationalization may sometimes be traced to the firms themselves or individual national governments. Evidence obtained by Scherer, et al. (1975), for instance, on S.K.F.'s Western European operations suggested that rationalization was delayed for a decade after the EEC's formation and when it did occur it was the pressure of competition from cheaper Japanese imports and, ostensibly, greater savings to be had through spatial product specialization that finally stimulated the action. In addition, respective national branch plant administrators are known to jealously protect the perceived interest of their own operations,--especially when they enjoy a strong degree of corporate autonomy,--and oppose product rationalization schemes (Valtz, 1964). Further, national governments, like branch plant administrators, are inclined to be wary of international rationalization schemes undertaken by multinational corporations especially when there exists the prospect of losing key product activities and perhaps even a manufacturing facility without comparable replacements. On occasion such fears are translated into written safeguards, such as the

Canada-US, Automotive Products Agreement, 1965 or legal instruments in the form of non-tariff barriers or simply covert action and political pressure.

Product-Plant Assignment Change and Location

With regard to product-plant assignment, one study worth noting is that by Berry (1967), who analysed plants belonging to the 494 largest U.S. industrial corporations listed in the <u>Fortune Plant and Product Directory</u>, 1961 and 1966. Part of his analysis revealed that these plants "are by no means tied to particular products even over as short a period as five years . . ." when products are measured at the two- and four-digit Standard Industrial Classification code level (Berry, 1967, 419). He further questioned the view that companies add and drop products chiefly by closing old plants and acquiring new ones in view of the evidence that there is substantial entry and exit amongst industries occurring without shutting down or adding separate plant facilities. Given the additional finding that no significant change in the degree of plant specialization occurred over his analysis period, 1960-65, he concluded that the "capital represented by plant facilities is evidently more mobile than the theory underlying . . . investment models has assumed". At least part of the fixed capital of modern manufacturing can be allocated readily among different manufacturing activities (Berry, 1967, 419-20). Circumstances that lead to change in plant product mandates and geography include product turnover, plant rationalization and fluctuations in product output.

<u>Product Turnover</u>

For reasons alluded to earlier, a firm may find it necessary to market new product lines or withdraw aging or unprofitable items.

Turnover of products within a firm has a direct impact on the product-mix of particular plants. A product may be added to some plants while for others products may be removed. For yet a third group of plants, although, the number of items may not be altered, the specific items that constitute the plants' product portfolio may be changed. Further, the rate of product turnover and hence plant-product change no doubt varies considerably between industries, depending probably on stability of market preferences, degree of non-price competition, and developments in product and process technologies.

The literature dealing with the product life cycle model offers some insights regarding the production location of new and mature (standardized) products. A key feature of the product life cycle is the changes in relative importance of individual production factors during various phases of the product cycle (Vernon, 1966). The 'introduction' phase is usually characterized by low capital intensity largely because of relatively short production runs and rapidly changing technology. Firms rely a great deal upon external economies, subcontracting and specialized human skills in the scientific and engineering fields. During the 'growth' phase individual firms confront demand which is increasingly price elastic. Mass production techniques characterized by a higher capital-labour ratio become a necessary means to reduce prices as industry competition also grows. Finally, in the 'mature' stage, production and technology remains relatively stable with few innovations of importance and production is characteristically large scale. Capital, consisting of large amounts of specialized equipment, and unskilled and semi-skilled labour are production factors particularly important at this stage.

Enterprises "respond to changing critical input requirements by altering the geographic location of production to minimize costs and thereby insure competitiveness in a tightening market" (Erickson and Leinbach, 1979, 58-9). Thompson (1965) noted that the production site of a new product is likely to be the metropolitan area, which is also the location of the firm's principal plants and management functions--in other words, the core area. Availability of critical external economies and specialist skills at metropolitan areas is the major locational attraction. Increasing competition may force the relocation of production at larger scale branch plants in smaller cities where labour and other cost savings are available especially when products are standardized and production processes are routinized over large volumes (Pred, 1974, 7). Thus, as products become increasingly older, production assignment within corporate systems shifts to:

> . . . Location in the "urban field" of the metropolitan area wherein the organizational headquarters are located, or into distance urban fields or even interstitial nonmetropolitan areas at some distance from metropolitan population concentrations (Erickson and Leinbach, 1979, 60).

Production will further 'diffuse' to foreign locations when the product reaches an advanced stage in its life cycle. Crookell (1970) has provided one of the more interesting attempts to evaluate Vernon's ideas. He was able to verify Vernon's basic thesis in a study of the Canadian major electrical appliance industry. Essentially, he found that products early in their life cycles were generally produced in U.S. plants and imported into Canada. Mature products, however, were eventually assembled or manufactured in Canadian-based branch plants of U.S. multinationals. He argued that even with the removal of tariff barriers, this general pattern would be perpetuated. Although, there would be some rationalization in the product-mix or lines between U.S.- and Canadian-based plants,

> The specialized Canadian plants would then be in continual danger from displacing innovations originating in the U.S., and threatening to capture the market currently supplied by Canadian production. The economic viability of subsidiary production operations would be constantly under review by parent organizations as market conditions changed under the impetus of innovation. Since managerial and marketing decision power would logically be centralized in the U.S. it is likely that some legislated safeguards would be necessary on an ongoing basis to ensure the survival of Canadian-based production operations, and with a varied and changing product-mix, these may prove troublesome to enforce (Crookell, 1970, 80).

An important feature of the product cycle model is the definition of 'new products'. According to Vernon (1966) they refer to products which are not only technologically new, but are also unfamiliar to buyers--goods which cater to newly realized wants. Finger (1975) points out that there are many products with new technology but essentially old product lines and that do not necessarily cater to newly realized wants. Given that the majority of so-called new products today do not fit Vernon's definition, interpretations of spatial diffusion based on the product life cycle model require careful scrutiny.

Other studies have questioned the validity of the product cycle model. For instance, in a recent analysis of five multinational firms and fifty-two products, Leroy (1976) found that firms used a variety of alternative strategies to diffuse their products. For products developed in the firm's parent company, three product strategies were commonly adopted: (1) domestic production followed by exports only; (2) domestic production followed directly by foreign production with no exports; and,

(3) domestic production followed by exports, then foreign production. In essence, spatial assignment of production does not necessarily follow the spatial sequence of the product life cycle model. In general, consumer products have a greater likelihood of being introduced and manufactured simultaneously in the home country and internationally. The degree of novelty of a product, however, plays an important role in determining the time lag before it is introduced into international markets. Leroy found that totally new products had considerably longer time lags, over eighteen months, compared to two to seven months for products that were minor modifications in terms of performance relative to the previous product the firm was marketing. Products that were characterized by technological novelty (newness of the production process) were usually exported from the home country rather than produced at foreign locations.

Generally, overseas production is considered to be synonymous with foreign direct investment and the establishment of new plant facilities. What would be the most obvious pattern of product assignment, if plant facilities are already in place? The plausibility of simultaneous production in parent- and foreign-nation plants would depend on the relative significance of what Fayerweather (1978, 220) termed as "fragmentation-conformity influences". Production is least likely, presumably, when fragmentation is strong, that is, the standard of living, lifestyles, tastes, etc., are vastly different from the innovating nation's, and hence demand for the new product is very limited. In contrast the probability of simultaneous production is greatest when conformity influences predominate and when some reasonable economic threshold is reached. For plants located in nations which are in some ways economically integrated with the parent nation, the chances of obtaining new product mandates are comparable to a peripheral plant.

Plant Turnover

Generally, new plant locational decisions are relatively rare, resulting in a high degree of locational inertia, which is often considered as a failure to respond to some new equilibrium position. But Townroe (1974, 291) observes:

> For the individual firm, however, locational inertia may be highly rational. . . In maximizing profits and returns on capital, there are clearly costs of moving or of closing a plant. Furthermore, a location sub-optimal in operating expenses may still be optimal in returns on capital, especially when locational incentives from a governmental agency are accounted for at least in the short-run amortization period of the initial investment. Short-run benefit is accepted rather than a positive long-run benefit, which may be greater but is associated with a high degree of uncertainty.

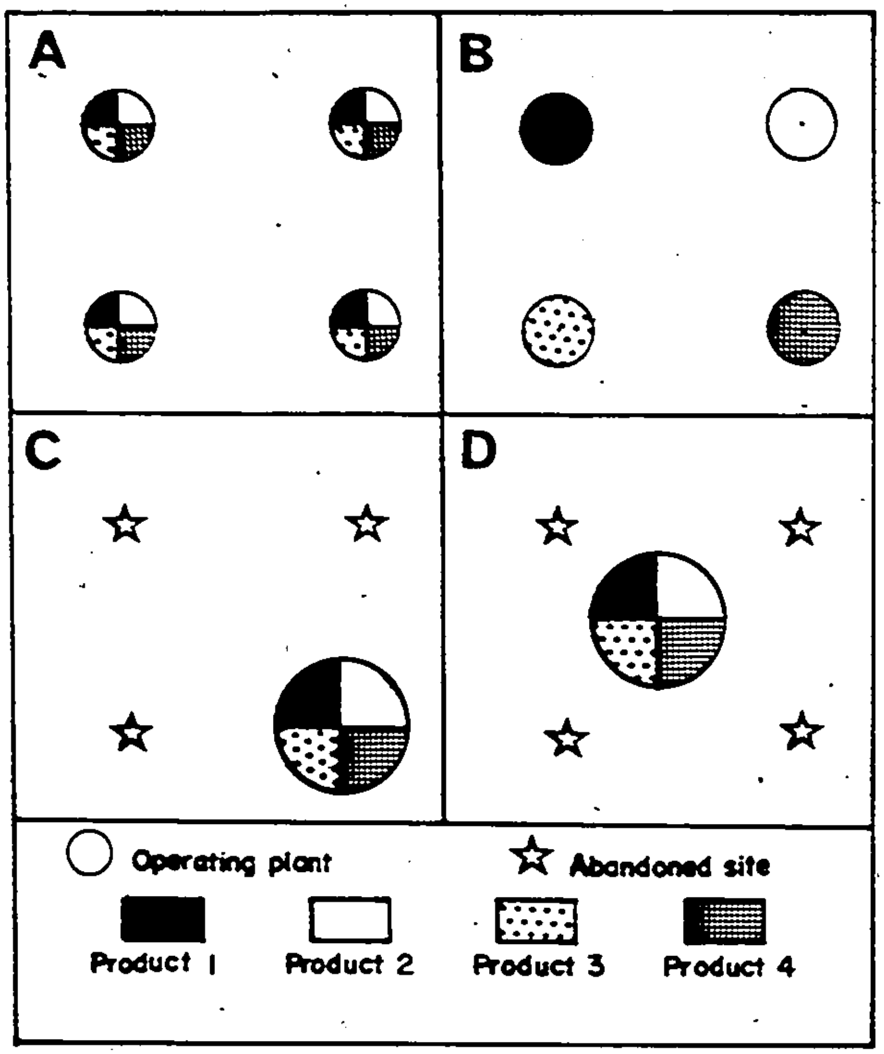
However, the number of plants operated by a large enterprise seldom remains fixed, especially in the long run when firms have the option to adjust their stock of plants to meet specific corporate requirements (Krumme, 1969). For instance, old plants may be closed or sold and new facilities may be constructed or else acquired.

Age of plant, antiquated equipment and inefficient plant layout in the wake of technological advance or a location which no longer meets current material-sourcing or marketing requirements may be serious enough to force a permanent closure. During periods of sales expansion, these plants may gain a temporary reprieve, but in periods of depressed market conditions, closures may be speeded up. Further, plant closures may in circumstances be part of some major corporate rationalization plan, in which case, product mix within the surviving system of plants may be reorganized (See for example Fleming and Krumme, 1968; Hayter, 1976).

Watts (1974) who examined the spatial changes in large corporations has schematized the patterns related to rationalization (Figure 3). An explicit feature of Watts schema is that product realignment amongst a firm's plants may be a part of the rationalization process. In his example, rationalization proceeeds from a situation (A) in which all plants have identical product mandates. The firm then has three alternatives. It can retain all its plants, with each specializing in just one product (B) or it can abandon all except one plant which produces all four product lines, but at an expanded scale (C). Alternatively, it can close all previous locations and move all production to a new an enlarged facility (D). Generally, the options for rationalization indicate the possibilities of securing product-specific scale economies (case B) or perhaps plant economies of scale (cases C and D). Clearly, Watts' schema is highly simplified as to the range of alternatives available to the firm. There may indeed be numerous possibilities of assigning the four products between the polar situations depicted by A and B.

In contrast, new plants may be established to replace old, uneconomical plants which have been closed, to develop regional markets for existing products, to take advantage of labour or perhaps other production factors, or to produce a new generation of products which require processes and tooling not available at existing plants (Krumme, 1970; North, 1974; Sloan and Miles, 1980). Plant product-mix may remain unaltered when (a) a new plant is built to replace an obsolete facility since products from the latter may simply be transferred to the former, (b) a new plant is constructed to produce a generation of new products, and assuming that these new products do not replace older lines produced in other plants, and (c) a new plant is constructed to serve some regional

Figure 3: Hypothetical Rationalization Strategies for a Multiplant, Multiproduct Enterprise



Source: Watts (1974)

market which has attained an economic threshold sufficient to support a separate facility. However, change may occur when a new plant adds to firm capacity and firms reallocate product lines from other plants to the new plant. In this case, product change will be observed in plants which have been deprived of the manufacture of particular product lines.

Output Change

Production of individual lines often fluctuates over a range of outputs, the result of uncertainties in demand and perhaps a feature of the product life cycle noted earlier. Given the presence of scale economies in production and distribution, production may take place in larger numbers of plants at increasingly higher output levels, a factor which alters plant-product mix. However, which particular plant locations most likely to be affected by variations in output levels has not been made explicit in any of the studies reviewed.

CHAPTER III

THE NORTH AMERICAN AUTOMOBILE INDUSTRY: DEVELOPMENT AND STRUCTURE

The automobile industry is one of the largest, most important and highly concentrated manufacturing sectors in North America. The industry produces a highly differentiated product in integrated large scale plants located around the Great Lakes region and assembles a large proportion of the finished vehicles in several decentralized plants in the U.S. and Canada. This chapter outlines, briefly, the growth of the industry, its principal firms and its evolution into a differentiated oligopoly. In addition, there is an outline of developments relating particularly to the Canada-U.S. Automotive Products Trade Agreement of 1965.

Development of the United States Auto Industry

The U.S. auto industry, had its beginnings at the close of the last century. The period until 1910, marked by pioneering, experimentation and rapid growth, saw numerous firms entering and leaving the industry with no single producer attaining a position of dominance. Following development of the gasoline automobile at the end of the nineteenth century and a steady expansion of demand, the number of automobile producers grew from a dozen to nearly seventy between 1902 and 1913 (Table I). This rapid increase was the result of limited capital requirements and the relative simplicity of the manufacturing process which consisted primarily of design and assembly of vehicles. Parts and

TABLE 1

STRUCTURE OF U.S. AUTOMOBILE INDUSTRY 1902-1922

YEAR	ENTRANTS	EXITS	FIRMS REMAINING
1902	-	-	12
1903	13	1	24
1904	12	1	35
1905	5	2	38
1906	6	1	43
1907	1	0	44
1908	10	2	52
1909	18	1	69
1910	1	18	52
1911	3	2	53
1912	12	8	57
1913	20	7	70
1914	8	7	71
1915	10	6	75
1916	6	7	74
1917	8	6	76
1918	1	6	71
1919	10	4	77
1920	12	5	84
1921	5	1	88
1922	4	9	83

Source: Epstein (1928, 176-7).

components were usually made to specifications by specialist firms (Lanzillotti, 1971, 25). Some of the leading car firms of the period included the Olds Motor Works, Ford and Cadillac which collectively manufactured more than a third of the cars produced in the United States (U.S. Senate, 1958, 4). Despite the youthfulness of the industry, product differentiation was increasingly the basis of competition amongst the producers.

The end of the first decade of the 20th Century was marked by two major developments. First, General Motors (GM) was organized by William C. Durant who purchased the Buick Motor Company in 1908 and proceeded to acquire control of over twenty automobile and accessory firms including Buick, Cadillac, Oldsmobile and Oakland by 1909 (Boyle, 1974, 85). The expansion of GM continued into 1910 with more acquisitions of companies producing cars and accessories until Durant overextended himself and was relieved of his position of leadership in GM. Durant, subsequently proceeded to organize the Chevrolet Motor Company which eventually prospered to the point that he was able to regain control of GM in 1915, by skillfully trading stocks and with strong financial backing of the Du Pont family. Following the Chevrolet-GM union, a new company, in essence the present GM, was formed.

Second, Ford began to make a major impression on the industry with the famous Model T, a utility vehicle which had a standardized design for several years. The introduction of this car and its subsequent popularity enabled Ford to capture a major share of the U.S. market, an event which was undoubtedly aided by a famous innovation--the assembly line technique of production introduced in 1914, which reduced, rather substantially, the cost of production (Abernathy, 1978).

During the second decade Ford pioneered the spreading of final automobile assembly plants throughout the American market. His idea involved producing parts in specialized plants in the Detroit area and shipping them assembled or in some cases unassembled to regional plants. From 1910 to 1917 Ford established regional assembly plants in Kansas City, Long Island, Chicago, San Francisco, Memphis, Los Angeles, St. Louis, Denver, Portland, Seattle, Columbus, Dallas, Houston, Minneapolis, Indianapolis, Pittsburg, Atlanta, Cincinnati, Cleveland, Louisville, Buffalo, Milwaukee, Washington, Oklahoma City and Omaha (Boyle, 1974, 93-4). During this period, the most active years of capacity decentralization was 1914-1916.

Notable features of decentralization were that each plant was located in the major city of its region. Each city was also a major freight breakpoint. Each plant served its region as the principal production source and regional sales office for dealership supervision, as well as for the training of local repairmen. After 1925, each plant was equipped with the light hand tools needed to 'frame' the major steel body sections with extensive painting lines. The introduction of these process capabilities and the decentralization of assembly capacity created the basic outline of today's assembly plant (Abernathy, 1978, 120).

Although Ford was the acknowledged pioneer in assembly plant decentralization, other major firms rapidly followed the same strategy. Chevrolet, established in 1913, began large scale production following its union with GM and was decentralized from the very beginning. In 1916, Chevrolet produced about 70,000 cars, of which a third were sourced at Flint, while the remainder came from five other plants: Tarrytown, Oshawa, St. Louis, Fort Worth and Oakland (Bloomfield, 1978, 169-76). Despite active decentralization of assembly operations, the Midwest, particularly Detroit, became the most important centre of the automobile industry (Boas, 1961, 223).

The second decade of the 20th Century was also marked by the development of a mass market and more importantly an increase in industry concentration. Ford's success as a result of the Model T and assembly line techniques and GM's rapid growth following a series of mergers and acquisitions caused industry concentration to increase moderately despite the steady entry of new producers.

Throughout the major part of the 1920's, Ford remained America's largest auto producer, but after 1921 the company's share of the market declined from more than half to about one third by the end of the Twenties. Ford's failure to respond to the changing nature of demand for something beyond a basic economical and dependable automobile, which the Model T provided, was the root of the company's decline. Chevrolet, a competing product made by GM, though more expensive, offered not only better appearance, performance and engineering features, but also a car the public increasingly preferred (U.S. Senate, 1958, 6).

During 1927 and 1928, GM became the largest producer when Ford halted production and switched from the Model 'T' to Model 'A'. Ford regained the title of largest firm temporarily, but since 1931 GM has been the industry's biggest producer in North America (White, 1977, 175). Besides a successful management system based on several autonomous divisions, important marketing strategies which propelled GM to the forefront were the sale of a broad range of cars "for every purse and purpose" and the annual modification of cars by introducing engineering advances, convenience improvements and exterior and interior styling changes. This latter strategy was of paramount importance because it was directed at replacement demand which became an increasingly important part of the automobile market (White, 1977, 175). The former strategy enabled the company to offer products that would meet the demands of a heterogeneous market.

Another major feature of this period was the formation of a third major auto firm, Chrysler in 1925. Walter Chrysler, a former GM employee had earlier become president of the Maxwell-Chalmers Corporation. In 1924 the company introduced a car, the Chrysler 6 which featured a high compression engine and other engineering features which made the car an instant success. Following this, Walter Chrysler took control of the firm and named it after himself. In 1928, he acquired the estate of the Dodge Brothers and introduced the Plymouth and DeSoto makes in the same year.

By the end of the 1920's, the U.S. automobile industry had already assumed the main structural features which have persisted until the present. The auto market, for instance, was dominated by three large firms which controlled seventy-two per cent of total sales of 4.6 million cars in 1929. Entry into the industry was increasingly difficult during the late 1920's. By 1929, the number of surviving firms had dwindled to less than half the eighty-four that were active at the start of the decade (White, 1977, 176). Further, during this period, assembly operations are believed to have reached their widest geographical extent. Ford operated thirty-one U.S. and four Canadian plants in addition to 'home' plants in Detroit and Windsor, Ontario. Chevrolet cars alone were assembled in twelve plants across the continent (Bloomfield, 1978, 166-7).

Since the late 1920's, the total number of assembly plants has decreased markedly outside the Midwest, and by 1935 the number of Ford plants had decreased to fifteen. In the mid-1930's, however, GM gradually increased its branch plants, after the formation of the Buick-Oldsmobile-Pontiac division. So did Chrysler when a number of facilities outside Detroit was added.

The decade of the 1930's was a period characterized by a substantial exit of producers. The Great Depression trimmed auto sales to a mere fraction of the level attained at the end of the previous decade. Mâny companies that met with failure were mainly small firms. Those that did survive,--Studebaker, Hudson, Nash, Packard and Willys (the 'Independents'),--tried diversifying their product lines but met with little success, largely because of soft market conditions. Ford jumped into the act as well in 1938 when it introduced the Mercury, thus adopting a strategy already employed by its two largest rivals. Meanwhile, the technology and design of automobiles underwent some revolutionary changes. Bigger and heavier cars with large engines, enclosed steel bodies featuring 'aerodynamic' designs and automatic transmissions became increasingly common (White, 1977, 177).

The decade of the 1940's was another major milestone in the U.S. auto industry. The outbreak of World War II led to a cessation of all automobile production by the eight surviving firms in the industry, GM, Ford, Chrysler, Studebaker, Hudson, Nash, Packard and Willys. Production did not resume until 1946 following the end of the war. Pent-up demand for cars during the postwar era, and easy access to wartime factories and machinery, made it possible for new firms to enter the auto industry (Banner, 1953, 38). Two firms that did eventually enter the industry and produce cars were Kaiser-Fraser and Crosley Motors. The latter folded in 1952 while the former merged with Willys in 1953, but eventually ceased production in 1955. Ford, which had slipped into third place behind Chrysler in 1937 regained its second place standing behind GM in 1948, after a timely reorganization of the company and introduction of a highly successful postwar car which rescued it from the brink of financial disaster.

Despite generally favourable demand conditions, auto production during the immediate postwar period was hampered by material shortages, price controls and also the Korean War. The end of hostilities and lifting of controls in 1953 enabled production to expand rapidly once again. For the Independents, however, the Fifties was another stormy period. In general they had higher manufacturing costs compared to the Big Three and were producing cars which lacked consumer appeal because of the absence of power and convenience features. Faced increasingly with financial difficulties, several mergers followed between the Independents. Initially, Willys united with Kaiser-Frazer in 1953. Then in 1954, Hudson merged with Nash to form American Motors while Studebaker teamed up with Packard. Unfortunately for some, merger offered only a brief lease of life; Kaiser-Willys eventually ceased operations in 1955 and Studebaker-Packard did likewise in 1966. The only surviving Independent is American Motors, which for many years remained the fourth major domestic producer until 1978, when the Volkswagon of America Corporation commenced production of cars in Pennsylvania. With the demise of most Independents and their considerably weakened state, the Big Three's dominance of the U.S.

auto market was more significant than before, a situation which has continued until the present.

Development of the Canadian Auto Industry

In Canada, development of the automobile industry was closely related to developments in the United States. Although automobiles were built before the turn of the century, commercial manufacture did not commence until 1904 when a group of Canadian businessmen organized the Ford Motor Company of Canada and obtained exclusive rights to produce Ford cars for sale in Canada and elsewhere in the British Empire outside the British Isles. Production began, initially on a modest scale and consisted of installing bodies and wheels on chassis delivered from Detroit (Royal Commission on Canada's Economic Prospects,[1] 1956, 2-3). Generally, it was the thirty-five per cent tariff the industry inherited from the carriage building trade that made possible the assembly of American cars in Canada. The tariff, designed to protect the Canadian industry from U.S. imports did not, however, prevent the failure of automobile firms, and those that eventually survived were allied to successful U.S. auto firms.

In 1907, a Canadian company, the McLaughlin Motor Car Company of Oshawa, established by R. S. McLaughlin, produced a vehicle of Canadian design with engines supplied by Buick Motor Company of Flint. Later in 1915, Mr. McLaughlin organized the Chevrolet Motor Company of Canada to produce Chevrolets under an agreement with the Chevrolet organization in the U.S. Both these companies were amalgamated in 1918, and reorganized as GM of Canada, Limited (Royal Commission on the Automotive

[1]Hereafter RCCEP.

Industry,[1] 1961, 5).

Other firms that featured prominently in Canada's auto industry included the Studebaker Company which entered into production of cars in 1910 at Walkerville (Windsor) but ceased in 1936 following revisions in the Customs Tariff in 1936, only to resume production in 1948 at Hamilton.

Canada's third largest car producer, Chrysler, was organized in 1925 as the successor to the Maxwell-Chalmers Motor Company (Canada) at Windsor. Four years later, in keeping with developments in the U.S., Chrysler Canada absorbed Dodge (Canada) and also organized the DeSoto and Plymouth Divisions (Motor Vehicle Manufacturers' Association of Canada,[2] 1970, 5).

American Motors, Canada's fourth largest automobile firm traces its origins to the predecessor Nash Motor Company which began auto production in Toronto in 1946. Two years after the formation of American Motors in the U.S., the Canadian counterpart was organized through the merger of Nash and Hudson, then operating out of Tilbury, Ontario. Following the merger, Canadian production of cars ceased and autos were imported from the U.S. for a number of years before production resumed in 1961 in a new plant located at Brampton (MVMAC, 1970, 4).

Besides the U.S.-owned firms, an European firm, Volvo of Sweden, also produces cars in Canada. Since 1967, Volvo has been assembling cars first at Dartmouth and later Halifax, Nova Scotia. French Renault motor cars were also assembled in Canada, at Ste. Bruno, Quebec, beginning

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[1]Hereafter RCAI.

[2]Hereafter MVMAC.

in 1969, but production has since ceased (MVMAC, 1970, 8). Japanese Toyotas were also produced briefly at Point Edward, Cape Breton Island, but assembly was discontinued in 1975.

The Canadian automotive industry is concentrated largely in Southwestern Ontario. Ford which began in Windsor relocated its motor vehicle operations in 1953 to Oakville where a giant plant, then reputed to be the largest in the Commonwealth, was erected. A second assembly plant, smaller than Oakville, was built at St. Thomas in 1967. Chrsyler's growth and expansion were concentrated largely around Windsor. In 1929, the company erected a new passenger car assembly plant at the outskirts of the city. GM of Canada has developed Oshawa into one of Canada's major auto producing centres. At this location GM's operations consist of an industrial complex manufacturing all manner of auto components, trim, finished passenger cars and trucks.

In recent decades, GM is the only major firm to assemble cars in Canada outside Ontario, locating a new plant at Ste. Thérèse, Quebec, twenty miles north of Montreal. Prior to World War II, however, various attempts had been made to decentralize assembly operations from Southern Ontario, notably with the establishment of branch assembly plants in St. John, New Brunswick, Montreal, Winnipeg and Vancouver by Ford and in Regina by GM. These plants generally proved uneconomic and were closed either prior to or during the last war. An exception was Ford's Vancouver plant which was reopened in the postwar period but was subsequently closed in 1950 (RCCEP, 1956, 49).

From a geographical standpoint all Canadian assembly plants today are located on the Windsor-to-Montreal axis, historically Canada's largest concentration of manufacturing and population. Opportunities for the takeover of infant Canadian auto firms (as in GM's and Chrysler's cases) and the geographical proximity of the region to parent firms headquartered in Detroit, no doubt influenced the location of assembly facilities during the early years and decades later as well.

The most notable features of Canada's auto industry are the overwhelming dominance of that industry by the U.S. and the high concentration. The principal producing firms are directly owned and controlled by U.S. parent organizations. Products made in Canadian plants are designed in the U.S., while production processes and technology follow closely those developed by their parent companies. Further, many inputs and components that make up the Canadian product are manufactured in the U.S. Although in the process the Canadian auto sector shares in the large scale economies achieved by the U.S., it also has little choice but to accept certain features of the U.S. industry, such as the multiplicity of models and frequent model changes.

From the start, Canadian car production was dominated by members of the Big Three, Ford, GM and Chrysler. In the ensuing years, this dominance has increased as smaller producers failed or ceased production or switched to importing. From 1947 to 1960, for instance, the Big Three produced between ninety-four and ninety-nine per cent of all passenger cars (Table 2). Ford, once the leading producer, dropped into second place behind GM in the postwar years and progressively accounted for a smaller share of Canada's total production. Chrysler, the third largest producer also saw its share of production shrink, from twenty-seven per cent in 1948 to fifteen in 1960. Meanwhile, GM's strength grew from modest to substantial, at the expense of both Ford and Chrysler.

TABLE 2

SHARE OF AUTOMOBILE PRODUCTION BY PRINCIPAL FIRMS IN CANADA, 1947-1960

YEAR	CHRYSLER		FORD		GM		OTHERS	
	No. of Cars x 1,000	% of Total	No. of Cars x 1,000	% of Total	No. of Cars x 1,000	% of Total	No. of Cars x 1,000	% of Total
1947	43.5	26	63,4	38	58,8	35	1.5	1
1948	45.0	27	54,6	33	65.2	39	2.0	1
1949	46.6	24	72,9	38	62.6	32	11.5	6
1950	55.1	19	94.2	33	117.9	42	16.9	6
1951	52,9	19	79,4	28	133.0	47	17.4	6
1952	51.8	18	82,9	29	136,0	48	17.4	4
1953	61,8	17	124.2	34	162.9	45	16.1	4
1954	51.1	18	102,5	36	122,6	43	7.7	3
1955	97,4	26	137.6	37	128.6	34	10.9	3
1956	92.1	25	119,6	32	148.2	40	14.8	4
1957	69,4	20	109,9	32	153,4	45	7.7	2
1958	44,1	15	89,3	30	158.2	53	5.3	2
1959	42,6	14	99.7	33	150.2	50	8.3	3
1960	50,4	15	94,2	29	175.1	54	5.7	2

Source: RCAI (1961, 102).

The North American Automobile Industry Since 1965

Despite the broad similarities in the U.S. and Canadian auto industries there was nevertheless, a notable difference: automobile manufacturing costs in Canada were higher than those in the U.S. (RCCEP, 1956, 75), mainly because of smaller scale operations and tariff legislation. In respect of the latter, the RCAI (1961, 9-10) solemnly notes:

> There are many parts the cost of which in the United States, with its high volume of production, is so much lower than in Canada, with its much lower volume of production, than even high rates of duty would not suffice to induce the Canadian automobile manufacturer to buy or produce them in Canada. If a duty were imposed, these parts would still be imported, the Government would collect revenue, the Canadian consumer would pay more for his automobile, and the Canadian parts manufacturers might well find that the higher prices of automobiles would reduce sales and thus reduce the demand for those parts which they could and did produce.

During hearings before the Royal Commission on the Automobile Industry Vincent Bladen, the Commissioner, received a number of proposals from car producers and labour representatives regarding the integration of the Canadian and U.S. auto industries. The Ford Motor Company indicated that integration of production subject to "inter-company and inter-government agreement to insure continued growth of the Canadian industry . . . could result in important benefits to Canadian consumers through lower prices" (RCAI, 1961, 41). American Motors noted the feasibility of international company-to-company arrangements which would permit companies to establish

> . . . an international manufacturing bridge between themselves. . . . Under this system, each country would be encouraged to produce not only the product or component which it is best able to produce but also to develop the basic skills of

> manufacturing rather than depending on the elemental art of assembly alone (RCAI, 1961, 41).

These proposals were supported in principle by the United Automobile Workers (UAW) Union which acknowledged that the basic problem facing the Canadian industry was low production volumes, one that could "scarcely be dealt with by attempts to increase tariff protection". In their own brief, the UAW went on to propose that

> The Commission examine the feasibility of an international agreement which would permit free trade in the products of any motor vehicle manufacturing company provided that the company produced in Canada or had produced for it in Canada a quantity of motor vehicles and parts, sufficient to assure maintenance of current levels of employment at current production volume and future increases in employment parallel with the growth of the company's Canadian market (RCAI, 1961, 43).

There were, of course, parties that did not share the opinions on integration. Automotive parts producers in particular favoured greater rather than reduced protection. In its recommendations to the Canadian government, the Commission did not forward any integration schemes but instead proposed changes to the excise tax, import duties and content requirements, which were already in effect.

Following the Report of the Royal Commission, the Canadian Government adopted the recommendations on the removal of the excise taxes and the valuation basis for sales tax purposes which discriminated against domestic producers, but there were other recommendations which were not immediately enforced. In 1962, the Government instituted a duty remission scheme on automatic transmission and engine blocks, on condition that manufacturers exported Canadian made parts over and above the level attained between November 1, 1961 and October 31, 1962. In 1963, this scheme was extended to cover imported vehicles and original equipment. Although it received the approval of industry and labour on both sides of the border, as well as the U.S. government, there was also the possibility, because of a petition filed by a U.S. parts producer in April, 1964, that such a scheme in fact subsidized exports to the U.S. through a "bounty or grant", as defined under the U.S. Customs Act of 1930. If such circumstances were proven, the U.S. Treasury Department could impose countervailing duties against Canada.[1] Fears on the part of the U.S. Administration, that such an event would only be detrimental to the U.S.-Canada trade and economic relations, led to an urgent search for a mutually satisfactory solution (Dykes, 1977, 46).

The integration scheme, first raised by Canada in September, 1964, rapidly gained the approval of U.S. officials and after several months of negotiations between the respective national governments and labour and industry representatives, the Canada-U.S. Automotive Products Trade Agreement (APTA) was signed in January 1963. The event marked a major turning point in the history of both auto industries, Canada's in particular. For Canada, it was "part of an evolutionary process which may be traced to the Canadian content scheme of 1926 which represented the first of a series of attempts to reconcile a protective national policy with the necessity for Canada to keep pace with an increasingly competitive world" (Reisman Commission, 1978, 25).

Briefly the principal objectives of the APTA were:

(a) To consolidate the two markets into a single automotive market, allowing increased benefits of specialization and large-scale production;

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[1]See Inquiry into the Automotive Industry Simon Reisman, Commissioner (1978, 24), hereafter referred to simply as the 'Reisman Commission (1978)'.

(b) To remove trade barriers, allowing industries in both countries to participate equitably in expansion of the market;

(c) To provide conditions that could allow market forces to determine patterns of investment, production and trade in vehicles and parts on both sides of the border.

Although the objective of the APTA advocated free trade, the details surrounding the Agreement quickly put an end to such projections. Duty-free import into the U.S. was permitted provided at least fifty per cent of the appraised customs-value of vehicles or components imported from Canada was either Canadian- or U.S.-made. This condition effectively discourages a third country from shipping almost completed cars into Canada and with a little more assembly work, reshipping the same cars into the U.S. duty-free. A vehicle brought into Canada duty-free, has to be imported by a Canadian manufacturer of that class of vehicle covered by the Agreement. Further, the manufacturer must have produced that type of vehicle during all four quarters of the 1964 model year and every year since. Not less than seventy-five per cent of the manufacturer's sales of that type of vehicle, moreover, has to be made in Canada. A final restriction is the proportion of value added in Canadian-made vehicles must at least equal that attained in the 1964 model year. Since the Agreement contained no assurance for growth in the Canadian automotive sector the Canadian government elicited commitments from domestic manufacturers to increase the Canadian portion of North American auto production. Although these commitments were made outside the provisions of the Agreement itself, they nevertheless complemented the text of the Agreement. Producers agreed to increase the Canadian value added in automobiles by sixty per cent of any year-to-year increase in sales over the 1964 base (Beigie, 1970, 48).

The provisions of the Agreement have encouraged the restructuring of the industry as a whole. Although it is beyond the scope of this section to detail all the instances of rationalization, the effects on product-plant mix and assignment of special interest here will be mentioned briefly, leaving room for a more detailed treatment of the issue in a later chapter. Beigie (1970) and Cowan (1971) have noted that assembly operations, like other segments of the industry, were restructured; auto firms began specializing in the production of particular models and producing more units of each model simultaneously. In some years, Canada was in fact designated the exclusive source for certain models, a strategy pursued independently by the manufacturer. Clearly, the agreement provided a greater, though not complete, freedom amongst the producers to allocate automobile lines on a North American basis. The broader implication of this freedom is perhaps more significant. For example in 1974 and 1975, when higher gas prices sparked demand for more gas-efficient cars Canadian plants, being more geared for small cars than U.S. plants, saw their share of production jump from approximately 11 to 13.6 per cent (Hervey, 1978). Overall, the pact has favoured a greater emphasis on assembly operations, at the expense of in-house parts manufacture, and this condition is visible in a positive balance of trade in finished vehicles for Canada, but a substantial deficit in auto-parts.

After a decade of operation, the expected impact of this trade arrangement between the two countries has clearly failed to materialize. Canada's adverse negative trade balance in automotive products has created tensions which threaten to dismantle the accord. Meanwhile, however, the industry operates and remains structured on the basis of strategies established since the early years of the Agreement.

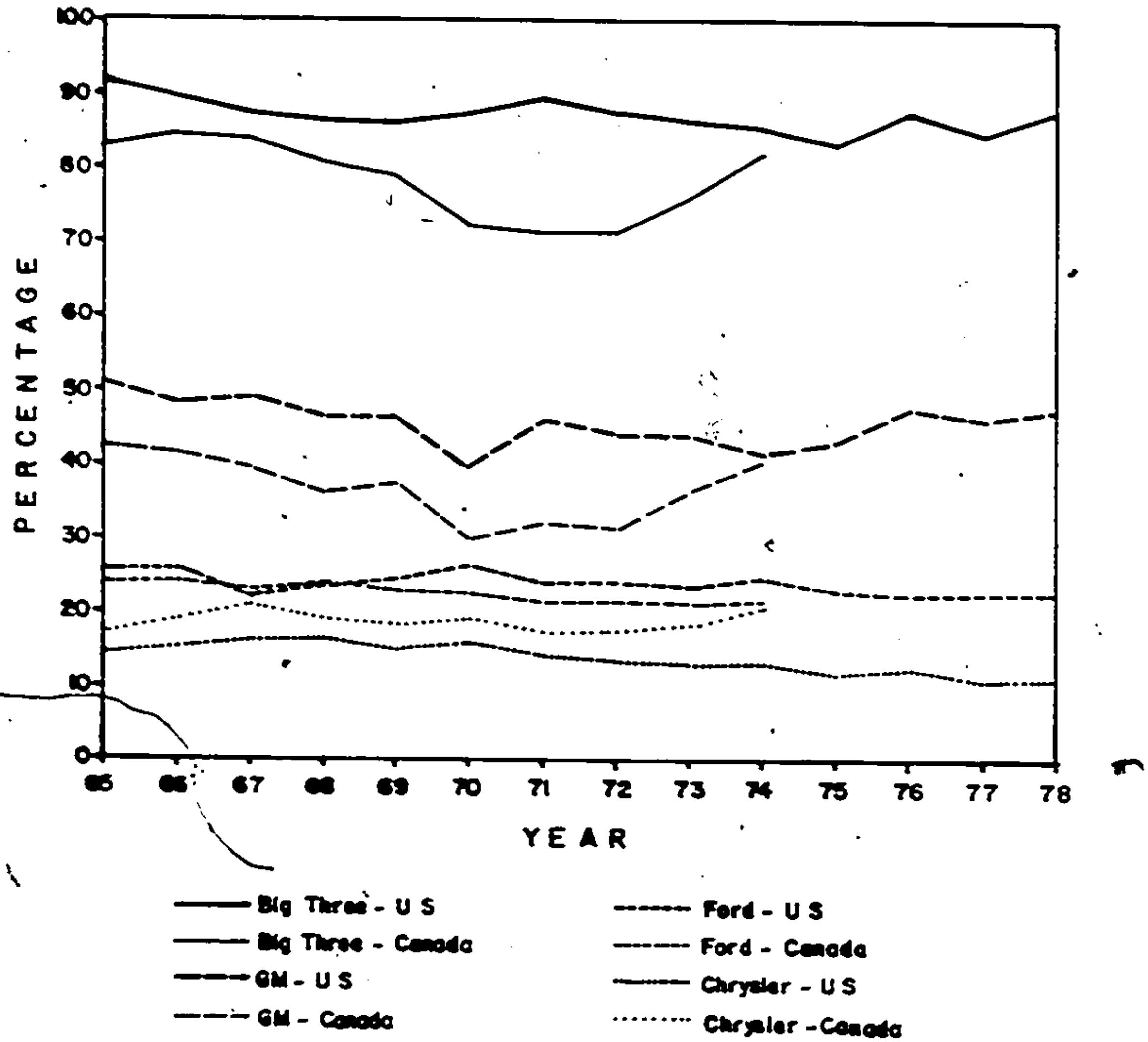
Industry Structure

Excluding a number of small specialist producers, the manufacture and assembly of passenger automobiles in North America are currently undertaken by six firms, American Motors Corporation, Chrysler Corporation, Ford Motor Company, General Motors Corporation, Volkswagen of America Incorporated and Volvo of Canada. At present, Chrysler, Ford and GM are the only multiplant producers of passenger autos in North America. These same three firms continue to dominate the North American market for new automobiles.

In the U.S. GM has consistently held between forty to fifty per cent of the new car market since the mid-Sixties. While its annual share varies from one year to another, it has been steadily increasing since 1974 when one of the lowest shares was experienced (Figure 4). During the same period, Ford managed to capture twenty-two to twenty-six per cent of all new car sales. In recent years, however, it appears to have secured a reduced share of the new car market, which reached 10.9 million vehicles in 1978, following a steady increase since the 1974 recession when only 8.7 million vehicles were sold. Although in the past Chrysler obtained from thirteen to sixteen per cent of the U.S. market, recent figures show its share to have declined to approximately ten per cent. Part of Chrysler's and Ford's losses have been apparently taken up by GM and the rest mainly by imports.

The relative market power of the Big Three differs somewhat in Canada. GM's dominance of the Canadian market is less significant than that in the U.S.; Ford's is rather similar but Chrysler's position is

Figure 4: Share of New Car Registration by Major Firms, 1965-78

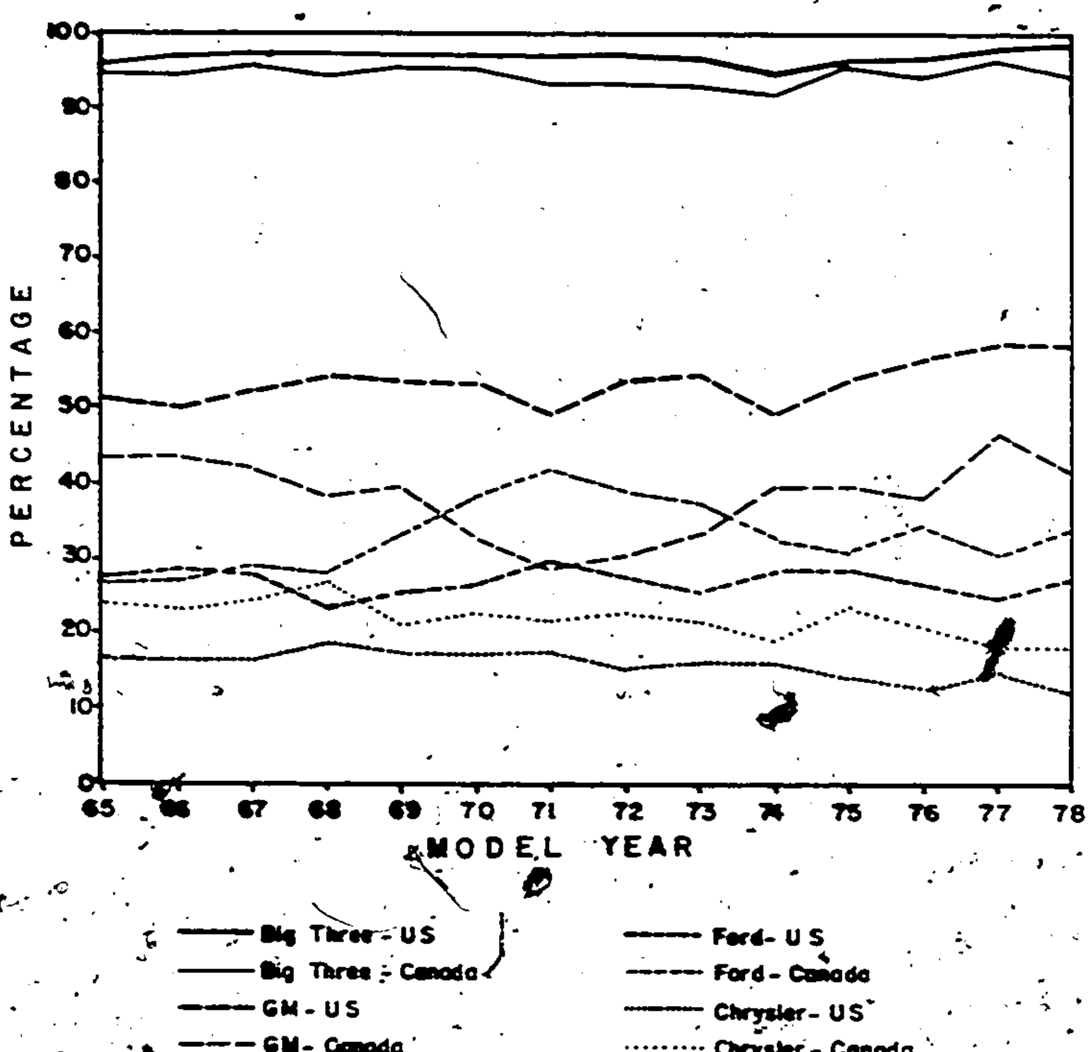


relatively stronger. Unfortunately, the shares of the Big Three after 1974 are not available since new car registration data is not currently available. However, recent reports from industry sources suggest that Chrysler's position in the marketplace has regressed substantially in part because of its serious financial difficulties while the winners have been GM and small car specialists, including AMC and imports.

The overall market power of the Big Three has generally been lower in Canada than in the U.S. However, the reverse appears to be true in the mid-Seventies, and to what extent this reversal persists is difficult to speculate without more recent information. When both the U.S. and Canadian markets are combined, the respective shares of GM, Ford and Chrysler tend naturally to parallel closely that of the U.S. since this new-car market is over twelve times that of Canada's.

Production data reveal in part the highly concentrated character of automobile manufacture. GM, Ford and Chrysler collectively accounted for approximately ninety-five per cent of all cars produced in the U.S. between 1965 and 1978 (Figure 5). In recent years, this figure has exceeded ninety-eight per cent. However, a slight decline may be expected with the recent entry of Volkswagen into the North American scene. GM alone produced over half the American output for most model years except 1974, an industry recession year. Since the mid-Sixties, Ford has accounted for about one quarter, while Chrysler has managed between one-sixth to less than a fifth of total U.S. output. GM's lead has grown steadily in recent years largely at the expense of Chrysler and AMC. Canadian production shares of the three firms, though far from being equitable, are nevertheless less skewed compared to the U.S. profile. Between 1970 and 1974, Ford was in fact the largest producer of

Figure 5: Share of New Car Production by Major Firms, Model Years 1965-78



automobiles and GM a close second with percentage shares diverging further back in time. GM surged ahead of Ford in 1974 and has continued to draw away from both Ford and Chrysler, which currently produce less than a third and less than one fifth, respectively, of Canada's annual production of more than a million vehicles. The combined share of the Big Three is less than that in the U.S. but is nevertheless increasing because of the discontinuation of Renault assembly since 1974 and Toyota since 1975.

CHAPTER IV

PRODUCT DIFFERENTIATION IN THE AUTOMOBILE INDUSTRY

The avoidance of intense price competition and emphasis on other competitive elements, particularly product differentiation is an outstanding feature of the automobile industry (Ueno and Muto, 1980, 172). The competitive strategies stem from the oligopolistic structure of the industry and also the heterogenous and demand-saturated character of the market for new automobiles. Especially prominent are extensive car line policies, frequent model and styling changes incorporating varying degrees of engineering innovation to create the image of a new car and the development of car lines for previously undefined market segments. Traditionally such strategies have enabled individual companies to maintain or else expand their market share of the new car sales. Recently, U.S. federal legislation on traffic safety, exhaust emissions and especially fuel economy has intensified non-price competition because manufacturers are literally forced to develop a whole generation of new cars which afford greater protection from physical injuries, pollute the atmosphere less and are smaller, lighter and consume less gas. The large variety of highly differentiated car lines and the frequency of model and styling change have profound repercussions on the arrangement and scheduling of assembly operations, and plant-product mix.

Product Differentiation

Product differentiation in the automobile industry takes several forms: make, car line, models, market segments, price, class and so forth. Some discussion of the forms of this diversity will assist in providing an understanding of product marketing and assembly characteristics in the auto industry.

Makes, Lines and Models

Any passenger automobile is customarily recognized according to its 'make', 'line', 'series' and 'model'. 'Make' is the brand name and is frequently accompanied by a separate production organization within the company, separate dealerships and marketing campaigns. General Motor's Chevrolet, Ford's Mercury and Chrysler's Plymouth are some examples of makes (Table 3). Most makes familiar today became symbols early

TABLE 3

CAR MAKE, LINE AND MODEL

CLASSIFICATION \ FIRM	GENERAL MOTORS	FORD	CHRYSLER
MAKE	CHEVROLET	MERCURY	PLYMOUTH
LINE	MALIBU	COUGAR	VOLARE
MODEL	TWO-DOOR COUPE FOUR-DOOR SEDAN 2/4-DOOR 'STANDARD' 2/4-DOOR 'CLASSIC' 2/4-DOOR V-8 (eng.) 2/4-DOOR V-6 (eng.) STATION WAGON	TWO-DOOR FOUR-DOOR XR7	TWO-DOOR COUPE FOUR-DOOR SEDAN STATION WAGON

Source: Automotive News 1978 Market Data Book Issue, in the history of the industry. GM's rapid acquisitions and mergers in the first two decades of this century brought numerous makes under one company. Today, however, only five--Buick, Chevrolet, Cadillac, Oldsmobile and Pontiac[1]--remain. Ford operated under the 'Ford' banner for many years before it acquired the Lincoln Motor Company while the Mercury division was created much later. The Edsel was to be established as a separate make but its premature demise scuttled Ford's plans for a fourth make in its stable. Chrysler, Plymouth and Dodge, are the three surviving makes of the Chrysler Corporation; DeSoto and Imperial[2] were dropped in 1960 and 1976 respectively.

'Line', a sub-category of make, is usually distinguished by a unique name (for example, Pinto, Mustang) and a separate design, depending on the interpretation of the term 'design'. Increasingly, the true connotation of separate design as applied to automobiles has been weakened as components, particularly exterior sheet metal become completely interchangeable for several car lines. Sometimes, the only features that distinguish one line from another, within a firm, are parts of the grill, tail-light cluster, interior trim and minor external details. Modern examples include the late model Ford Mustang and Mercury Capri, and the Pontiac Le Mans and Chevrolet Malibu.

A 'model' is a sub-class of line and refers to a car with a certain body style (for example, two- or four-door sedan, hatch back, station wagon) or special option and trim. Differentiation at this level is also related partly to variations in wheelbase length, engine

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[1]Originally the Oakland Motor Car Company.

[2]The Imperial was reinstated in the 1981 model year.

size and body dimensions. The Chevrolet Malibu, for example, is differentiated according to the Malibu or Malibu Classic, two- or four-door body styles, and station wagon and various engine sizes.

All three companies manufacture a large number of models. In recent years, however, this number has fallen, from 316 in 1975, to 246 in the 1978 model year (Table 4). In contrast, manufacturers appear to have increased, though modestly, their product offering by introducing more car lines since the Arab oil embargo. This indicates the growing importance of product differentiation made possible perhaps by the increasing interchangeability of parts and components. The number of makes, however, has remained relatively unchanged over a period of many years.

The strategy of the Big Three during the past decade has been to generate a shrinking number of basic vehicle configurations or unique designs and to broaden the appeal of each by offering a wide variety of bodies, trim combinations, power trains and option packages. This enables each automaker to offer individualized products in different segments and subsegments of the overall market while personally benefitting from economies of production scale and economies of standardization (Schnapp, 1979). Hanson (1980, 150) attributes this decline in the number of basic variants offered to the vast capital requirements made necessary by corporate average fuel economy (CAFE)[1] standards and by cost pressures already affecting car design and development, processes which have encouraged the use of common parts and component systems in different models. As a result,

[1]CAFE standards for an auto manufacturer are the number of miles per gallon for the firm's fleet of cars obtained by dividing the total distance travelled and total volume of gas consumed by each vehicle (Automotive News, Nov. 27, 1978,8 & 21). These standards will be increased progressively to 27.5 miles per gallon by 1985.

TABLE 4

NUMBER OF MAKES, LINES AND MODELS PRODUCED BY THE BIG THREE

YEAR	NO. OF MAKES				NO. OF LINES				NO. OF MODELS			
	GM	FORD	CHRYS.	BIG 3	GM	FORD	CHRYS.	BIG 3	GM	FORD	CHRYS.	BIG 3
1973	5	3	4	13	22	12	10	44	144	73	74	291
1974	5	3	4	13	22	12	8	42	147	66	75	290
1975	5	3	4	13	27	16	10	53	174	66	76	316
1976	5	3	3	12	29	16	11	55	150	64	70	284
1977	5	3	3	12	29	15	11	55	138	60	65	233
1978	5	3	3	12	28	15	12	55	138	66	42	246

Source: Automotive News, Almanac Issue, various years.

different models from the same manufacturer are almost identical from the 'skin' and under. Another reason may indeed be quality control problems arising from the simultaneous assembly of a seemingly endless permutation of body shapes and options in individual auto plants. Recent evidence from Japanese, European and U.S. plants indicate that the production of a narrow standardized range of cars may be the key factor in the high quality of finished vehicles (Fortune, June 16, 1980).

Market Segments

The principal auto manufacturers have traditionally pursued a strategy of partitioning the market into several distinct submarkets and then producing cars which match the demands of these markets. With this practice, then, modern North American automobiles can be further identified on the basis of different market segments.

Various organizations, trade journal publishers in particular, have devised several market classification schemes for cars but there is no universally accepted system. The scheme used by the publishers of Ward's Automotive Yearbook recognizes four domestic automobile classes, Subcompact, Compact, Intermediate, Full-Size, and Passenger vans (Table 5). With the exception of vans, all other domestic classes are then subdivided into at least two sub-classes, 'Regular' and 'Specialty'. Full-size vehicles have a more complex system of six sub-classes. Besides the Regular or Specialty label, cars are further recognized as 'Standard', 'Medium' and 'Luxury'. Imported cars are simply recognized as one homogeneous group.

This classification scheme is based on wheelbase, price and vehicle weight, criteria used also by organizations such as the Motor Vehicle Manufacturers Association of the U.S. and other trade publications. The

TABLE 5

WARD'S MARKET SEGMENTS

NATIONALITY	MAJOR SEGMENT	SUBSEGMENT	
Domestic	Subcompact	Subcompact	Regular
		"	Specialty
Domestic	Compact	Compact	Regular
		"	Specialty
Domestic	Intermediate	Intermediate	Regular
		"	Specialty
Domestic	Full-size	Standard	Regular
		"	Specialty
		Medium	Regular
		"	Specialty
		Luxury	Regular
		"	Specialty
Domestic	Passenger Vans	-	-

Source: Ward's Automotive Yearbook, 1978.

significance of each criterion has never been explicit. Judging from the car lines in each major class or sub-class, it does appear that the wheelbase of subcompacts is normally below 100 inches; compacts, between 100 and 112 inches; intermediates, 112 and 120 inches; and full-size, over 120 inches. There is, hence, a corresponding increase in vehicle weight and external and internal dimensions from the subcompact to full-size cars. Cars under the rubric 'Regular' may be described as general-purpose sedans serving a broad market appeal for basic transportation. 'Specialty' vehicles tend to appeal to a more exclusive clientele. Further categorization of full-size cars into 'Standard', 'Medium' and 'Luxury' appears to be based largely on price. Passenger vans, though available in various shapes and sizes are easily recognized as a separate category and require no further elaboration.

The extent of participation in the various market segments varies amongst the Big Three (Table 6). All three firms had or have products for each of the major market segments. Chrysler entered the subcompact market only during the 1978 model year with the domestic built front-wheel-drive Dodge Omni and Plymouth Horizon lines. Previous to this, Chrysler marketed Japanese Mitsubishi cars in the U.S. and Canada under Plymouth and Dodge nameplates. GM and Ford on the other hand, have produced and sold subcompacts since the late 1960's. Amongst the Big Three, Chrysler's participation is least complete. Out of a possible twelve, Chrysler produced and sold cars in eight or less of the subsegments between 1971 and 1978. In 1971, 1972 and 1973, GM made cars in eleven subsegments and Ford in ten. Since then, however, both firms are competing in all twelve subsegments.

In the past, the three automakers did not generally attempt to satisfy all segments or subsegments of the market. For example, it took several years before the Big Three challenged the imports in the subcompact market with cars produced domestically, mainly because the size of this market and the potential unit profit, even at efficient product volume levels, did not provide an attractive enough financial prospect to merit the investment. In the opinion of Detroit, at least until more recently, imports and the great diversity of appeals they generated, reflected much of the non-mass elements of the market, the residue that the Big Three believed they could not reach economically (Schnapp, 1979, 104).

This strategy of being represented in all possible markets can be traced to GM's full-line strategy adopted in the 1920's. Contrary to Ford's emphasis on a single automobile, the Model T, GM embarked upon a policy of manufacturing a broad range of products that would blanket

TABLE 6

PARTICIPATION BY DOMESTIC MARKET SEGMENTS: BIG THREE, 1971-1978

MARKET SEGMENT	GM								FORD								CHRYSLER							
	71	72	73	74	75	76	77	78	71	72	73	74	75	76	77	78	71	72	73	74	75	76	77	8
SUBCOMPACT																								
Regular	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								•
Specialty				•	•	•	•	•				•	•	•	•	•								•
COMPACT																								
Regular	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Specialty	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
INTERMEDIATE																								
Regular	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Specialty	•	•	•	•	•	•	•	•				•	•	•	•	•				•	•	•	•	•
FULL SIZE																								
Standard	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Standard Specialty									•	•	•	•	•	•	•	•								
Medium	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Medium Specialty	•	•	•	•	•	•	•	•																
Luxury	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Luxury Specialty	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•								
PASSENGER VANS	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
TOTAL+	11	11	11	12	12	12	12	12	10	10	10	12	12	12	12	12	7	7	7	8	8	7	6	8

Source: Ward's Automotive Yearbook, 1976, 1979.

+Excludes passenger vans.

the market. GM's highly successful strategy, which could be aptly summarized as "a car for every purse and purpose", was aided by some appropriate and timely circumstances. First, it had a number of separate makes, lines and dealer organizations which created different identities in the minds of consumers. Second, demand existed for more than just one basic type of vehicle. Third, and most significantly perhaps, was the growing importance of replacement demand. A full-line policy allowed the firm to exploit brand loyalty and 'trading up' amongst car-owners who considered replacing their old vehicle (White, 1977).

It has also been suggested that multiple makes serve an important risk-diluting function (White, 1977, 205). By offering cars to different segments of the market and enjoying separate identification in the minds of consumers, multiple makes act as a buffer to company fortunes if consumer tastes change from one segment to another. Multiple makes also give the company a better chance of retaining the "trading up customer". While White is essentially right in his observation, he does create some confusion by implying that makes are synonymous with market segment, which is only partially true. We noted that there are several makes which are represented in several market segments, while others, particularly those in the upper end of the price spectrum, are limited to the luxury categories. Depending on a customer's previous market segment, trading up may actually occur within the same make, or it could involve change from one to another, but still within the same firm. What White in fact proposes is that multiple lines, which are usually specific to a market segment, and makes, together constitute a risk-diluting function.

Undoubtedly, the reasons for such behaviour which were important in earlier years are still relevant today. Ford and, especially, Chrysler, who eventually copied GM's strategy, are making every effort to maintain this policy, although the financial difficulties faced in more recent years might force them to be more selective in their market participation. Hanson (1980, 152), we noted earlier, suggests that CAFE standards threaten full-line strategies and product-mix. The need to meet fleet average mileage standards has forced companies to emphasize subcompact sales since small cars increase the corporate fleet average. Keeping large cars on the road will require the sale of more small cars. Further, massive capital investments necessary to redesign models are causing manufacturers other than GM to consider withdrawing from particular market segments, giving up the traditional full-line strategy. Chrysler, unable to afford the redesign of all its models in a short time, has let some segments drift until redesigns can be accomplished. Ford has considered pulling out of some segments entirely and Henry Ford II is quoted as saying in June 1978:

> We have discussions every week about whether we should compete across the board with GM. As of now, we're going to meet them across the board. But there are a few exceptions . . . . It's hard to say what part of the market we would withdraw from. . . . If you don't have the money, you have to pick and choose" (Hanson, 1980, footnote 10).

New car purchases are unevenly distributed amongst the different market segments (Table 7). In recent years, nearly a quarter of new cars registered were either in the intermediate or full-size classes; compacts accounted for one-fifth of the U.S. new-car market and subcompacts, ten per cent. The proportion of imports, while fluctuating over the years, has reached the eighteen per cent level recently. Growing interest in outdoor recreation has also seen increases in the share of

TABLE 7

PERCENTAGE DISTRIBUTION OF U.S. NEW CAR REGISTRATIONS BY MARKET CLASSES

MARKET CLASSES	YEAR							
	1978	1977	1976	1975	1974	1973	1972	1971
SUBCOMPACT	10.4	8.5	10.1	12.6	12.4	9.4	8.1	7.4
Regular	6.0	5.3	6.4	8.1	9.1	9.4	8.1	7.4
Specialty	4.4	3.2	3.7	4.5	3.1	-	-	-
COMPACT	19.8	20.0	23.1	21.3	20.0	17.7	15.4	15.8
Regular	13.2	12.7	15.2	14.0	16.6	13.9	12.2	11.5
Specialty	6.6	7.3	7.9	7.3	3.4	3.8	3.2	4.3
INTERMEDIATE	26.7	26.6	26.7	23.8	24.2	23.0	21.7	20.3
Regular	17.5	16.7	17.2	15.5	18.8	19.1	18.9	18.1
Specialty	9.2	9.9	9.5	8.3	5.4	3.9	2.8	2.2
FULL SIZE	23.9	25.4	24.0	22.7	26.6	33.9	39.7	40.7
Standard Reg.	8.4	9.5	8.9	8.8	12.5	15.9	20.7	20.8
Standard Spec.	-	0.1	0.8	0.4	0.5	0.7	0.5	0.4
Medium Reg.	9.9	10.3	9.3	8.3	9.1	12.8	14.1	15.1
Medium Spec.	0.5	0.5	0.4	0.4	0.5	0.6	0.8	0.8
Luxury Reg.	3.0	3.0	2.8	3.0	2.7	2.6	2.6	2.7
Luxury Spec.	2.1	2.0	1.8	1.8	1.3	1.3	1.0	0.9
PASSENGER VANS	1.4	1.2	1.2	1.2	1.0	0.7	0.6	0.6
IMPORTS	17.8	18.2	14.8	18.3	15.7	15.2	14.4	15.1
MISCELLANEOUS	*	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: <u>Ward's Automotive Yearbook</u>, 1976, 1979.

*Negligible.

passenger vans to over one per cent.

Major shifts occurred in the share of different market segments in the U.S. during the 1970's. Full-size vehicles were traditionally the dominant class, since most cars built in the past several decades were large and there were proportionally fewer intermediate and compact cars. Subcompacts were only introduced in the 1970's. As recently as 1971, nearly forty-one per cent of all new cars sold in the U.S. were full-size units, twenty per cent were intermediates, sixteen per cent were compacts, about seven per cent were subcompacts and fifteen per cent were imports. In 1978, the proportion of full-size cars declined to just over half of the 1971 share while other major segments registered increases. The dramatic shifts from large to smaller cars which occurred in the Seventies were no doubt heavily influenced by the aftermath of the oil embargo.

The shift toward smaller vehicles has also involved a basic restructuring of the industry's product lines. The combined threat of more expensive gas and the U.S. federal legislation controlling emissions from cars has forced auto markets to design a whole new generation of smaller and lighter cars causing periodic reclassification of certain car lines from larger to smaller market segments. The shift to smaller cars has received an additional boost from fleet operators. A recent survey indicated that more companies are switching to smaller cars for business use to combat the rising cost of operating business cars (<u>Automotive News</u>, March 7, 1977, 16).

From a production standpoint, such shifts have brought some serious problems to the major auto makers. Industry adjustment to an increasing preference for smaller cars has not proceeded smoothly. The long lead times necessary for producing a whole new generation of cars to meet the needs of the market have contributed to the erosion of the market for domestic producers and boosted the share of imports. Although the Big Three producers, by introducing several new subcompacts such as the Dodge Omni, Plymouth Horizon and Chevrolet Chevette and Pontiac Acadian have recaptured some lost ground, financial and parts-sourcing problems and dependence on captive imports have continued to leave a substantial share of the market to imports.

From a marketing standpoint, the general shift in the various market segments has been particularly disturbing for a partial-line firm such as Chrysler. From 1971 to 1977, the share of the new-car market in which Chrysler cars were not produced for sale increased from 11.7 per cent to 21.4 per cent. This dropped to 12.2 per cent in 1978 following Chrysler's entry into the subcompact market. For Ford and GM, the largest recorded share in the corresponding market over the same period was 4.5 per cent (in 1973) and 0.8 per cent (in 1976) respectively. These latter figures are indicative of how a full-line policy, if not one that is close, offers the firm certain market advantages.

The absence of data precludes an analysis of the structure of the segmented market in Canada. However, fundamental similarities of both the U.S. and Canadian markets suggest that the structure and changes occurring in the market in Canada would not be far different from that of the U.S. Recent industry reports suggest that there is probably a proportionally larger market for full-size cars in Canada compared to the U.S. Comparatively lower gas prices in recent years are believed to have sustained the demand for full-size cars despite the progressive decline of this class in the U.S.

Model Change

The terms 'model' and 'styling' have been used interchangeably by different authors. 'Model' will be preferred here since model change involves styling as well as engineering and component changes.

A conspicuous feature of North American automobile manufacture is the frequency of this model change, which involves essentially "styling changes coupled with some moderate engineering changes to create the image of a new and different ('improved') product each year" (White, 1971, 199). Initiated by General Motors in the 1920's, model change was largely a marketing strategy aimed at exploiting replacement demand which was becoming an increasingly important feature of the automobile market. In contrast to Ford's single model philosophy at that time, GM decided to modify its cars each year with a combination of engineering advances, convenience improvements and interior and exterior styling changes. Such replacement demand now involves the purchase of a new car in which the old car is scrapped, sold or offered as a trade-in. Hence, it is a non-replacement purchase when the consumer buys a car for the first time, or buys a second car while keeping the first (Smith, 1975, 45).

During an annual model change it is estimated that approximately one-third of all parts used to assemble a complete automobile undergo some design modification or are replaced (U.S. Department of Commerce, 1977). The most visible parts of a car such as the outer sheet metal are the favourite target for restyling exercises. In addition, there are frequent modifications or replacements of components and redesign of less visible areas of a vehicle. The 1969 Chevrolet Impala two-door hardtop, for instance, had numerous detailed changes grouped into twenty-seven major categories ranging from increases in rearview mirror size to a number of major safety advances such as improved side impact resistance, addition of head restraints, security features for fuel-tank and improved engine performance (General Motors Corporation, 1968). Thomas Prendergast (1965) who analysed and classified automobile design changes as part of a larger study to determine their effects on market shares identified the parts of an automobile in which change usually occurs. An entirely new model frequently includes changes in body and chassis, engine, transmissions, suspension, brakes, steering and a miscellaneous category which includes individual components and mechanicals. Sherman and Hoffer (1971) who conducted a similar study identified styling change as affecting primarily the visible parts of a car. They point out that the segment of the body most costly to change is the portion between the front cowl and the rear window. Because it includes all the windows, this portion is known as the "greenhouse".. By using the same greenhouse, but varying the sheet metal, basically similar autos can be made to look significantly different. They categorize all styling changes into one of four classifications according to the magnitude of the change involved:

1. An entirely new body sheet design;
2. The basic body design is retained, but all sheet metal with the exception of the greenhouse is altered;
3. A partial sheet metal change;
4. Minor changes to the grill, tail-lamp assemblies and trim, leaving the sheet metal unaltered.

Generally, annual model changes are incremental in nature and examples in recent years include the 5 miles-per-hour bumpers, catalytic converters, electronic ignition systems and lateral-impact-resistant doors. As noted before, annual model changes facilitate the introduction of technical innovations and improvements which are usually made available initially on a particular limited volume car series. Once their value to the customer has been demonstrated and production capacity has been sufficiently expanded, such engineering developments are added to other car lines in succeeding model years (General Motors Corporation, 1974). Further, annual model change does not necessarily involve a redesign of all the firm's car lines or even any single line every year. Often, changes for individual models are staggered. Major redesigns of all sheet metal components, or the introduction of completely new models are introduced at longer intervals ranging from four to twelve years. For an all new car, eighty to ninety per cent of vehicle components will change, but generally not engines or transmissions.

New Model Development Cycle

Until 1959, the basic pattern in the auto industry was one of major design changes--frame and body shell--every three years, with 'facelifts' of the exterior sheet metal in the interim. The cycle was related to the design tooling and production lead time of about three years, although, this was not a hard and fast rule. The Korean War, for instance, delayed most of GM's and Chrysler's changes to a four-year period and major changes occurred in 1949 and 1953 or 1950 and 1954. When the occasion arose, manufacturers were willing to enter into two-year cycles--notably Chrysler, with major changes in 1953, 1955 and 1957--, but three years was considered the 'norm' (White, 1971, 201).

Since the late 1950's, however, a two-year cycle has been the norm for full-size cars, with the compacts and intermediates initially exhibiting a slower pace but speeding up as volume increased and consumer replacement demand became more important. The new product development cycle--the time from the commitment to undertake a project to the roll-out of 'job 1'--has, however, become more extended in the U.S. auto industry. During the early 1970's, when GM made its decision to begin down-sizing its full-size vehicles designated the 'B-body' design, the cycle was approximately three years; today it appears to fall in the range of six to seven years.

The relatively short cycles that prevailed prior to the establishment of the CAFE formula stemmed from the fact that much of the 'newness' of new products was in styling or in discretionary introduction of technology. For example, the initial GM down-sizing programmes, both for the B-body and then for the intermediate vehicles designated the 'A-body' design, involved such straight forward efforts as to 'sweat' weight by a variety of means, among which materials substitution figured prominently.

The lengthening of the planning cycle is due primarily to various changes required to ensure compliance with CAFE standards, such as new engines, and new and lighter materials. For instance, development lead times are notably long for new engines and the varieties of trade-offs that must be considered grow in number and complexity. Glass thickness, for example, has remained unchanged for many years. Reducing the thickness, however, would save a substantial amount of weight, but this brings into question interior noise levels, occupant safety and time required to create a thinner glass that could meet current noise barrier and safety standards. The combination of newness, novel technology and complementary need to introduce redesigned components that require thorough testing force a delay of start-up dates. An additional impact of both time and the CAFE standards in the product planning process is that some products will be transitional in designs needed to help their manufacturers meet the early CAFE requirements but not sufficiently fuel-efficient to help meet the later standards (Schnapp, 1977, 108-9). One manufacturer, usually GM, introduces a styling innovation, such as the 'hardtop' or the 'coke bottle' shape , and, if it is accepted by consumers, other companies follow suit and adopt it at the next major face-lift.

Obvious discontinuities in styling for the whole market are rare. As White (1971) notes: "Introducing new models and new lines, the Big Three have been conservative in their styling and model change behaviour". The reason for the absence of large discontinuities is that major innovations in design are not only risky and expensive but take a long time to implement. The lag between initial design and introduction is usually in the order of three years and consumer acceptance of a radical change in design is impossible to predict that far ahead. For instance, the Edsel was conceived during the 1955 boom when the fashion was for that type of large car, but by its introduction in 1957, consumers showed little interest and the model was a commercial disaster. The cautious approach to change is, perhaps, best characterized by Chrysler, which after a series of unsuccessful design innovations, settled for evolutionary rather than revolutionary styling advances.

Model and Style Changes: Rationale

Automobile manufacturers offer various euphemistic rationales for annual model and styling changes. General Motors, in a study submitted to the U.S. Senate noted:

> In addition to shifts in consumer demand and expectations, product or process changes by auto manufacturers are triggered by the innovations of other producers, government, safety and emissions regulations, and shifts in the relative cost of productive factors . . . (General Motors Corporation, 1974, 65).

Industry analysts generally agree that model and styling change is crucial in stimulating and maintaining consumer demand. For instance, White (1971, 200) argues that:

> . . . for a firm faced by oligopolistic rivals, styling changes are not only a way of quickening the replacement pace of its 'loyal' customers, but also a way of attracting new customers away from other firms. With price competition largely eschewed, rivalry for customers is centered on a styling strategy rather than on a major technological change strategy for the same reasons as were advanced for a styling strategy to speed replacement.

The industry, thus places a great deal of importance on change, especially that involving styling. Indeed, Edwards (1965, 203) found that the most preferred styles would sell best, and the company which provided the preferred styles was in a most fortunate position. The feeling was that style changes significantly influenced the level of demand for the products of the individual firm and that style changes had to be made to enable the firm to expand, or even retain its market share.

It is widely accepted in the automobile industry that new cars are bought by a particular group who are not typical of the average car owner. This point of view is argued strongly by White (1971, 96):

> Those who buy new cars display different characteristics from those who own cars in general; that is, new cars are not bought by a random selection of car owners, but instead, tend to be

> bought by a small group who buy new cars comparatively frequently and sell their used cars to the general public to hold.

He also cites evidence indicating that the average income of new car buyers is substantially higher than that of the average car owner. In addition, market research data indicate that the large majority of new car buyers also bought their previous car new. As an approximation then, there are two groups of car buyers, those who buy their cars new and those who buy them used. It could be assumed that to car buyers, the utility provided by new and used cars are different; the automobile has become a necessity in modern America, but a new car is still a luxury. So it is suggested that used car buyers are interested primarily in transportation, while new car buyers value newness as such and are willing to pay a premium for it in order to gain the associated status and prestige (Smith, 1975, 44). Styling and model change do satisfy these status and prestige expectations of the new car buyer.

The relationship between model and styling changes and market share has been examined by Sherman and Hoffer (1971). Having developed a weighted index representing various levels of styling change,[1] the authors studied two well defined price fields during periods when those portions of the market were comparatively stable. For the 'high-priced' field, they examined the Cadillac, Lincoln and Imperial, between the years 1955 and 1966. In the 'low-priced' field, they analysed Ford, Plymouth and Chevrolet from 1954 to 1959. The styling changes were then related to market share, taking the market to be the sum of the sales of the three brands considered. They show that market share does respond to style changes, and more so in the high-priced field, but given their

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[1]See page 87.

their estimates of the cost of style changes, it was not a very profitable activity for the manufacturers. It is also thought that Chrysler obtained a large share increase in 1957 by completely restyling its range, but since the company could not afford to do so the next year, it suffered a substantial slump in the market share.

Generally the element of styling is very important in the context of non-price competition because poor designs can lead to loss of sales, in the present and in the future, as customers switch to other brands. Hence, it is important to produce an attractive model and to do so regularly because delays in new model introduction may again result in lost sales as customers want an 'all-new' model and not a modified version of what was new a few years ago.

An associated rationale to the model change and replacement process has been the 'trading-up' strategy. Customers are induced not merely to replace the cars for something similar but to purchase more expensive and more profitable versions of a firm's product. The strategy is to attract customers to a more costly version of a car with better discounts (White, 1971, 200).

An additional incentive is that new models also allow manufacturers to respond to material cost changes. For instance, the shift from the 'greenhouse' look of the early 1960's to the 'coke bottle' shape of the late 1960's with its much smaller glass area, (advertised as increased privacy), reflected changes in the relative price of steel and glass over that period (Smith, 1975, 23).

Economists also tend to regard model change as a form of barrier to entry. Menge (1962) long ago noted that large automobile firms have a relative cost advantage over smaller independent firms, and a firm entering the business could find it extremely difficult to compete with the Big Three. It is also noteworthy that AMC, the smallest of the domestic producers has abandoned this annual model change policy.

Although economists such as White (1971) and Edwards (1965) do not emphasize this point, regular model and styling changes also facilitate the opportunity to correct previous design mistakes. Design modifications made under these circumstances are mainly engineering changes to existing equipment required to correct certain malfunctions that show up after the automobile has been produced and sold. Often the problem or defect is known but cannot be corrected in time for the introduction of the automobile. Corrective work is hence undertaken during the following model year (Prendergast, 1965).

Improved manufacturing techniques in the production of automobiles and in related industries are also responsible for many design changes. An important example in related industries is the progress made in glass technology which resulted in the wrap-around windshield, curved glass that is completely stress relieved. In addition, new welding techniques have enabled the production of the unitised body which resulted in lower production costs and lighter automobiles (Prendergast, 1965).

Since the mid-Seventies, the greatest factor in model change has been the changes in fuel economy standards. Producers, forced to meet increasingly stringent CAFE standards, have begun a massive programme of redesigning their entire fleet of cars by emphasizing smaller overall external dimensions, shorter wheelbases, weight reduction through new lightweight metals, high strength plastics and fibre-based materials, aerodynamically designed bodies with lower drag coefficients, new fuel efficient engines and numerous innovations in electronic ignition control systems and instrumentation. GM has unequivocally been the front-runner in what has been commonly known as the down-sizing program. All its car lines have been down-sized at least twice and more such phases are planned.

New Market Segments

More fundamental than the restyling of an existing model is the introduction of cars that fit into previously undefined market segments. Despite the plethora of models, the range offered by manufacturers for most of the postwar period has been rather limited, compared with that available from European producers, for instance. Until very recently, most American automobiles conformed quite closely to a basic design with respect to size and mechanical design. However, there have been discontinuities in the market when the manufacturers were forced by foreign competition or public demand to extend their range. Notable instances of this were the introduction of compacts in 1960, and subcompacts in 1970 by Ford and GM and in 1978 by Chrysler.

Despite experiments in the 1950's, the Big Three refrained from producing small compact cars. The Independents, Nash, Kaiser, Willys and Hudson, undeterred by the decision of the Big Three, offered compact cars to the public between 1950 and 1954. The reluctance on the part of GM, Ford and Chrysler was based on a "room for all" philosophy which meant that a market of sufficient size had to exist before the major firms were willing to commit major investments. Further, the increasing domestic demand for imported cars was erroneously viewed as a temporary trend and the public's desire for 'cheap' transportation as revealed by the demand for small imports, was expected to be easily met by the suppliers of used cars. A more important reason perhaps was the enduring fear that sales of new cars were certain to encroach upon those of the large existing lines--a problem which of course did subsequently materialize. Sales of small cars directly by the Big Three in the meantime were made possible through captive imports produced by their respective European subsidiaries. However, as imports grew rapidly, after the mid-1950's, the industry leaders were forced to reevaluate their position. By 1958, plans for compact cars were completed and in the 1960 model year, Chrysler introduced the Valiant, Ford the Comet and Falcon, and GM the Corvair. These new models, generally well received by the North American consumers, dealt a severe blow to imported vehicles.

Following the debut of the Big Three's compacts, plans were laid by Ford and GM to eventually produce yet smaller subcompact vehicles. These vehicles, however, never made it to the market because manufacturers started to upgrade compact models to intermediate vehicles in the late 1960's. The producers firmly believed that the public preferred larger cars once again and that something had to be done to offset the lack of enthusiasm for compacts which were generally less profitable than full-size cars. The Ford Maverick (103 inch wheelbase) appeared in the spring of 1969 and the AMC Hornet (108 inch wheelbase) appeared in the fall of 1969. Unable, however, to ignore the rising tide of imports which reached 986,000 units or 10.5 per cent of the market in 1968, American auto manufacturers were forced once again to rethink the small car market. In 1970, subcompact cars with a wheelbase below 100 inches appeared; Ford's new car was called the Pinto and GM's the Vega, manufactured by Chevrolet. Chrysler, unlike its major rivals did not produce a competing subcompact, but relied instead on cars made in Japan by Mitsubishi Heavy Industries and sold under a Chrysler nameplate. Although this arrangement continues, Chrysler finally produced a subcompact based on a similar design developed by Chrysler's French subsidiary. Sold as the 'Horizon' under the Plymouth Division and the 'Omni' under the Dodge Division, the car features front-wheel-drive, a transversely mounted, Volkswagen-made, four cylinder engine and body styling popularised by the Volkswagen Golf (Rabbit).

Another product-market innovation of less importance but which is of some interest for the light it sheds on the development of new market segments is the introduction of the 'sports-compact' cars. Following more than three years of technical development and market testing, Ford introduced the Mustang in April 1964 (Gerlach and Wainwright, 1968, 143-52). By 1966, it held six per cent of the new car market, and by 1967, when it had been followed by various competitors, sports-compacts accounted for 10.8 per cent of all new car sales. The Mustang represented a marketing innovation rather than a technical advance: It was constructed of a sporting body and was sold through a large advertising campaign. The variety of engines, body styles and accessories offered gave consumers the illusion of designing their own car when ordering a Mustang. The existence of a large affluent and youthful market guaranteed the success of a status symbol that claimed kinship with competition racing machines. Racing and sports cars are often used as test beds for mechnical innovations that subsequently percolate through the family saloon. But in this case, it was the image, not the mechanics that sold the the Mustang (Smith, 1975, 24). As in the case of previous entirely new model introductions, the Mustang's debut was quickly followed by GM's Chevrolet Camaro and Pontiac Firebird in 1967.

CHAPTER V

ECONOMIC GEOGRAPHY OF AUTOMOBILE ASSEMBLY

Broad variations in the type of automobiles produced, distinguished on the basis of features such as body construction, size, degree of luxury and number of accessories and regular changes in these specifications place not only different but continually shifting demands on the basic assembly line. The capability of such individual plants and a firm's total resources to accommodate the production of certain models with a range of specifications at a given time may be fundamental in determining what models can be assembled at a given plant. Product specific scale economies may limit the variety of models that can economically be produced in one plant. Compatibility or incompatibility in run-length economies and plant scale economies may lead to specialized single- or multiple-product plants. Alternatively, plant numbers, location and utilization of certain production factors at the level of the firm may ultimately determine what products are to be produced in individual plants that would benefit the firm most.

Assembly Plant and Operations

The assembly plant is essentially the final link in a series of highly coordinated operations which commence at the ore pits and coal mines and carry through into basic manufacturing and into parts fabrication. Earlier stages in automotive manufacture include the stamping of body panels, casting and machining of engines, manufacture of chassis, transmission and thousands of other components from windscreens to wipers. At a precise moment in time and space, these various parts and units are brought to a focal point, the final assembly plant where they are fed into an assembly line and emerge as completed automobiles.

No two assembly plants are the same and it would be hazardous to speak of the typical assembly facility. Nevertheless, there is a wide degree of convergence in terms of basic design, plant layout, production techniques, production capacities and manpower requirements. In general, the modern assembly plant is a massive single-storey building with a huge parking lot for completed vehicles. Plants of an older vintage, particularly those in the heart of the auto industry, are multi-storied structures. They are not considered to be efficient and are gradually being abandoned (Sloan and Miles, 1980, 110-12). Chrysler, for instance, anouced in 1979 that its historic Hamtramck plant, which was built originally by the Dodge Brothers and first produced cars in 1914, would be closed permanently in mid-1980. The antiquated structure is eight stories high at certain places and is extremely inefficient from the standpoint of the cost of utilities compared to a modern plant (Detroit Free Press, May 30, 1979, 1A & 15A).

Assembly operations, unlike physical plant design and dimensions, are remarkably similar between plants as well as individual enterprises. Basically, assembly involves hundreds of workers, stationed along a moving conveyor, adding parts to a 'carcass' to eventually build a complete car. At the start of this line, stamped sheet metal parts are placed on jigs and welded together, mostly by hand and sometimes by industrial robots, to form the inner and outer portions of the body. Welded edges and surfaces are smoothed and a rust proofing solution applied before the body is sent for painting. The metal is then given a number of coats of paint and baked in hot ovens between coats. After painting, the upholstery, seats, interior and exterior trim, windows and windshields are added, and the completed body is then stored temporarily. Sometimes the body-building process is carried out in separate premises and shipped to final assembly operations, as occurred for example when the Fisher Body Division was not completely integrated with GM's final assembly operations. Bodies then were built in adjacent Fisher plants and sent to GMAD or the respective Divisional plants to complete the assembly process (Smith, 1966). Meanwhile, the frame--in the case of a 'frame-on body' type car--is built up attaching the springs, brakes, motor and transmission, off the main assembly line. At the proper moment, the right body is mated to the right frame. However, in the assembly of cars with unitized body construction, the step involving the mating of the separate frame and body is eliminated. Also excluded is the separate line for assembly of the frame. Subsequently, wheels, front fenders, grills and bumpers are installed, final adjustments made and the complete car driven to a test stand where front wheel alignment is checked, a final inspection given and the car prepared for shipment. Cars found wanting by inspectors anywhere along the line are pulled off the line into special bays and repaired before being shipped off.

Assembly Operations and Manpower Requirements

On the assembly line, the total work content of a complete automobile consists of a large number of highly simplified operations. Along the main moving line, for example, individual operations may include installing clips to hold the chrome moulding strip to the body, attaching a piece of rubber which fits on the hood latch to prevent rattling or installing bolts that hold the spare tire clamp. Each operation requires a certain amount of time varying from a few seconds to a minute or more perhaps, depending on the task's complexity. To each assembly line worker is assigned one of several tasks repeated endlessly. One survey of an automobile assembly plant in the late 1940's, (Walker and Guest, 1952) found that while a third of the workers sampled performed single operations, the majority performed two or more. Of this latter group, nearly half were responsible for more than five operations. Although this study is somewhat dated, the basic functions on the assembly line have not changed significantly. The actual number of operations is usually a function of the cycle time which is the amount of time the worker has available to carry out his assigned tasks when the incomplete vehicle passes him. In practice, the cycle time is frequently determined by required production rates, which vary commonly from forty to eighty cars per hour. If higher line speeds are desired, cycle time would automatically be reduced and each worker has time only to execute fewer operations. More workers will then be required on the assembly line to carry out the operations relinquished by other workers. White (1971) relates an example which illustrates the point. Given a line speed of sixty cars per hour a worker's tasks at a certain work station may consist of placing the left front wheel on the axle, hand screwing five nuts to the wheel, tightening them with a five-nut torque gun and finally placing the left rear wheel on the rear axle, actions which would consume the cycle time of a minute. If the line speed is increased to, say, seventy per hour, the same worker would be spared of his final task, that of placing the wheel on the rear axle. Likewise, other workers along the line will be relieved of part of their operations which are then allocated to new workers hired for the line.

The almost simple cause and effect relationship between line speed increase and expansion in the assembly workforce is the result of union pressure which has been effective in preventing straight speedups, meaning workers perform the same number of tasks regardless of line speed. It appears that the union and the industry have agreed on an acceptable task level for a cycle time of one minute. Hence, if a faster pace is effected, new workers must be employed, rather than increase the task level. Kilbridge and Wester (1966) report that most companies, when the volume of sales was high and consistent, chose cycle times of about sixty seconds and in the auto industry typical assembly cycles range from 1.0 to 1.5 minutes.

There is, however, some upper limit to which line speed can be increased. A faster production line means that additional floor space is required to accommodate more workers on the assembly line and higher stocks of parts and components in storage areas adjacent to the line. Plant floor space, especially the lack of it, is hence a major constraint on the increase of line speed. Other constraints would be paint-drying, oven space and testing booth space at the end of the assembly line (White, 1971).

Model Mix and Assembly

Market heterogeneity and consumer demands for a greater choice of cars have forced manufacturers to produce a wide variety of models. When an assembly line produces more than one model of a given product either of two assembly systems may be used: batched assembly or mixed model assembly. In the former, models to be assembled (for example A, B, C) are scheduled down the line in batches whereby a cluster of, say, A model are assembled, and then a cluster of B model, and so forth. In the latter, models are intermixed down the line in an arbitrary order. For instance, a schedule may call for a sequence: "A B A C C B C A A . . . and the line is prepared to handle any sequence of models. The automobile industry is a classic example of this type of production. Here the models differ by the number of doors, wheelbase, type of engines and so forth.

Mixed model assembly on the assembly line is feasible partly because of two fundamental ideas which in the first place made assembly processes possible, standardization and interchangeability. Separate models of cars may be identified by unique names and may have some unique features but to a large extent one model shares identical parts and components with another within the same family and even with those of another family group. For the assembly line worker, assembling two, three or even four models could mean a difference only in name. The parts and motions required in his set of tasks may indeed be identical. On the other hand, there may also be substantial differences for some workers who may be required to switch to completely different tasks when another model comes down the line, such as installing some optional equipment, required on some cars but not others, a factor leading potentially to significant inefficiencies. Prior to Fall 1979, for instance, Volkswagen found the cars produced at its Westmoreland, Pennsylvannia plant were often rated above its German-built models in quality terms. Since then, however, quality has declined, and management attributes this largely to the several new models and numerous options that were introduced to the assembly line at that time (Fortune, June 16, 1980, 86).

There are several advantages in mixed-model assembly because it provides a continuous flow of each model, reduces finished goods inventory, eliminates line changeover, and provides greater flexibility in production. However, the system does present some serious problems such as line balancing for a given production schedule, sequencing of models and scheduling of parts for various sub-assemblies (Prenting and Thomopoulos, 1974). Line balancing is the procedure of assigning work to assembly operators in such a manner as to apportion the assembly work among the operations as evenly and compactly as possible, without violating any sequential or precedence restrictions. It is, however, complicated by several models each requiring a different total work content time. A four-door model will require more time to build than a similarly equipped two-door model. Likewise, an option-laden car needs a larger total work content than a similar but 'stripped' model, causing an uneven distribution of work along the line and variations in the work load of individual stations. A major factor in mixed-model assembly is to determine the optimum ordering or sequence in the flow of models to eliminate if not minimize the idle time of operators and the effect of work congestion which occurs when the product moves through the station with a frequency which prevents the worker from completing his work assignment (Wester and Kilbridge, 1964). Another problem is of course to coordinate the stocks and flow of parts and components for a broad range of models. While computer scheduling of applications has made complex supply and inventory problems manageable, there are limits beyond which costs per car become prohibitive.

Another source of additional costs, when model mix becomes complex, is that arising from learning or doing new tasks. In mixed-model learning situations, the worker is not always performing the same operations on all models. Some work elements are unique to certain models, while other elements are common to two or more models. Consequently, the rate at which workers are learning and completing their assigned tasks, varies from one element to another and from one model to the next. Thomopoulos and Lehman (1969) confirmed what had long been suspected, that if more than one model is produced on one line, an increase in assembly time is required to process the units over an equivalent single model line.

Assembly involving different models from one family of cars can be a major problem. Assembling models from different families is even more complex, especially when parts and components are less standardized and interchangeable and total work content is even more divergent. One source of this divergence is the body construction, which can be either of frame or unit body construction. In frame construction, the passenger compartment of the automobile body is mounted on a chassis and the front panels bolted on. Assembly procedures are different from unitized body construction to the extent the engine transmission is mounted on the frame and the body lowered and bolted on to the frame and front panels added. In unitized body construction, the entire body is welded, painted and all other components, engine and transmission added later. In essence, then, the assembly operations of these two body types are different. In frame assembly, there is the additional task of building up the frame with engine and transmission of a sub-assembly line and assembly of the body segment on a separate main line. The entire assembly process for unitized body vehicles occurs on a single continuous line since no major sub-assemblies are necessary in the build-up of the vehicle. This fundamental difference serves to separate the assembly of car lines of frame and unit body types. In yet another extreme situation, GM and Ford produce light trucks on the same lines as cars in several regional assembly plants. Nevertheless, the fact that "rarely do two identical cars follow each other down the line" (White, 1971, 26) suggests that assembly lines are quite flexible. The extent of that flexibility, however, is less certain, a point made more interesting by the practice of mixing assembly of cars of different families and even with other vehicles such as light vans and trucks.

Automatic Assembly

The substitution of automatic equipment for labour has occurred in many automative manufacturing and assembly operations. Large and small components automatically assembled include the engine blocks, piston connecting rods, spark plugs, started motors, alternators, batteries, carburetors, fuel pumps, and so forth (Prenting and Kilbridge, 1974). One stage of production where automatic assembly remains minimal and where manual work still dominates is final assembly. This situation has popularised the impression that "the assembly plant is equipped only with portable powered hand tools, mechanized moving assembly lines and painting booths" (Abernathy, 1978, 132). Insofar as Ford is concerned, some progress is evident in automation especially in the area of body welding functions. Other automated processes include tire-mounting and inflation, painting, door aligning and hanging, wheel alignment, rust proofing, electrocoating and car-testing (Abernathy, 1978). The extent of these automatic final assembly functions in the rest of the industry is not so well publicized. Indications are that automatic body construction is still limited in car assembly. In the early 1970's, the Ford Pintos and

Mustangs were framed and spot-welded in one automatic process. Perhaps the best known instance during this period was at GM's Lordstown plant which boasted eleven unimate robots along a moving body line to perform welding operations automatically. Investments in automatic equipment have been applied primarily to smaller unitized body cars while plants assembling cars with frame bodies have yet to be so equipped. Given the variety of cars and frequent model changes and the premium placed upon plant flexibility, a factor hindering investments in automatic equipment is the possible constraint such equipment may have on plant flexibility in producing a diverse and changing set of product lines.

Assembly Plant Scale Economies

The economic scale of auto manufacture, including auto assembly has formed part of the subject of several independent studies and Congressional Hearings into the U.S. automobile industry. Consequently, there exists a number of estimates of scale economies of auto assembly since the 1950's. Since this study deals with the post 1965 period, only those estimates of scale economies by White (1971) and Toder (1978), which are compatible temporally with this analysis are reviewed. Before proceeding, however, it is useful to indicate that efficient plant size or rate of output at lowest average cost can be considered from the standpoint of two output levels, the 'minimum optimal scale' (MOS) and 'optimal scale' (OS). Used generally in the context of Bain's definitions, optimal scale means

> The scales of plant or firm (as measured in designed rates of output) at which the lowest attainable unit costs are attained. . . . There may be a range of alternative optimal scales for a plant or firm in a particular industry, if after a critical size necessary for lowest costs has been reached, further increases in size will neither increase nor decrease unit costs. The

> smallest scale at which a plant or firm may achieve the lowest attainable unit cost may be referred to as the minimum optimal scale of the plant or firm (Bain, 1956, 53).

Another point worth noting is the substantial disagreement amongst economists as to the preferable basis for measuring scale economies, a factor which undoubtedly has far-reaching implications on estimates of efficient size production units. Moreover McGee (1974), has drawn attention to the general neglect of total model volume as an important dimension of efficient size and output. He has criticized those who have regarded size exclusively in terms of output rate, and estimates of economies of scale in auto assembly are framed entirely in terms of output rates, a point which should be emphasized at the start of our brief review.

White (1971), who was concerned with the U.S. auto industry as a whole, estimates that the "optimum rate" for auto assembly plants in the late 1960's was in the range of 200,000 to 250,000 units per annum. These figures were based apparently on two plants, Chrysler's Belvidere facility and GM's Lordstown, Ohio plant, both of which were constructed in the mid-1960's and designed to produce at the rate of sixty vehicles per hour. Further, these figures referred obviously to the optimal scale and though he did not explicitly venture an estimate for the MOS, White did suggest that outputs well below the OS were not inconceivable, since some plants, like GM's at Framingham, Massachusetts, were operating at half the hourly rate compared to Belvidere and Lordstown. The 1979 rate at Framingham, for example, was forty-five units of Buick Century and Oldsmobile Cutlass cars per hour.

White, as others before him, regarded assembly as an operation concerned with homogenous products and made no effort to distinguish the potential effects on efficient rate of plant output by assembling cars of different sizes. This point is considered by Toder who notes that:

> The production scale economy issue is complicated by the fact that automobiles are highly differentiated, offered with many features and options, as well as in different sizes, degrees of luxury, and body styles. Cars with different characteristics can be produced on the same assembly line so long as the differences are not great. For example, a Chevrolet Vega and a Pontiac Astre might be produced together since the main differences between the two cars are in the nameplate and in a small amount of external trim. For purposes of assessing scale economy, it is sensible to view the Astre as a separate car with a suboptimal level of output; on the other hand, Vegas and Cadillacs clearly cannot be produced on the same line. For less extreme cases, the distinction may be less clear; for some parts of cars there are joint economies of production but not perfect jointness (Toder, 1978, 130).

Toder divided cars into four categories: mini (subcompact), compact, intermediate and standard/luxury. The economies of producing an automobile he expressed as the sum of eight "cost elements" or parts of the production process, of which final assembly was one. Other cost elements included body unit (metal stamping), frame (chassis), engine, transmission, tires, body components and other components. His estimates of optimal scale for automobile assembly and unit assembly costs for the four classes of automobiles are shown in Table 8.

TABLE 8

MINIMUM EFFICIENT SCALE AND UNIT COSTS AT OPTIMAL SCALE FOR AUTOMOBILE ASSEMBLY, 1974

COST ELEMENT	TYPE OF AUTOMOBILE			
	Subcompact	Compact	Intermediate	Standard/ Luxury
Auto Assembly (x1,000)	400	300	250	200
Auto Assembly ($US)	343	343	443	492

Source: Toder (1978, 132-3).

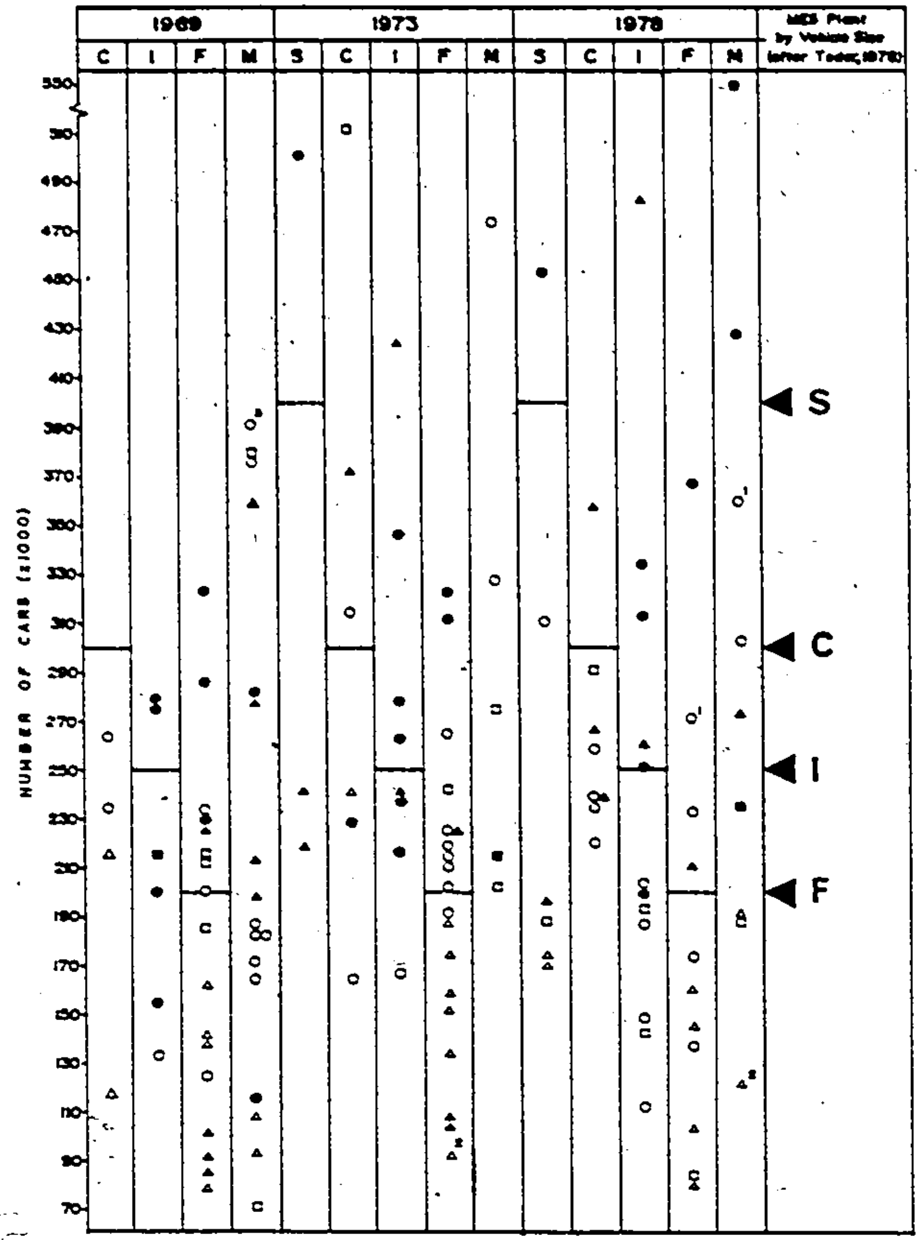
The optimal scales give approximate annual output for a two-shift, five-day work week with production at a plant large enough to realize all scale economies. "Attempts to increase output beyond the level reported (in the Table) will at some point, lead to increasing unit cost of production; in the long run, increasing costs can be avoided by constructing additional plants" (Toder, 1978, 133). It is worthwhile noting that Toder's optimal scale for Standard/Luxury vehicles corresponds to White's figures based on Belvidere and Lordstown. Incidentally, both these plants initially assembled full-size or standard cars--Chevrolets at Lordstown and the Plymouth Fury and Dodge Polara at Belvidere. One way of explaining the difference in minimum efficient scale among different types of cars is to view a given investment in tooling as producing a roughly similar value of output for different types of cars. The types of operations and tools used in the production of both small cars are the same, but big cars require more operations--and more work stations in the factory for a given output--because they have more parts. Thus, the same number of workers with the same amount of capital can produce fewer big cars than small cars (Toder, 1978, 139). Hence, there is a higher optimum scale for each class of smaller cars. In reality, this is borne out by general differences in the hourly production rate of assembly plants. When both Lordstown and Belvidere were converted to produce subcompact vehicles, hourly rates were increased to seventy to eighty-five units at Lordstown and seventy at Belvidere. One major drawback of White's analysis is the absence of an explicit MOS estimate which would have established the lower limit for efficient plant output.

A notable feature of both White's (1971) and Toder's (1978) estimates is their emphasis on production economies as a key determinant of plant scale economies. Although White's figures on plant size were derived from two operating plants, Lordstown and Belvidere, both were established during the 1960's when transportation costs were believed to be less important. Toder (1978, 131) on the other hand clearly indicated that he was considering only scale economies in production. If, however, transport costs were significant, plant sizes smaller than those derived purely on the basis of production economies would be more efficient (Scherer, et al., 1975). By considering the real output of assembly plants, a clearer idea of assembly plant size, which apparently incorporates not merely production but a host of other economies including distribution costs to dealers, may be obtained. Further, such analyses will indicate how real output compares to those estimates over the past decade.

Assembly Plant Output Levels

Figure 6 shows the actual output of Big Three assembly plants specializing in subcompacts, compacts, intermediates and full-size cars for the 1969, 1973 and 1978 model years. There is also an additional category of 'mixed' plants producing cars from two or more classes. Strictly speaking, some plants specializing in one class of cars are also mixed since they also assemble trucks. Their position on the vertical scale includes truck production, since omitting the latter would artificially understate the true output of plants concerned. It is generally acknowledged that truck assembly in turn has the effect of understating a plant's potential capacity especially when the same plant may be used exclusively to assemble cars instead of both cars and trucks (Boyle, 1974). The criteria for choosing the three particular years,

Figure 6: Assembly Plant Output and MES by Vehicle Size, Model Years 1969, 1973 and 1978



LEGEND

VEHICLE SIZE
S = Subcompact
C = Compact
I = Intermediate
M = Mixed
F = Full-size

PLANTS
GM ○
Ford △
Chrysler □
Darkened symbol indicates truck assembly as well.

PLANTS EXCLUDED
Oakville, St Thomas, Jefferson Ave., Lynch Rd., Ste. Thérèse : 1969, 1973.
Oshawa : 1973
Flint : 1969, 1973, 1978

NOTES
[1] Two lines
[2] Excludes truck output
[3] Oshawa: includes some output from Ste. Thérèse.

Source: Ward's Automotive Yearbook, Automotive News Market Data Book Issue, various years.

reflect in part the desire to avoid recession years like the 1974-75 model years, and, where possible, contract talk years, which were, on occasion, marred by ugly severe strikes, disrupting industry output. Though 1973 was a contract year, production was not affected in any major way. This year was preferred over 1974/75 because of a recession following the aftermath of the 1973 oil embargo crisis: and over 1972 because 1973 appears to be closer to a temporal mid-point between 1969 and 1978. The years chosen are close enough to warrant comparison with the most recent estimates of assembly plant scale by White and Toder, who based their figures on the years 1968 and 1974, respectively. It is assumed that Toder's estimates are the most reasonable approximations for the period covered by this study.

How do the actual output levels of Big Three plants compare to Toder's estimates of minimum optimal scale for different classes of vehicles? In 1969, there were only two GM and two Chrysler plants assembling full-size cars exclusively that were at or above the MOS. Eleven others producing only cars in the compact, intermediate or full-size classes, but not some combination, were below the MOS. Six other plants were above and seven were below the MOS but part of their production consisted also of light trucks. The proportion of light trucks produced in passenger car plants varies from a few to over fifty per cent of total plant output. During the 1973 model year, nine single class, car-only plants were efficient by Toder's standards, but eleven were not. At the same period, nine car-only assembly plants met MOS requirements and seven failed to do so. In 1978, there were considerably fewer efficient car-only plants (three) and many more inefficient ones (twenty-three). Of the 'car and truck' plants, eight were at or above the MOS and only three were below. Overall, there were generally fewer single class, car-only MOS plants. In contrast, there were more car-truck plants of MOS in two of the three years analysed. This seems to suggest that most car-only plants had difficulty in attaining efficient size output, but those that did had capacity allocated partly to truck assembly.

Another notable feature of the actual size of assembly plants is the wide variation in size above and below the MOS estimates in each of the vehicle classes and a complete absence of any clustering around the MOS. It may be an indication that there are a wide range of optimal sizes or that Toder's estimates are questionable. With regards to the latter point, Toder (1978, 140) noted:

> In general qualitative terms, we have probably overstated unit costs both below and above 'minimum efficient scale' output, failing to account for potential scale economies beyond existing plant sizes, and not considering potential ways of reducing the capital stock when output is planned to be lower.

Indeed, this statement suggests that the actual MOS may be higher but on the other hand, unit cost penalties at production levels below the MOS may be less serious than first suspected.

The question whether 'mixed' plants turning out two or more classes of automobiles are producing cars efficiently remains unresolved for the moment since no previous attempt has been made to determine this. The output range of mixed plants during the three years analysed is large, as in the case of single-class car plants.

Perhaps the most outstanding feature of Figure 6 is the persistent variations in actual plant sizes notwithstanding the class and mix of cars produced. Despite strenuous efforts to pinpoint efficient size of plants, evidence strongly suggests that there may indeed be a much wider range of outputs within which assembly plants can function efficiently and with a great deal of flexibility. This may be due partly to some significant scale economies beyond the product and plant dimensions. There is evidence, for instance, of scale economies in retailing and distribution of automobiles as well as in production (Pashigian, 1961). In addition, "It is likely that scale economies can be found to exist in overall management, marketing and research and development. . . . Such sources of scale economies are important for determining the size distribution of firms" (Toder, 1978, 130). How these economies and also those related to multiplant operations, affect overall plant efficiency and size distribution remains to be clarified.

Multiplant Operations of the Big Three

Plant Numbers and Locational Inertia

General Motors, Ford and Chrysler together operated a total of forty-six automobile assembly plants in the U.S. and Canada in 1979 (Table 9). The number of assembly facilities serving the North American market has remained rather consistent with only a slight variation since 1965. From 1966 until 1970, there were at least fifty plants, but since then, the number has declined to forty-six in the 1979 model year.

GM, the largest firm accounts for half or more of the total number of Big Three plants, depending on the specific model years concerned. Over the past fourteen years, GM has maintained between twenty-three and twenty-five assembly plants. One plant closure, at Bloomfield, New Jersey, occurred after the 1968 model year. During the mid-Sixties, two new plants were opened, Lordstown, Ohio, and Ste. Thérèse, Quebec. A recent addition to GM's stock of assembly plants is the Oklahoma City facility which was commissioned in May 1979.

Over a third of Big Three plants are owned by Ford, which has

TABLE 9

BIG THREE AUTO ASSEMBLY PLANTS IN THE U.S. AND CANADA

MODEL YEAR IN OPERATION	FIRM			
	GM	FORD	CHRYSLER	BIG THREE
1965	23	17	7	47
1966	25	17	8	50
1967	25	17	8	50
1968	25	18	8	51
1969	24	18	8	50
1970	24	18	8	50
1971	24	17	8	49
1972	24	17	7	48
1973	24	17	7	48
1974	24	17	7	48
1975	24	16	7	47
1976	24	16	7	47
1977	24	16	7	47
1978	24	16	7	47
1979	25	15	6	46

Source: <u>Ward's Automotive Yearbook</u> and <u>Automotive News Almanac Issue/ Market Data Book Issue</u>, various years; <u>Motor Vehicle Manufacturers' Association of the United States Inc</u>. (1979).

operated fifteen to eighteen plants over the years. Since the late Sixties, a steady decline in the number of Ford plants has been evident. The company currently maintains fifteen North American plants; a recent closure was at Dallas (1970). The Norfolk and St. Paul plants were converted to light truck assembly after the 1974 and 1979 model years, respectively.

Chrysler, the smallest of the Big Three, in 1979 operated a total of six plants, down from eight in the late Sixties and early Seventies, and, seven for most of the Seventies. The decline in the number of Chrysler plants followed the closure of the Los Angeles operations in 1971 and more recently the conversion of the East Jefferson Avenue plant in Detroit to light truck assembly.

One notable feature of Big Three assembly plants is the slow pace of plant turnover and rather high degree of locational inertia. GM has only recently embarked upon a massive plant replacement programme after several decades of 'recycling' antiquated, multistorey assembly plants (Sloan and Miles, 1980). The company's U.S. plants currently average thirty-nine years and this programme of closing assembly plants because they are old and replacing them with new modern single-storey structures represents a 'first' in its seventy-two year history. Prior to this, GM's profit criteria which required a return on investment in five years or less effectively ruled out new plant investment. Production of a new generation of car lines which are substantially different from their predecessors, the high cost of refitting old inefficient plants and strict environmental standards governing factory emissions have combined to bring about a policy change. However, new locations sought are in the general vicinity of existing plants largely because of the economic costs and political pressure brought to bear upon companies relocating to another region.

Spatial Organization of Assembly Plants

Assembly plant location patterns show elements of concentration as well as dispersion. Dispersion is evident in that the plants of the Big Three in 1979 were located in all the main geographic regions of North America, with the exception of the Mountain region in the United States and the Western, Northern and Atlantic regions of Canada. Plant distribution by major geographic regions is shown in Table 10. There are five plants in the West, three of which belong to GM and two to Ford. The North Central region has the largest concentration of plants. Almost half the auto assembly plants of the Big Three are situated there. GM produces cars in eleven plants in the region, Ford, seven and Chrysler, four. The South, particularly the South Atlantic region is another major location of assembly plants. Other regions with major assembly facilities are the North-east and Central Canada, with five plants each.

There are some distinct contrasts between the geographies of new automobile consumption and production. However, the principal locations of assembly plants are generally the major regional markets for new automobiles (Figure 7). The East North Central division, America's largest regional market consumed an average of over 2.2 million new cars a year between 1974 and 1978, and also had the most number of plants, sixteen. However, its total output far exceeded regional consumption. Other major markets are the Middle and South Atlantic and Pacific divisions. Each has three or more plants but produces less cars than the number purchased regionally. Two other major concentrations of plants are the West North

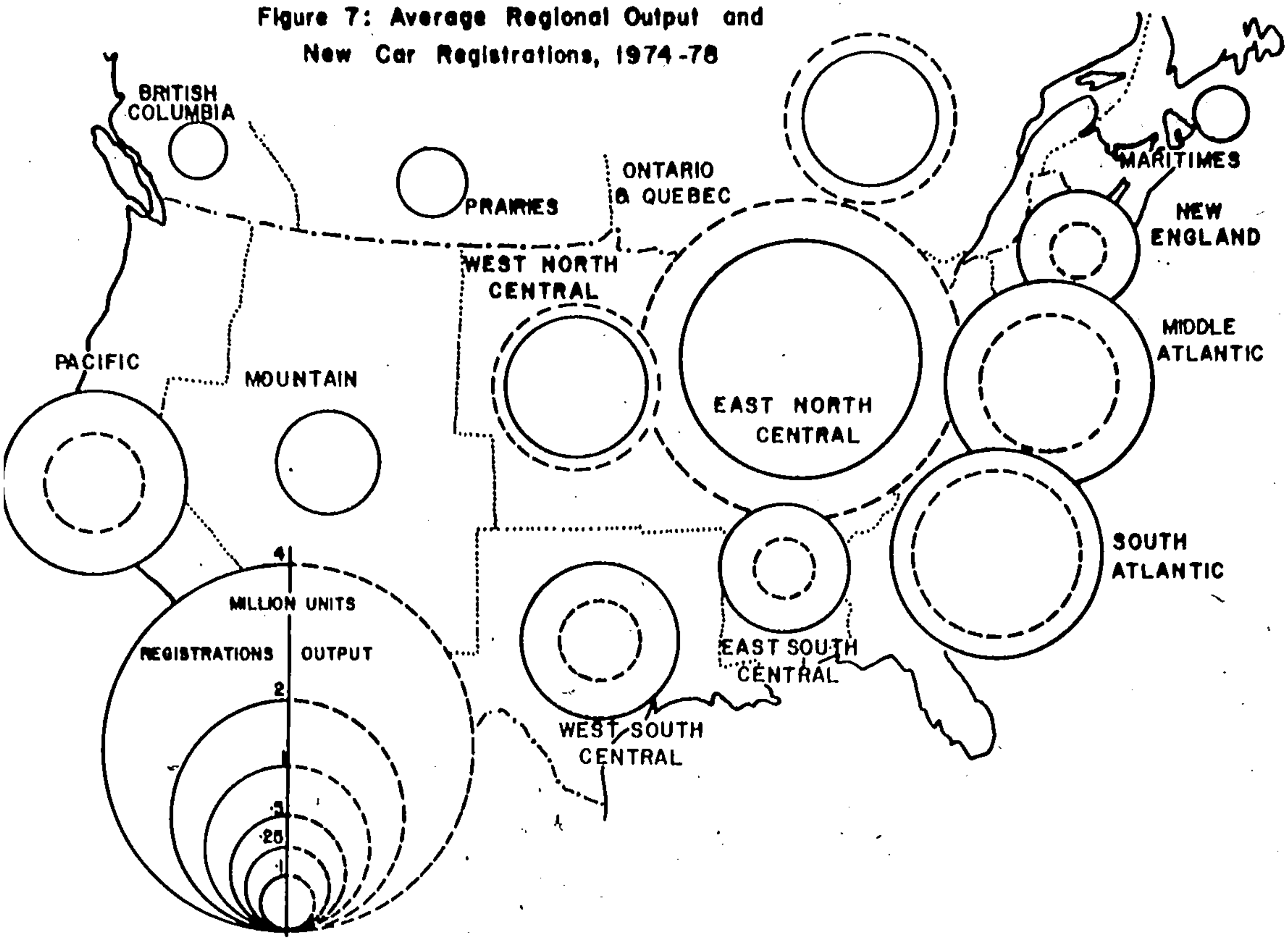
TABLE 10

DISTRIBUTION OF BIG THREE AUTO ASSEMBLY PLANTS
BY GEOGRAPHIC REGIONS OF THE U.S. AND CANADA, 1979

GEOGRAPHIC REGIONS	GM		FORD		CHRYSLER		"BIG THREE"	
	No.	%	No.	%	No.	%	No.	%
U.S.A.								
WEST	3	12.0	2	13.3	-	-	5	10.9
Pacific	3	12.0	2	13.3	-	-	5	10.9
Mountain	-	-	-	-	-	-	-	-
NORTH CENTRAL	11	44.0	7	46.8	4	66.6	22	47.8
West North Central	3	12.0	2	13.3	1	16.7	6	12.9
East North Central	8	32.0	5	33.5	3	49.9	16	34.9
SOUTH	6	24.0	2	13.3	1	16.7	9	19.5
West South Central	2	8.0	-	-	-	-	2	4.4
East South Central	-	-	1	6.65	-	-	1	2.2
South Atlantic	4	16.0	1	6.65	1	16.7	6	12.9
NORTHEAST	3	12.0	2	13.3	-	-	5	10.9
Middle Atlantic	2	8.0	2	13.3	-	-	4	8.7
New England	1	4.0	-	-	-	-	1	2.2
CANADA								
WEST	-	-	-	-	-	-	-	-
British Columbia	-	-	-	-	-	-	-	-
Prairies	-	-	-	-	-	-	-	-
CENTRAL	2	8.0	2	13.3	1	16.7	5	10.9
Ontario	1	4.0	2	13.3	1	16.7	4	8.7
Quebec	1	4.0	-	-	-	-	1	2.2
ATLANTIC	-	-	-	-	-	-	-	-
NORTH AMERICA	25	100.0	15	100.0	6	100.0	46	100.0

Source: Motor Vehicle Manufacturers' Association of the United States Inc. (1979).

Figure 7: Average Regional Output and New Car Registrations, 1974-78



Central division, and Ontario/Quebec, each producing approximately one million cars but consuming three quarters of a million or less new cars annually from 1974 and 1978. Smaller markets (about 0.5 million units), such as New England and the East South Central division, each have only one plant. An unusual situation is that of the West South Central division, which has average annual new car sales of nearly 900,000 units but is serviced by only one plant, at Arlington, Texas. The recent establishment of GM's newest plant at Oklahoma City, Oklahoma may be a response to this imbalance. Four regions, British Columbia, the Prairies and the Maritimes in Canada, and the Mountain division in the United States, do not have regional assembly plants. Each has only a small market, with between 80,000 and 400,000 units sold. In general, Big Three assembly plant locations correspond only roughly to the geography of the North American new car market, with excess production occurring in the three most central regions, and deficits elsewhere.

This portrait of plant distribution by major regions conceals a large degree of localization within each region. A large proportion of plants are concentrated in a few key states and one Canadian province, the most important of which are Michigan (ten plants), Missouri and California (five plants each) and Ontario (four plants). States with three plants are Ohio, New Jersey and Georgia. Few have two plants while several have single or no facilities. There has long been a significant concentration in Michigan, the auto industry's core producing area. Some of the oldest plants, most now fully modernized, are located there.

Another feature is the concentration of plants in a few major urban conurbations. In 1979, twenty-seven plants were located in eight major U.S. conurbations (Table 11). Many of these were, however, in

TABLE 11

BIG THREE ASSEMBLY PLANT LOCATIONS IN MAJOR URBAN CONURBATIONS, 1979

CONURBATION	NUMBER OF PLANTS			
	GM	FORD	CHRYSLER	TOTAL
San Francisco	1	1	-	2
Los Angeles	2	1	-	3
Kansas City (Kansas & Missouri)	2	1	-	3
St. Louis	1	1	1	3
Atlanta	2	1	-	3
Detroit-Windsor	1	3	3	7
Philadelphia Camden-Wilmington	1	-	1	2
New York City-Newark	2	2	-	4
TOTAL	12	10	5	27

smaller urban communities situated close to larger centres. The greater Detroit-Windsor area has the major concentration of auto assembly plants. Within Detroit's city limits are situated GM's Cadillac plant and Chrysler's Lynch Road and Hamtramck facility. Other plants in the vicinity include Ford's Dearborn, Wixom and Wayne plants, and Chrysler's plant in Windsor, Ontario. Another major agglomeration is the New York City-Newark conurbation in which the Mahwah-Metuchen (Ford), Linden and Tarrytown (GM) plants are located. Notable in the pattern of plant distribution is the similarity in the choice of major urban locations, particularly between GM and Ford.

Four broad 'industry' regions or zones may be identified, using a somewhat different geographic perspective, to describe the spatial organization of Big Three passenger auto assembly plants (Figure 8):

(a) The 'Industry Core', consisting of the state of Michigan, is the heart of the North American auto industry. Apart from being the management and design centre, and the state with the most number of auto assembly plants, it also has the largest concentration of Big Three and other independent plants producing all manner of automotive components.

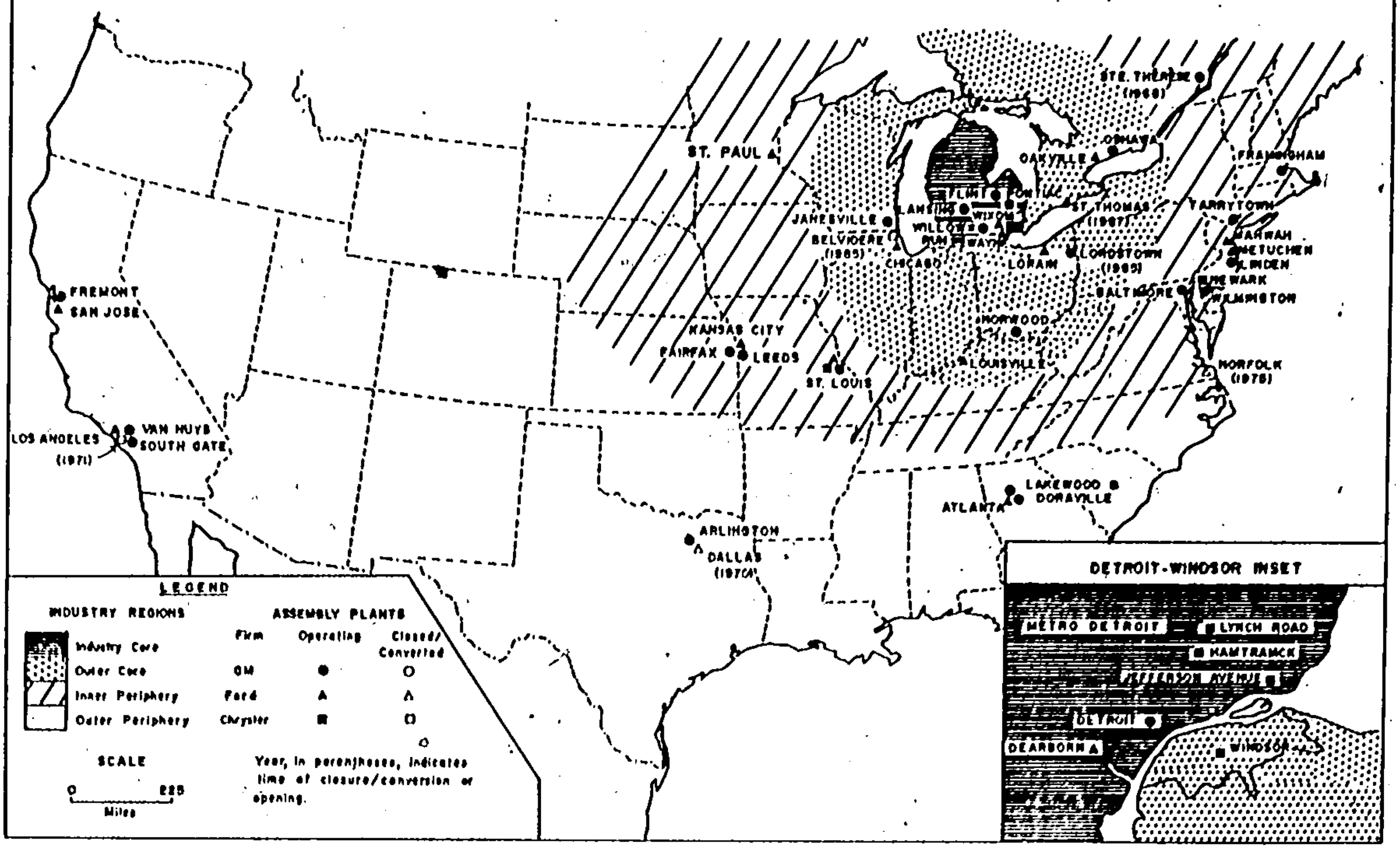
(b) The 'Outer Core' includes Ohio, Indiana, Illinois, Northern New York, Western Pennsylvania, Wisconsin and Ontario. These areas constitute a second major concentration of automotive industries and form almost a circular belt around Michigan.

(c) The 'Inner Periphery' on the fringe of the Outer Core, is an area with a large number of assembly plants, but has little or no other automotive industries. Most assembly plants are located, in a semi-circular fashion, around the Outer Core. States in the Inner Periphery with assembly facilities include Minnesota, Kansas, Missouri, Kentucky, Virginia, Maryland, Delaware, New Jersey, South-eastern New York, Massachussetts and the Province of Quebec.

(d) The 'Outer Periphery' is the extensive area, furthest from the Industry Core, in which is located a number of assembly centres. The states assembling cars in the Outer Periphery are Georgia, Oklahoma, Texas and California.

In 1979, approximately half the assembly plants in North America were located within the core areas. Ten plants of the Big Three were situated in Michigan alone. Ten other plants were located in the Outer Core, the majority in Ohio, Illinois and Ontario. Plants in the Inner Periphery were localized in the major North-eastern markets of Massachusetts, New York, New Jersey and Maryland. Other locations in this zone were Kentucky, Kansas and Missouri. Outer Periphery assembly plants consist of three discrete concentrations, the largest of which is in California where five plants belonging to Ford and GM were located to serve the Mountain and Pacific States. The West South Central area was

Figure 8: Big Three Automobile Assembly Plants, 1965-78



served by two plants, the Arlington, Texas facility and a brand new Oklahoma City plant, both of which are owned by GM. In the East Central area of the Outer Periphery, Georgia had one Ford and two GM plants.

Each firm had a different number of plants in the four industry zones identified. GM had only five plants, twenty per cent of GM's total number, in Michigan. However, it had an equal number in the Core and Immediate Periphery. Overall, more GM plants were located in the Periphery than in the Core. Ford's plants were almost evenly distributed between the Core and the Periphery. Chrysler, has in recent years focussed two-thirds of its assembly facilities in the Core and one third in the Immediate Periphery. The company withdrew from the Outer Periphery in the early Seventies.

Although, there are more differences than similarities in the proportion of each firm's plants in the four industry regions, there is no statistical difference in the frequency distribution of plants in the four regions belonging to the three companies.[1] Allowing for their differences in size, the three firms appear to have behaved rather alike in locating their plants among the four zones.

Factors in Assembly Plant Decentralization

The economic forces that promoted geographic dispersion in auto assembly are relatively straightforward. Decentralized markets and the relatively high expense of transporting completed vehicles have prompted the setting up of regional plants to which are shipped parts for final assembly and delivery. While transport costs are a major element, other factors have also been emphasized including certain advantages associated

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[1]The results of a χ^2 test (3.5 at 9 d.f.) were significant.

with being more responsive to local market requirements, quicker deliveries and better labour environments.

Transportation Costs

Transportation costs are generally acknowledged as the key factor in assembly decentralization (Smykay, 1960). Their role and influence can be viewed from two perspectives; first, as a real saving in the final delivery of a finished automobile; and second, as enabling increased profitability for the largest manufacturers.

Because of the size and weight of automobiles, transportation costs generally constitute an important part of the delivered price of the vehicle. Real savings in the delivery of completely knocked down (ckd) cars to regional assembly plants instead of completely built up (cbu) cars to regional markets, have been noted by the different manufacturers. The major companies provided evidence of this during the U.S. Senate Hearings on Automobile Marketing Practices in the 1950's. In 1955, for example, a GM executive acknowledged that his firm realized lower transportation costs from the use of branch assembly plants; he doubted lower cost would have resulted if his firm had produced all cars centrally for shipment. Even when allowance was made for the extra costs of branch plant operations (estimated to be between ten and fifteen dollars per auto) and parts handling (that is, packing, unpacking which costs a minimum of six dollars per car) savings were nevertheless reported.

Testimony by Chrysler's president indicated that Chrysler in 1955 suffered a transportation cost disadvantage when compared with its principal competitors, since Chrysler did not operate any extensive branch-plant system. Acting on the belief that there were savings to be secured, Chrysler planned to, and did, establish additional banch plants. In the two years following 1955, Chrysler expanded its assembly plant system with new plants in Delaware and St. Louis.

At the same Senate Hearings in 1955, Ford officials stated that the company's savings in transportation costs were only incidental to Ford's operation of branch assembly plants. Savings in transportation costs were not a principal feature of the early establishment of branch plants by Ford and no savings were obtained in the early days of the industry. Other reasons for the use of branch assembly plants were deemed more important than transportation cost savings. Among these were the desire to avoid damage which might otherwise result from long distance transportation of completed cars; to secure added flexibility in operations; to service local dealers more quickly; to gain local consumer support by operating in the local community; and to avoid problems of increasing size in central locations. However, it was acknowledged that long-run savings did accrue, as improved methods of handling and shipping materials were developed, although it was also indicated that Ford would actually pay out more for transportation in 1955 than it received. This occurred because some transportation costs were not passed on to dealers and consumers, principally since maximum freight charges were established for the West Coast.

During the mid-1950's, the advantages of regional assembly accrued not only to distant plants such as those in California but also to those closer to Detroit such as the facilities on the East Coast. For instance, the advantages GM had by producing locally in New York compared to Studebaker which had to ship a comparable vehicle from the industry heartland to the New York market was approximately forty dollars per car in 1955. Likewise, a shipment to a customer in Oklahoma produced a differential of twenty-seven dollars in favour of GM cars as opposed to Studebaker's. When a Nash and Ford were shipped to a South Atlantic destination, the differential ranged from negligible or up to seventeen dollars in Ford's favour (Table 12).

These transport savings are thus suggestive of the economic significance of decentralized assembly. In the Fifties, the significance was further amplified by the financial position of the small centralized firms compared to the Big Three multiplant producers. Edwards (1965, 177) observed that the disadvantage of the smaller firms was greatest in serving those areas most distant from their centralized plants and especially pronounced in the communities in which Big Three assembly plants were located. In the United States, these areas included the remote Northeast, Southeast, Southwest and West Coast, the latter three including the fastest growing markets. Partly because of this reason, the smaller firms' shares of the markets in some of the states more distant from the Midwest were lower than in their home and nearby states (Edwards, 1965, 178).

Decentralized final assembly led to tangible savings on transport costs for the Big Three. The potential for profiting from this arrangement no doubt spurred further decentralization. "Theoretically, transportation cost savings may be considered as accruing continuously to a large firm serving a national market when the volume required to maintain the regional assembly plants is met or exceeded by the large firm" (Edwards, 1965, 178). Such transportation cost saving, if not passed over to the consumer would constitute pure profit to the firm. A related concern with transport costs arose with the infamous "phantom freight"

TABLE 12

COST DIFFERENTIALS BETWEEN CENTRAL AND REGIONAL AUTOMOBILE ASSEMBLY

FIRM	CENTRAL SOURCE	REGIONAL ASSEMBLY	MARKET DESTINATION	VEHICLE WEIGHT	VEHICLE FORM	TRANSPORT MODE	TRANSPORT COST	OTHER COSTS	TOTAL COST	COST DIFFERENTIAL
Studebaker	South Bend (Ind.)	-	New York C.	N.A.	cbu	truck	$90	-	$90	$47
GM	Detroit	Tarrytown (NY)	New York C.	N.A.	ckd	-	$28	$15	$43	
Studebaker	South Bend (Ind.)	-	Enid (Okla.)	3,450 lb.	cbu	-	$124	-	$124	$27
Chevrolet	Detroit	Kansas City (Mo.)	Enid (Okla.)	3,300 lb.	ckd	-	$82	$15	$97	
Ford	Detroit	Norfolk (Va.)	Columbia (S.C.)	same	ckd	-	$105	$10-15	$115-130	$1-16
Ford	Detroit	Atlanta (Ga.)	Columbia (S.C.)	model	ckd	-	$87	$10-15	$97-102	$12-17
Nash	Kenosha (Wis.)	-	Columbia (S.C.)	300 lb. less than Ford	cbu	-	$114	-	$14	

Source: Edwards (1965, 176-7).

controversy in the automobile industry. Prior to 1936, the industry's advertised price differed markedly from delivered price because of accessories, state and local taxes, and carrying charges on sales-financing contracts. In that year, the Automotive Manufacturers Association published a list of agreed-price quotations, which led to the practice of including freight charges from the home plant (Detroit in the case of the Big Three) to the regional assembly plant in the final selling price. This meant that the customer paid freight on a fully assembled car shipped from Detroit even though the car may actually have been shipped unassembled from Detroit to a plant near the dealer (Hurley, 1959, 13). Testimony by officials of the National Automobile Dealers Association during the Hearings on Automobile Marketing Practices uncovered the practice by the auto manufacturers of charging dealers phantom freight cost. Until 1954, the auto manufacturers had charged phantom freight on car shipments to outlying areas, though parts were shipped to branch assembly plants and the cars assembled and shipped from there. Freight charges to the consumer were based on the assembled automobile railroad freight from Detroit to the consumer. In 1954 and again in 1956, in response to dealer dissatisfaction, Congressional pressure, and private "bootlegging", the manufacturers lowered their freight charges to outlying areas to what they claimed were roughly the real costs of shipment (White, 1971, 41-3). Bootlegging consisted mainly of used car dealers buying new cars from franchised dealers in Detroit, shipping them by truck or drive-away for less than the assessed rail rate, and thereby selling them for less than local dealers. This was especially prevalent on the West Coast, where the assessed freight charges could run as high as $279 for a Chevrolet and $365 for a Buick.

The extent to which such profit opportunities encouraged decentralization up to the 1950's is not clear, and no causal link has been noted in the literature on the industry. However, the opportunities must have appeared extremely attractive.

Regional Markets

Closely allied with transport cost savings are the advantages of being close to local markets, as indicated by Ford representatives and noted earlier. While evidence is sketchy at best for the whole industry, there were individual instances which served to underscore the market-proximity factor. Thus, in the late 1950's Chrysler Corporation decided to abandon its old body manufacturing and Plymouth assembly plant located in Evansville, Indiana, in favour of a new facility at Valley Park, twenty miles from St. Louis, Missiouri. The reasons given by Chrysler's management for the move are probably representative of the general locational influences affecting final assembly. Besides transport cost savings, other major reasons cited were largely market-oriented advantages (Neal, 1958, 38).

Firstly, plants located at the markets enable auto makers to be more responsive to regional customer needs, particularly in terms of items such as the options or various colour combinations. Secondly, proximity to regional markets reduces the delivery period for automobiles, which are increasingly produced to order. Local branch plants have the advantage of fulfilling orders on popular models and delivering them more rapidly than plants located thousands of miles away.

Recent Geography of Auto Assembly

Automobile assembly in the United States underwent a decentralizing trend during the postwar period prior to the Sixties. A total of fourteen plants, six GM, six Ford and two Chrysler facilities, were built in the peripheral zones. By contrast only five plants were erected in the core areas during the same period. However, during the past two decades there has been a tendency towards centralization of assembly facilities. Beginning in the late 1950's, three plants, GM's Willow Run (Michigan), and Ford's Lorain (Ohio) and Wixom (Michigan) plants were put into operation. During the Sixties, two new plants were constructed outside of Detroit but within the core region: Belvidere, Illinois and Lordstown, Ohio. The establishment of these core-oriented plants, it must be acknowledged occurred during a period when other peripheral plants such as GM's Fremont (California) and Ford's Kansas City (Missouri) facility and Chrysler's St. Louis (Missouri) plant were being constructed, an indication of some continuing advantages for decentralization. During the late 1960's and early 1970's, however, centralization trends were sustained, mainly by the closure of plants located in the peripheral zones. GM's Bloomfield, New Jersey plant, which for many years had produced a wide range of car lines at small volumes, was closed in 1968. Ford closed its full-size car plant in Dallas at the end of the 1970 model year and converted its Norfolk, Virginia plant to truck assembly in 1974. Chrysler's compact and intermediate car plant at Los Angeles ceased operations in 1971. It had begun production of cars there prior to the 1930's.

The recent centralization trends in the U.S. are generally attributed to the development and introduction of the 'piggyback'[1] and 'rack car' method of shipping automobiles in the late 1950's. The introduction of the oversized piggyback railway flatcars and rack cars substantially altered the pattern of physical distribution costs among the firms of the United States automobile industry.

While there is no explicit evidence available, the coincidence of the timing of more competitive freight rates on cbu vehicles and the opening of new plants in the automobile industry heartland is apparent and suggestive. White (1971, 43) has argued that these developments in transportation technology are rendering suspect the economic rationale of further decentralization. He also suggests that scale economies can be attained by concentrating assembly in the Great Lakes region and shipping completed cars to distant markets without any cost penalty. One saving from centralized production and distribution is that arising from costly back-haul of cross-market shipments of 'excess' production from regional plants. Though there may be some advantage to the firm in operating branch assembly plants at very great distances from Detroit, such as those in California, the disadvantages of core area plants at present are almost nonexistent. Other factors such as the absence of significant opportunities for in-bound transportation cost savings on component parts and insignificant local purchase of components serve to underscore the locational strengths of the centralized plants. For instance, White (1971, 44) notes that even the most distant locations

[1]"Piggyback" technically refers to automobiles as well as other product shipments in truck trailers placed upon flatcars, rather than the direct loading of automobiles in the bi- and tri-level rack cars (Edwards, 1965, 180n).

such as those in California obtain about ninety per cent by value of all parts from plants situated near the Great Lakes.

Recent discussions with an official of Ford's Automotive Assembly Division[1] confirmed the current realities of new assembly plant location. Apart from a minimum of local purchase of components and/or supplies, regional assembly plants do have a serious disadvantage, vis-a-vis central plants, in distributing cbu vehicles outside the major regional urban markets at which regional plants are located. The cumulative transport cost of a car assembled at a regional plant and sold outside the major urban market is almost as great as, if not greater than, the cost of bringing a cbu vehicle from a central plant. Added to this is the frequent need for cross-shipment of vehicles from one regional plant to another regional market area, a process which can be extremely expensive and which necessarily occurs in the case of lower volume models which are generally assembled in fewer plants.

Recent changes in the geography of Canada's automobile industry are those associated mainly with the opening of GM's Ste. Thérèse, Quebec plant in 1965 and Ford's St. Thomas, Ontario facility in 1967. The establishment of additional plant capacity in Canada appears to be an anomaly particularly in the light of apparent cost disadvantages of Canadian locations. Emerson (1975) compared the cost of assembling automobiles in Southwestern Ontario, and the East North Central Division (Wisconsin, Illinois, Indiana, Michigan and Ohio), the "revealed best" locations in Canada and the U.S., and concluded that overall it cost

[1]Interview with S. S. Bencuya, Product Planning Manager, Automotive Assembly Division, Ford Motor Company, October 3, 1979.

two per cent more to assemble cars in Ontario than in the East North Central Division. Further, a very high percentage of passenger cars and chassis exports from Canadian plants are shipped to the East North Central Division. Other factors such as a better labour climate may have been a consideration that led to the location of new plants in Canada. Emerson, however, argued that in cost terms this factor did not sufficiently justify their establishment.

CHAPTER VI

PRODUCT MIX IN AUTOMOBILE ASSEMBLY PLANTS

Given that each major producer manufactures in a limited number of assembly facilities a wide variety of cars, differentiated according to make, line, models, body construction and style and market classes, how are these individual products combined in a firm's system of plants? Do plants specialize in one type of car, all varieties or only a limited range of models? How important are specialized or multiple-model plants? Are there similarities or differences in the strategies or product-mix assignment between GM, Ford and Chrysler plants? Finally, what reasons and evidence can be extended to explain product-mix patterns in North American automobile assembly plants? This chapter examines product-plant assignment from the perspective of three major forms of product differentiation, make of car, car line and wheelbase dimensions which also relates to vehicle size and principal market segment.

The primary data source for the analyses in this chapter and the two following is Ward's Automotive Yearbook which contains information on individual car lines assembled in U.S. assembly plants owned by the Big Three. Armed with this basic data, other major product criteria are readily obtained. Further, data for U.S. plants are generally complete for the fourteen-year period 1965-1978, with some minor exceptions. Canadian plant product information was drawn from different sources including the Automotive News Almanac Issue, which since 1976 has been renamed the Automotive News Market Data Book Issue, Automotive Industries

(November 1, 1965 & July 1, 1968) and several annual editions of Facts and Figures of the Automotive Industry, published by the MVMAC.

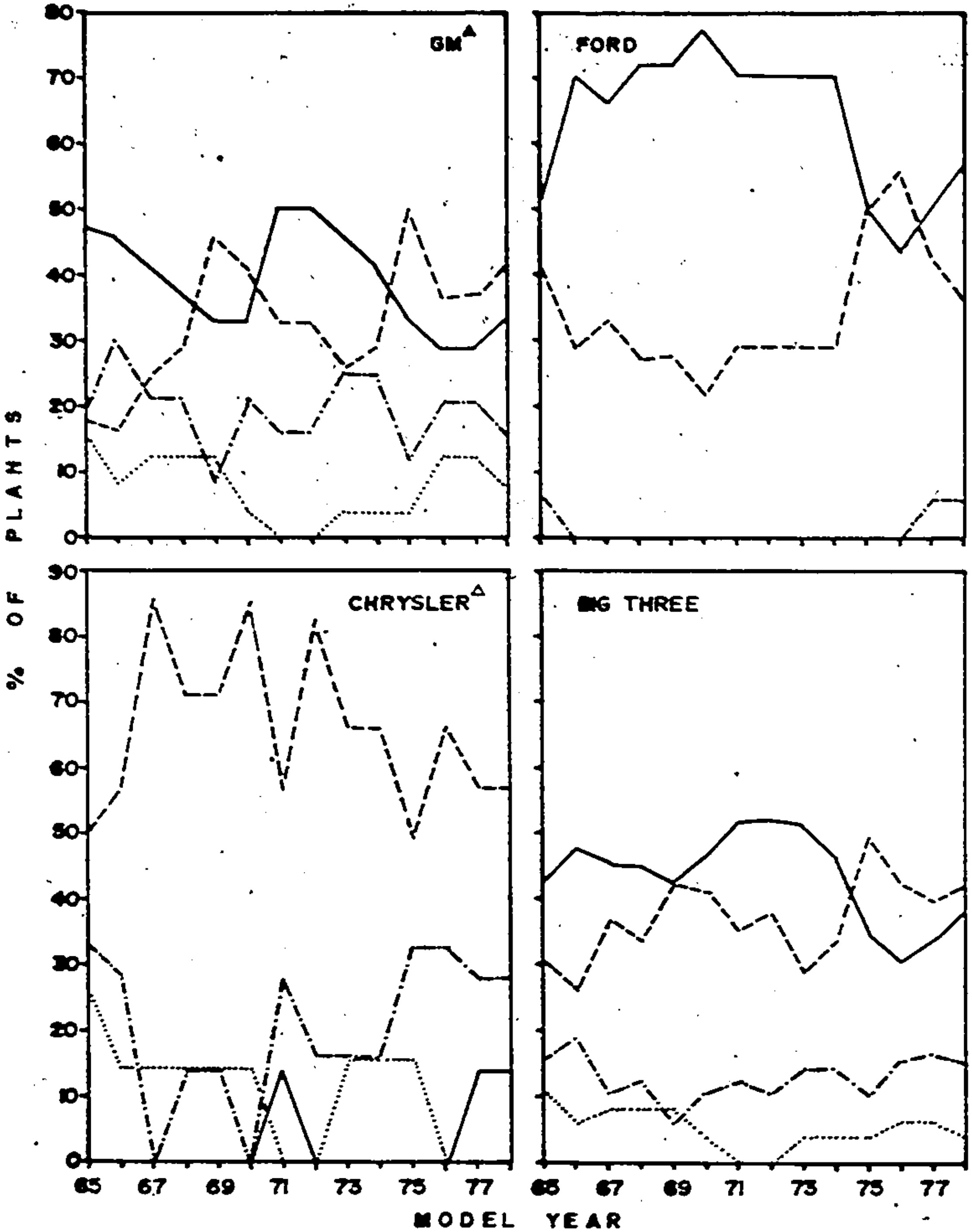
Car Make and Assembly Plants

The majority of Big Three assembly plants, in aggregate, produce cars of one or two makes. During the study period, 1965-78, from thirty to fifty-two per cent of all plants assembled only one make. During the same period between one quarter and a half were two-make plants (Figure 9), and the trend was towards more two-make as opposed to one-make plants. By comparison, plants assembling three and four makes were significantly less important; the former comprised six to nineteen per cent, and the latter less than eleven per cent of all plants. Although single-make plants were more common during the fourteen-year period, there have been more two-make plants since 1975.

Car line assignment patterns differ substantially, however, between each firm. GM has the largest number of assembly plants among the three firms. Consequently, its proportion of plants, in terms of the variety of makes, is generally closer to the aggregate pattern than is either Ford's or Chryiser's. It is worth noting that this is generally true of other product characteristics as well. Neither single-make plants nor two-make plants appear to dominate in GM's assignment strategy though there were periods when one appeared more important than the other. From 1965 to 1968 and again from 1971 to 1974, single-make plants clearly exceeded the rest, but during other years, there were more two-make facilities. Even fewer, proportionally, are plants assigned three or four different GM makes.

Ford during this period manufactured three car-makes. Nearly all plants were assigned either single- or double-makes. Unlike GM, however,

Figure 9: Plant Distribution by Number of Makes



MAKES PER PLANT

One
Two
Three
Four

▲ Ste. Thérèse excluded 1965-68.

△ Jefferson Ave. & Lynch Road plants combined 1965-76.

Ford's single-make plants clearly dominated, until the brief period of 1974 and 1975.

Chrysler, which carried four-makes until the Imperial was discontinued in 1975, clearly favoured a strategy of two-make plants above other types. At least half and sometimes in excess of eighty per cent of its plants assembled cars from two different divisions. It operated three- and even four-make plants. In only three years, 1971, 1977 and 1978 was one plant designated to produce a single make. In 1977 and 1978, the Jefferson Avenue plant in Detroit was the only Chrysler plant producing cars of one make. However, since model-sourcing data for this plant and Chrysler's other Detroit facility at Lynch Road were aggregated prior to 1977, there is no means of determining from this data base whether the former was in fact a single-make facility. These two plants notwithstanding, Chrysler's strategy seems to have been one favouring two-make plants and to a lesser degree three- and four-make plants, before the Imperial was discontinued.

When all plants of a single firm are considered in aggregate, to what extent is the 'average' plant of that firm more specialized (or diversified) compared to a rival firm's average? To facilitate this comparison, a simple measure devised by William J. Abernathy in his study The Productivity Dilemma, is utilised here. This measure is the average number of makes produced in each plant, weighted by the number of plants.[1] Between 1965 and 1978 the 'average' Chrysler plant assembled between 2.1 and 2.65 makes per plant, which exceeded Ford's plant averages over

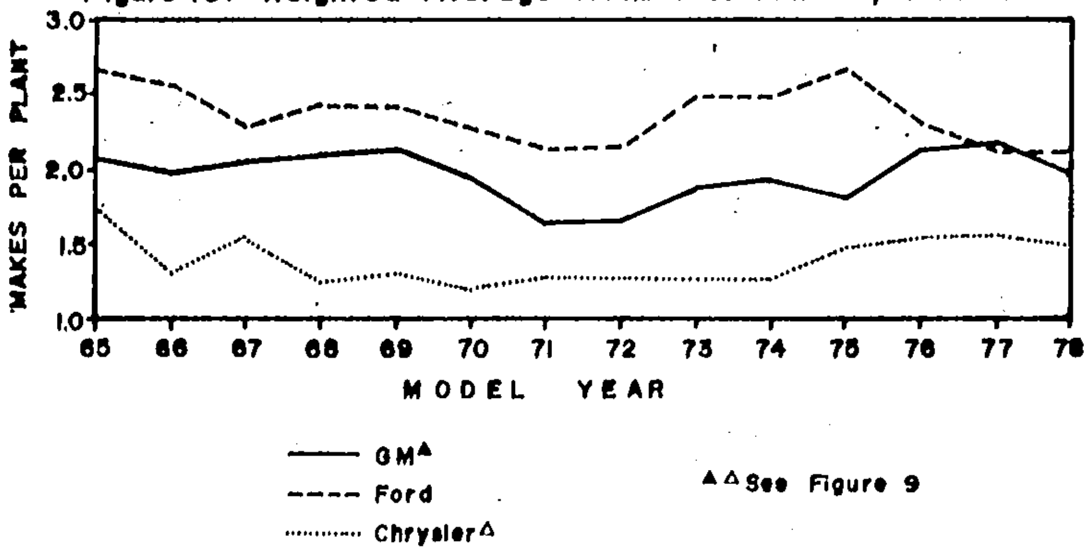
[1]A sample calculation is presented in Appendix A. This same measure is applied to derive the average number of car lines and wheelbase classes per plant in later sections of this chapter.

the fourteen years and GM's over thirteen years (Figure 10). GM plants were assigned an average of 1.6 to 2.2 makes per plant while Ford facilities, which had the lowest averages throughout, were assigned only between 1.20 and 1.55 per plant. Throughout the period, these weighted averages have generally varied over a small range of values, a characteristic probably attributable to the relatively constant number of makes and assembly plants. Chrylser's higher averages, it appears, are the result of its producing almost as many makes as bigger rivals, but having far fewer plants in which to assemble the different makes.

Generally each firm has a range of plants from specialized to diversified. For instance, GM's Flint, Lansing, Pontiac and Detroit plants are single-make specialists, producing Buick, Oldsmobile, Pontiac and Cadillac cars respectively (Table 13). Plants like GM's at Janesville produce only Chevrolet cars but others may assemble several makes. Fairfax, for instance, has consistently assembled three makes, Buick, Oldsmobile and Pontiac. A fourth category of plants produces some combination of all GM makes. At Ford, comparable single-make plants include St. Louis (Mercury) and Louisville (Ford). Other plants produced a Ford-Mercury combination (Dearborn, 1967-73; and Oakville) or a Ford-Lincoln mix (Wixom). At Chrysler, however, with minor exceptions, plants generally assembled some combination of Plymouth, Dodge and Chrysler cars.

What factors determine the make of cars allocated to particular assembly plants? Make of a car may have little significance as to where a car is assembled. As we shall note later, cars may be assigned to plants on the basis of certain design and other physical attributes. Often, cars of different makes have identical design and physical features

Figure 10: Weighted Average Number of Makes per Plant



▲△See Figure 9

TABLE 13

MAKE OF CAR IN SELECTED ASSEMBLY PLANTS, MODEL YEARS 1965–1978

PLANT	MAKE	65	66	67	68	69	70	71	72	73	74	75	76	77	78
GENERAL MOTORS															
FLINT	BUICK	•	•	•	•	•	•	•	•	•	•	•	•	•	•
LANSING	OLDSMOBILE	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PONTIAC	PONTIAC	•	•	•	•	•	•	•	•	•	•	•	•	•	•
DETROIT	CADILLAC	•	•	•	•	•	•	•	•	•	•	•	•	•	•
JANESVILLE	CHEVROLET	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FAIRFAX	BUICK	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FAIRFAX	OLDSMOBILE	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FAIRFAX	PONTIAC	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FREMONT	BUICK	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FREMONT	OLDSMOBILE	•	•	•	•	•	•	•	•						
FREMONT	PONTIAC	•	•	•	•	•	•	•	•	•	•				
FREMONT	CHEVROLET	•	•	•	•	•				•	•	•	•	•	•
LINDEN	BUICK												•	•	•
LINDEN	OLDSMOBILE	•	•	•	•	•	•	•	•	•	•	•	•	•	•
LINDEN	PONTIAC	•	•	•	•	•	•								
LINDEN	CADILLAC							•	•	•	•	•	•	•	•
ARLINGTON	OLDSMOBILE						•	•	•	•	•	•	•	•	•
ARLINGTON	PONTIAC	•	•	•	•	•	•	•							
ARLINGTON	CHEVROLET	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FORD															
DEARBORN	FORD	•	•	•	•	•	•	•	•	•	•	•	•	•	•
DEARBORN	MERCURY			•	•	•	•	•	•	•					
WIXOM	FORD	•	•	•	•	•	•	•	•	•	•	•	•		
WIXOM	LINCOLN	•	•	•	•	•	•	•	•	•	•	•	•	•	•
ST. LOUIS	MERCURY	•	•	•	•	•	•	•	•	•	•	•	•	•	•
LOUISVILLE	FORD	•	•	•	•	•	•	•	•	•	•	•	•	•	•
OAKVILLE	FORD	•	•	•	•	•	•	•	•	•	•	•	•	•	•
OAKVILLE	MERCURY	•	•	•	•	•	•	•	•	•	•	•	•	•	•
CHRYSLER															
WINDSOR	CHRYSLER	•	•									•	•	•	•
WINDSOR	DODGE	•	•	•	•	•	•	•	•	•	•	•	•	•	
WINDSOR	PLYMOUTH	•	•	•	•	•	•	•	•	•	•	•			
HAMTRAMCK	PLYMOUTH	•	•	•	•	•	•	•	•	•	•	•	•	•	
HAMTRAMCK	DODGE	•	•	•	•	•	•	•	•	•	•	•	•	•	
BELVIDERE	CHRYSLER									•	•	•	•		
BELVIDERE	DODGE		•	•	•	•	•	•	•	•	•	•	•	•	•
BELVIDERE	PLYMOUTH		•	•	•	•	•	•	•	•	•	•	•	•	•
JEFFERSON AVE.	CHRYSLER	•	•	•	•	•	•	•	•	•	•	•	•	•	•
JEFFERSON AVE.	IMPERIAL	•	•	•	•	•	•	•	•	•	•	•			

Source: Ward's Automotive Yearbook, Automotive News Almanac Issue/Market Data Book Issue, various years.

and are produced in common plants. Other individual car lines of one make may be produced at an output large enough to utilize the total capacity of several individual plants.

At GM, however, the make of car assembled in a given plant is also influenced by the firm's organizational structure. The assembly of GM cars is carried out in a multi-tiered system of plants. First, there is a system of 'home plants', common to many giant companies which usually consist of the oldest and sometimes the largest plants. Frequently, these plants are the only producers of some product lines made by the company (Moore and Jablonski, 1969, 85 & 133). At GM there are five home plants controlled individually by each of the principal car divisions. Buick Division's home plant is at Flint, Michigan, and so is Chevrolet's. Oldsmobile's is at Lansing, Michigan; Pontiac's is at Pontiac, Michigan; and Cadillac's is located in Detroit. At these plants, only the respective division's own make of car is assembled.

Besides the home plants, there is a system of what has been generally referred to as 'B.O.P.' plants, which produce Buick, Oldsmobile and Pontiac cars exclusively. An example of this is the plant at Fairfax, Kansas. Prior to the mid-1960's other examples included South Gate (California), Wilmington (Delaware) and Doraville (Georgia).

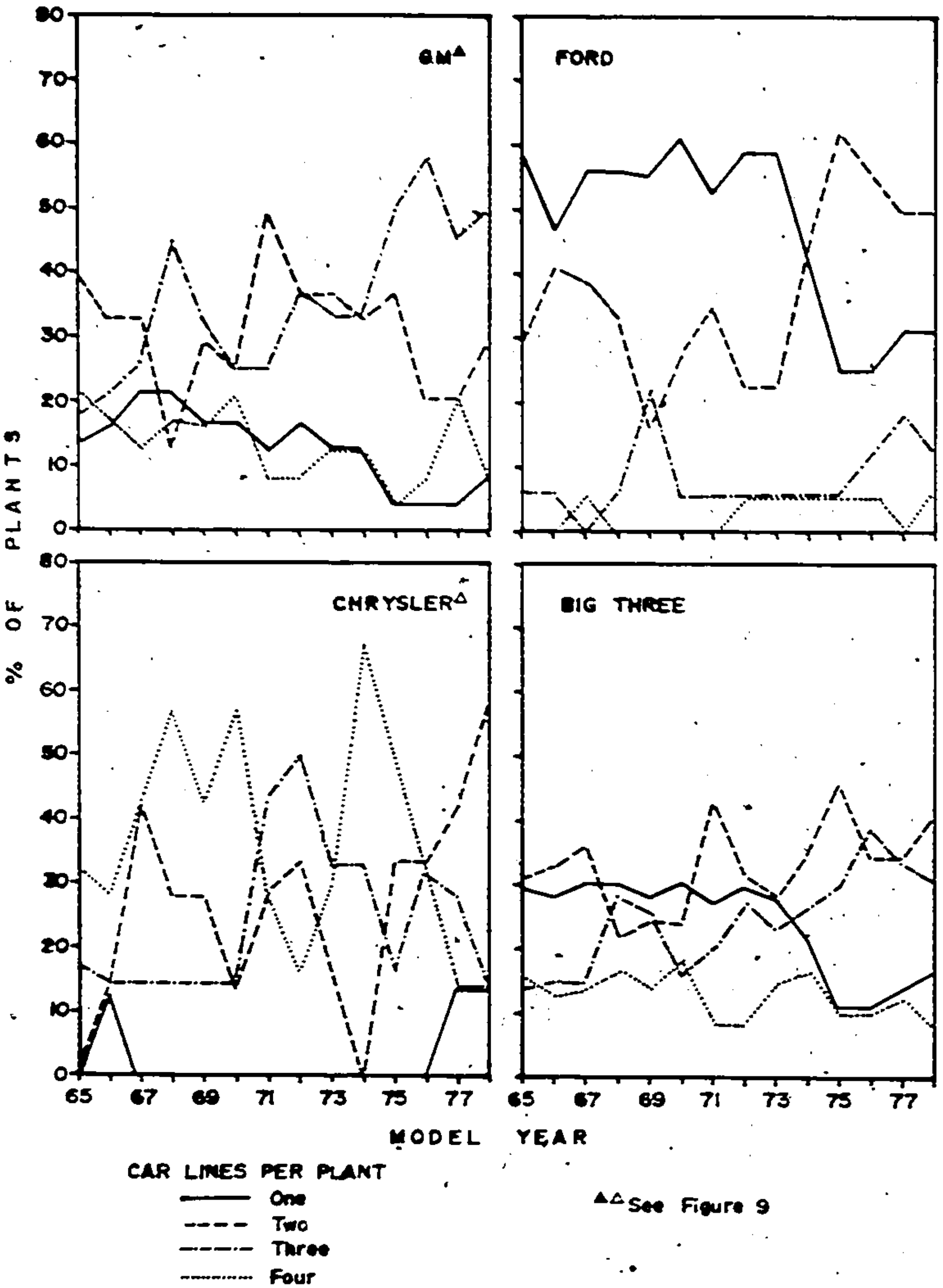
The third component of the system of GM plants comprises those producing some combination of the five makes. In recent years, these mixed-make plants, which include Fremont (California), Los Angeles, South Gate (California), Wilmington (Delaware), Doraville (Georgia), have been associated with the General Motors Assembly Division (GMAD).

Car Lines and Assembly Plants

Unlike the assignment of makes, most Big Three plants in aggregate produce multiple, but never full, lines (Figure 11). Two line plants formed the largest group proportionally for most years. Other important groups consisted of plants assembling single and three car lines. For several years until 1973, single line plants comprised nearly one-third of all Big Three plants, but this group declined to about ten per cent of the plant population in the mid-1970's. There were generally fewer four-line plants than single-, double- or triple-line plants during most of the years examined. The 'preferred' limit appears to be four lines per plant because beyond this, plants reporting five or more lines diminish rapidly, indeed were non-existent during most years covered in the study. The proportion of plants assembling five or more lines was generally small for the industry as a whole.

There were a number of notable differences in car line assignment among the individual firms. GM's revealed strategy consisted mainly of assigning two or three car lines to a majority of assembly plants. Since the mid-1970's, particularly, nearly eighty per cent of its plants have been in these two categories, and at earlier periods, fifty per cent or more. Single- and three-line plants have comprised one-fifth or less of all GM's plants. Exceptions to GM's strategy were two plants: Oshawa, which produced in excess of five different lines during most of the fourteen years; and the Bloomfield facility which on occasion produced five or more lines at rather small volumes, a sign perhaps of its impending closure. Oshawa, GM's largest passenger car assembly facility in Canada was particularly diversified in its range of car lines. The continuation of

Figure II: Plant Distribution by Number of Car Lines



this multi-line policy for the plant is not only interesting but suggestive of the plant's extreme flexibility or a situation that rather less integration than might be expected in final assembly has actually occured, a point which is explored further in Chapter VII.

The Ford Motor Company's revealed strategy in car line allocation, it appears, differs from GM's in that Ford has stressed plants specializing in single lines and to a lesser degree, two-line plants, a situation evident until the early 1970's, at least. Following 1974, however, Ford has operated more two-line plants, but whether this represents a departure in car line assignment policy remains unclear. Unlike GM and Chrysler, relatively few plants were assigned the assembly of three lines and even fewer produced four. Until 1978, Ford's main Canadian operation, like GM's Oshawa facility, was also unusually diversified. Periodically as many as six lines were produced there, a feature which again raises questions concerning the effect the Auto Pact has had on intra-corporate rationalization and integration of auto assembly functions.

One evident feature of Chrysler's car line assignment strategy has been the almost total absence of single-line plants, except for one each in 1966, 1977 and 1978. During the period, Chrysler's strategy has fluctuated as the dominant assignments shifted between four-line plants (1966-70; 1974-75), three-line plants (1971-73) and two-line plants (1967 and 1976-78). This instability may be partly attributable to data aggregation for the Jefferson Avenue and Lynch Road plants, which naturally raises the profile of multi-line plants and reduces the significance of plants carring one and perhaps two lines. Nevertheless, Chrysler's lack of single-line plants represents a distinct contrast to the approaches of GM and particularly Ford. Overall, Chrysler had a higher average number of car lines per plant than either Ford or GM until 1976, when its average fell below GM's (Figure 12). For several years, Chrysler's average exceeded three lines but this declined to slightly over two in 1978. GM's average has remained fairly consistent at between two and three car lines per plant. Ford's plants have the lowest averages (less than two) amongst the Big Three, but its trend is towards a higher level.

Car Line Output and Assembly Plant Numbers

In Chapter II, it was pointed out that in surveys of multiplant firms in several industries, there has been found a general relationship between production volume of a given product line and the number of plants from which the product is sourced. It was also suggested that when output exceeds plant MES, multiple sourcing becomes feasible. In final auto assembly, a general positive correlation may be seen to exist between an increase in car line output and the number of sourcing points (See Figure 13). This relationship is noticeable at the level of each firm as well as for the Big Three in aggregate. There is, however, a rather broad dispersion of individual car lines within each plant frequency class. In addition, there are numerous cases of car lines in different plant frequency classes with rather similar outputs. During the 1969 model year, for example GM assembled 288,000 Pontiac Tempest cars in six plants, 318,000 Chevrolet Novas in two plants and 300,000 Oldsmobile Cutlass models in four plants. Such patterns are observable for Ford and Chrysler as well.

When only the mean and median car line output are considered, however, the relationship between volume and the number of plant sources is

Figure 12: Weighted Average Number of Car Lines per Plant

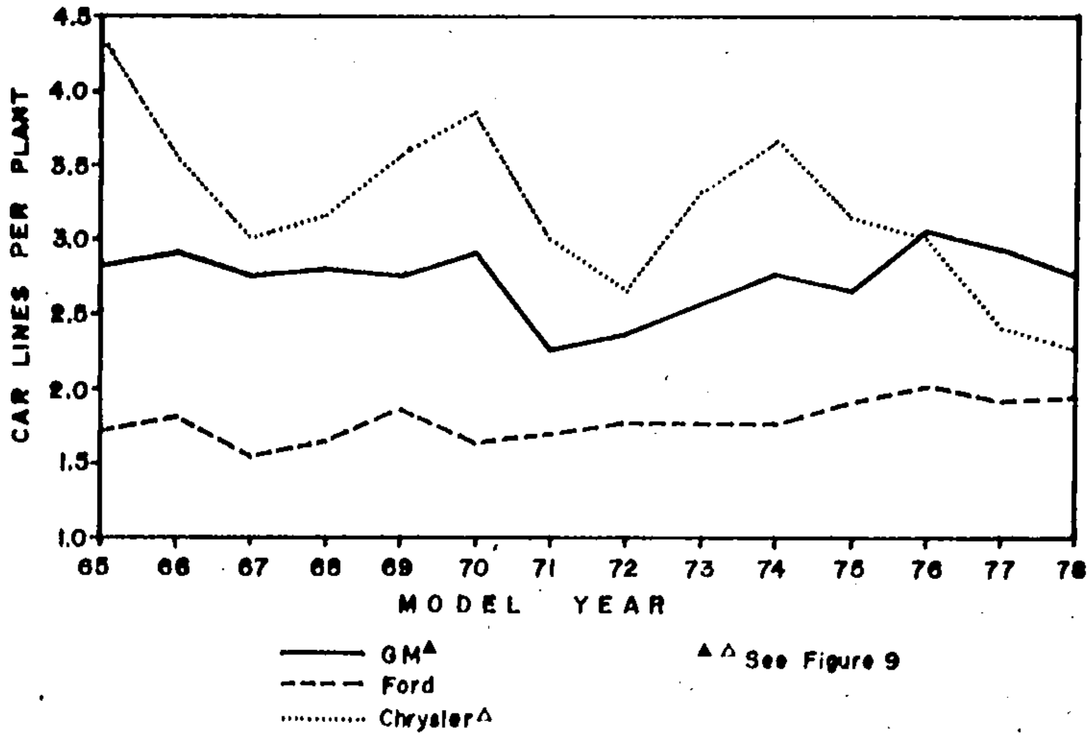
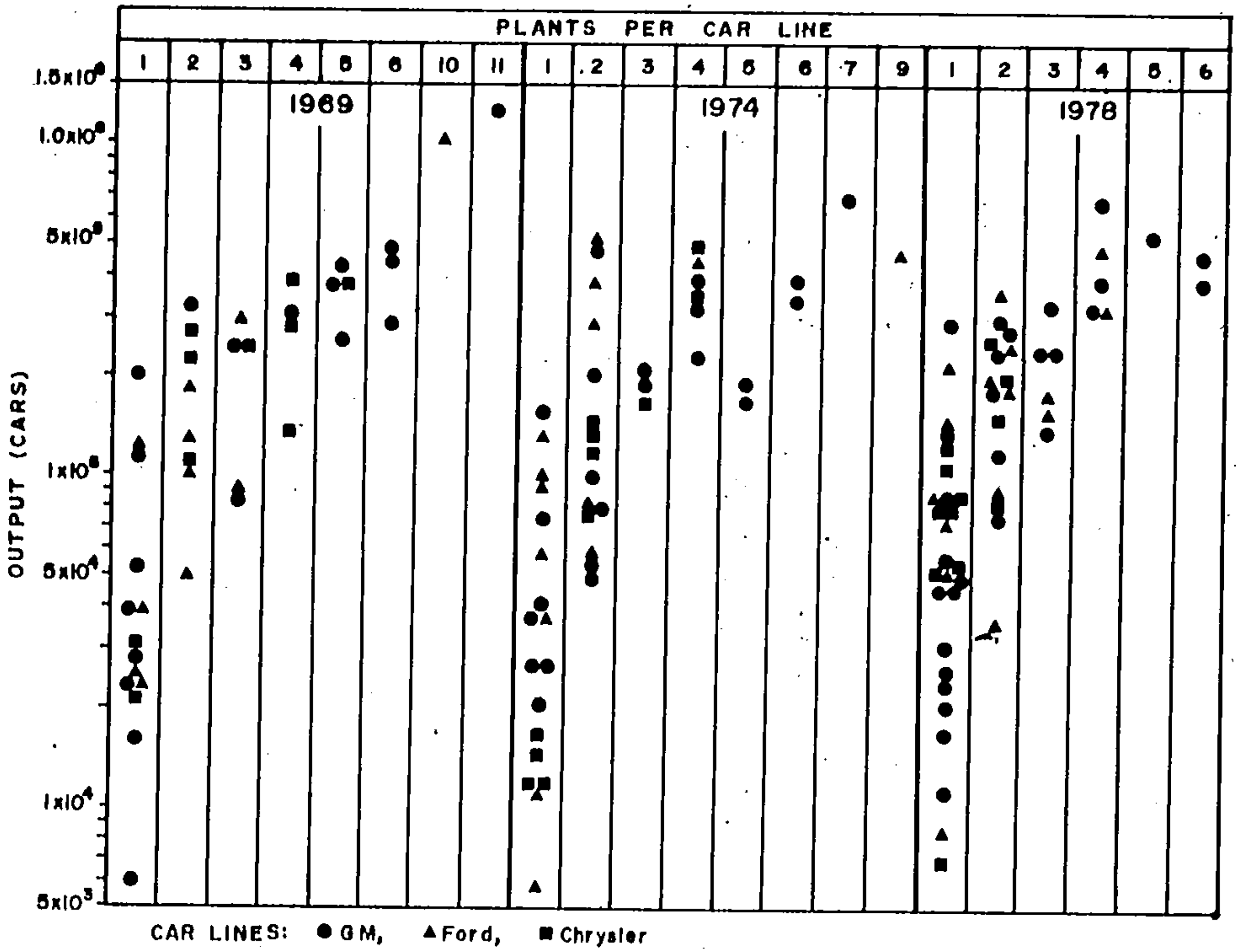


Figure 13: Car Line Output and Number of Sourcing Points (Plants)



more explicit (Table 14). Both the mean and median output tend to increase with the number of plants, a pattern which is generally true at the firm and industry levels. There are some minor exceptions where a larger mean or median output is associated with fewer plants. These exceptions, however, are generally associated with values derived from a single observation, rather than a sample.

In general, a large proportion of car lines from each producer is sourced at two or more plants. To what extent does multiple plant sourcing differ between the three principle producers and, how has it changed over time as well? To facilitate this comparison another measure, the "average capacity replication" index devised by Abernathy (1978) is utilised. Briefly, the measure R represents the extent to which available assembly capacity is allocated to provide production of the same product in different locations, and can be stated as:

$$R = \frac{1}{C} \sum_{i=1}^{I} r_i \, c_i$$

where r_i is the number of different plants in which the production of car, i, is replicated ($i = 1 \ldots I$); c_i is the amount of plant capacity devoted to produce i, in fractional assembly plant equivalents, and C is the total capacity in plant numbers. This provides a measure of the average number of times the process capacity to produce the same car is replicated at different locations. The average is taken over capacity not number of car models because the latter measure would bias results toward expensive, low-volume car lines.[1]

[1]See Appendix B for sample calculation.

TABLE 14

MEAN AND MEDIAN CAR LINE OUTPUT AND PLANT NUMBERS:
MODEL YEARS 1969, 1974 AND 1978

MODEL YEAR & PLANT NUMBER		MEAN CAR LINE OUTPUT				MEDIAN CAR LINE OUTPUT			
		CHRYSLER	FORD	GM	BIG THREE	CHRYSLER	FORD	GM	BIG THREE
1969	1	27,032	51,029	59,829	52,629	27,032	31,803	33,641	26,918
	2	194,243	114,943	318,122	170,078	214,751	113,951	318,122	155,215
	3	246,018	196,240	165,961	194,084	246,018	196,240	165,961	244,213
	4	271,724		300,387	278,890	292,631		300,387	296,509
	5		369,551	347,755	353,204		369,551	368,870	369,211
	6			401,302	401,302			439,244	439,244
	10		1,018,562		1,018,562		1,018,562		1,018,562
	11			1,250,514	1,250,514			1,250,514	1,250,514
1974	1	14,199	60,902	58,265	63,033	14,426	57,316	38,958	37,087
	2	117,503	210,567	186,410	196,778	123,938	295,120	99,817	123,938
	3	165,095		190,607	177,851	165,095		190,607	177,851
	4	408,015	435,330	309,325	374,002	408,015		309,326	391,033
	5			183,647	183,647			183,647	183,647
	6			364,376	364,376			364,376	364,376
	7			631,768	681,768			681,768	681,768
	9		464,796		464,796		464,796		464,796
1978	1	74,674	105,703	68,776	78,049	68,255	72,602	47,242	56,986
	2	109,479	165,412	149,339	178,263	115,778	188,899	216,584	188,899
	3		167,016	173,480	171,355		167,106	278,260	205,760
	4		399,739	466,287	439,668		399,739	395,946	395,946
	5			527,606	527,606			527,606	527,606
	6			416,696	416,696			416,696	416,696

Source: Ward's Automotive Yearbook, Automotive News Almanac Issue, various years.

Average capacity replication indices for GM, Ford and Chrysler, for selected years are presented in Table 15. Conclusions drawn from

TABLE 15

AVERAGE CAPACITY REPLICATION: NUMBER OF PLANTS PRODUCING THE SAME CAR

FIRM	MODEL YEAR	1969	1973	1978
GM		6.89	4.01*	3.78
FORD		6.45■	4.61■	2.89
CHRYSLER		2.99△	2.36△	1.41

*Excludes Canadian plants.

■Trucks at Louisville, Kentucky plant excluded.

△Production at Jefferson Avenue and Lynch Road plants combined.

these figures must be made with some caution, in view of the data deficiencies noted but nevertheless certain broad features are evident. First, the indices indicate that for two of the three years there is a general decrease in capacity replication as firm size decreases. Second, capacity replication has also diminished over the three years examined. The former feature may be attributed to the larger market share and output of car lines belonging to bigger firms. Output of Chevrolets, GM's single largest selling car was almost double that of the Ford LTD, and more than seven times that of the Plymouth Fury, both of which are comparable full-size cars. The decline in capacity replication from 1969 to 1978 may be related to the marked decline in the extremely high volume lines, which were often sourced from ten or more plants. In 1969, 1.2 million Chevrolets were produced in eleven plants and over a million

Fords were sourced from ten plants. Output of the same two cars in 1978 was approximately half and a third of the 1969 figures respectively and the Chevrolet was produced in four plants, and the Ford in three.

Assembly Economies of Common Body Features and Model Variations

For the individual firm, there seems to exist numerous possible combinations of car-line mix in assembly plants. Large cars are produced alongside other large lines or even small vehicles. Lines produced in one plant may feature broad physical similarities or none whatsoever, while others may be roughly identical or vastly different in terms of quantity produced. What factors, if any, lead to the assembly of specific car lines, and the exclusion of others, in individual plants? How important are the economies of production and distribution, noted earlier?

Despite the variety in plant car line assignment, there seems to be certain important technical, engineering and economic constraints that play a role in determining what car lines and combinations thereof, are assembled in individual plants. The three auto firms, as we noted, produced a wide range of cars but much of this diversity is the result of product differentiation for a rather heterogeneous market. A 'basic' car is frequently differentiated in terms of some minor design variations, trim and components and transformed into several distinct lines with different nameplates and marketed separately by the various divisions that comprise the firm. These distinct car lines are nevertheless derived from a basic model characterised by certain design specifications or 'body' designations and components. At GM, for instance, the full-size

Olsmobile, Pontiac, Buick and Chevrolet are basically identical vehicles in many respects, particularly their physical configuration. Together they comprise the 'B-body' cars. Similarly, the Chevrolet Nova, Oldsmobile Omega, Buick Skylark and Pontiac Phoenix, comprise the 'X-body' compact-size cars.

In 1978 the majority of Big Three plants were assembling two or more car lines. At GM, over two-thirds of these plants assembled car lines with common body designations (See Table 16). At Willow Run, for example, four different lines were manufactured, but all were essentially X-body cars. Likewise, at Lordstown, a multiple-line facility, all cars produced were H-body subcompacts. At Ford four out of ten multiple-line plants assembled cars with common body designations, whereas all Chrysler's multiple-line plants produced cars from identical body-design groups.

By assembling different product lines which share numerous attributes in common plants, producers are able to meet two important requirements: production economies and diversity in demand. In respect of the former requirement, we noted previously that a major source of production scale economies resides in specializing in one basic product or at least a very narrow range of products. Many assembly plants seem to satisfy this fundamental requirement in that though plants produce several distinct car lines, they are in fact specializing in one basic product by virtue of the common body designation. By so doing, plant equipment and tooling can be standardized, and cost saving techniques such as industrial robots can be installed at certain stages of the production process where the product remains totally undifferentiated, that is at the welding and painting stages, prior to final assembly when distinctive

TABLE 16

PLANTS ASSEMBLING CAR LINES
WITH COMMON BODY CONFIGURATION, 1978

PLANT	CAR LINES	BODY GROUP
GENERAL MOTORS		
Willow Run	Nova, Omega, Skylark, Phoenix	X-body
Leeds	Monte Carlo, Malibu	A-body
Norwood/Van Nuys	Firebird, Camaro	F-body
Lordstown*	Sunbird, Monza, Skyhawk, Starfire	H-body
Fremont	Century, Monte Carlo, Malibu	A-body
South Gate	Chevrolet, Oldsmobile, Buick	B-body
Doraville/Arlington	Monte Carlo, Cutlass, Malibu	A-body
Wilmington	Chevette, Acadian	T-body
Tarrytown	Nova, Skylark, Phoenix	X-body
Baltimore	Monte Carlo, Le Mans, Malibu	A-body
Fairfax	Oldsmobile, Pontiac, Buick	B-body
Framingham	Cutlass, Century	A-body
FORD		
Wayne	Granada, Monarch, Versailles	Unit body 12
St. Thomas	Fairmont, Zephyr	not available
Kansas City	Fairmont, Zephyr	not available
Metuchen	Pinto, Bobcat	Unit body 11
CHRYSLER		
Hamtramck	Volare, Aspen	
St. Louis	Le Baron, Diplomat	
Newark	Volare, Aspen, Le Baron, Diplomat	
Belvedere	Horizon, Omni	
Windsor	Cordoba, Charger, Magnum	

Source: Ward's Automotive Yearbook, 1978; Automotive News Market Data Book Issue, 1978 & 1979; Abernathy (1978); Gregory (1980).

*Light trucks excluded.

components and optional equipment are installed. Further, assembly line workers need not 're-learn' their work functions or make drastic adjustments because the vehicles they are assembling are essentially the same, despite minor variations from one carcass to the next, when they move down the assembly line.

Other sources of economies include less complex parts inventory problems which invariably arise if too many substantially different car lines are produced, and economies associated with massed reserves of plant equipment and services and production inputs.

It is also interesting to note that the assignment of car lines to plants extends into variations within individual models as well, something not revealed in our present analysis because data on such features are not normally published. We noted in Chapter III that each car line consists of a variety of models including two-door, four-door, sedan, coupe, station wagon and two-tone paint variants. Body styles, size configuration and extra equipment notwithstanding, the assembly line is also sensitive to model variations in each car line. Plants may be assigned the production of more two-door rather than four-door models or more two-tone paint bodies and fewer single tone models. The purpose of specializing in body style, paint work, or some other model feature is to maximize the use of the assembly line, which if considerably mixed will have to be extensively equipped and manned to accommodate the most complex body style. Assembly of a narrow model range will ensure maximum use of both tooling and manpower on the assembly line.

From the marketing standpoint, consumers tend to demand the entire range of products but in different proportions, however. For instance, Chevrolet car lines are generally produced and sold in greater numbers than either Buick, Oldsmobile or Pontiac. At Ford Motor Company, Ford lines tend to dominate production and at Chrysler, it is Dodge and Plymouth. For low-volume car lines, production at separate plants may involve major diseconomies especially when total output falls short of the minimum efficient size of plant. However, shared body design and major components facilitate the consolidation or centralization of the production of related car lines in economic lot sizes with little loss in efficiency arising from superficial differentiation between lines. This consideration is particularly important when firms seek to balance production and distribution costs to regional markets by allocating lines to match regional demand patterns. Doing so on the basis of individual lines may be uneconomical. However, this may be feasible if all lines with identical body configuration are considered simultaneously because, then, certain product- and plant-related scale economies may be obtained.

Consider the examples in Table 17. If each distinct line was produced separately, all lines with the possible exception of the Fairmont would probably be sourced from a single plant primarily because the individual output of these lines is far below the estimated MOS of 300,000 units for compact car assembly plants (See Chapter V). However, it is likely that the appropriate scale may be somewhat less if transport costs are taken into consideration (Scherer, et al., 1975). Even so, sourcing would be limited to one plant for each of the models. Given common line attributes, single plant sourcing may be avoided and multiple sourcing of car lines is feasible instead, thus overcoming some of the

TABLE 17

SOURCING OF COMPLEMENTARY CAR LINES, 1978 MODEL YEAR

FIRM	LINE	OUTPUT	ST. LOUIS	HAMTRAMCK	NEWARK
CHRYSLER	Volare	258,652	-	164,321	92,459
	Aspen	197,708	-	127,212	70,496
	Le Baron	149,894	130,967	-	18,927
	Diplomat	81,661	73,320	-	7,285
TOTAL		688,915	204,287	291,533	189,167

FIRM	LINE	OUTPUT	ATLANTA	KANSAS CITY	MAHWAH	ST. THOMAS
FORD	Fairmont	475,453	119,791	156,964	84,353	114,345
	Zephyr	156,156	-	54,118	33,321	68,717
	Other	-	70,777[+]	-	77,347[*]	-
TOTAL		631,609	190,568	211,082	195,021	183,062

FIRM	LINE	OUTPUT	NORWOOD	VAN NUYS
GENERAL MOTORS	Firebird	187,285	97,013	90,272
	Camaro	272,119	142,375	130,258
TOTAL		459,404	239,388	220,530

Source: Ward's Automotive Yearbook, 1979; Automotive News, Market Data Book Issue, 1978, 1979.

[+]LTD II.

[*]Ford Granada and Mercury Monarch.

diseconomies of extreme centralization and the consequent need for extensive cross-shipment of the final product. This point is clearly evident in sourcing of selected compact cars produced by the Big Three. For example, Chrysler, by partially combining the assembly of the Volare, Aspen, LeBaron and Diplomat, sourced each line from at least two locations in different geographic areas. The basic strategy is again evident in the production of Ford's Fairmont and Zephyr and GM's Camaro and Firebird.

Assembly Economies of Mixed Body Features

Table 17 also indicates that car lines which share some common body designation are not always necessarily assembled together. For example, besides the Fairmont and Zephyr, the Granada and Monarch are also produced at Mahwah, New Jersey. Instead of producing both the Zephyr and the Fairmont, as is the case in other plants, Ford chose to assemble the LTD II line along with the Fairmont at Atlanta. Besides these examples, there are several other such plants belonging to both GM and Ford which assemble lines of mixed-body configurations. Some notable cases include GM's home and Oshawa plants, and Ford's plants at Los Angeles and Oakville.

Mixed-body configuration assembly may be further complicated by the fact that some lines may be of frame construction while others are of unit body construction. Each type of body construction, we noted previously, required a somewhat different approach in production, particularly during certain stages of assembly. Generally, this form of assembly activity is undertaken but only with substantial costs incurred in making modifications in plant equipment and layout.

An example of the type of alterations and hardware required is usefully illustrated with the example of Ford's Wixom plant in the mid-1960's (Geschelin, 1966, 68-72). First, alterations were deemed necessary because the 1966 Thunderbird was redesigned with a separate chassis frame for the 1967 model year, a departure from its previous integral body frame construction. Second, the Lincoln Continental which was also produced at Wixom entered the 1967 model year with its integral body frame design unchanged. As the Wixon plant was designed to handle cars with integral body construction, extensive plant alterations had to be made since the company chose to continue building the new Thunderbird at the plant. Some major alterations included eliminating the former overhead conveyor line for the assembly of running gear, and addition of a Thunderbird chassis assembly line. Other additions were the merry-go-round assembly line for the preparation of the front end sheet metal and other components, and a frame assembly line for the Thunderbird. Further, it was necessary to change the engine dress-up conveyor system so as to separate Thunderbird and Lincoln power plants for distribution to different assembly points. The Thunderbird power plant was installed before the chassis reached the final assembly line whereas the Lincoln power plant was installed further along the line. Some alterations were so complex and extensive that work began long before the 1966 production was phased out. Although no estimate of costs was given, a Ford official[1] interviewed in 1979 indicated that a plant designed to assemble both frame and unitized body car line today is likely to cost approximately US$50 million more than a plant which handles cars of a single body construction.

In the 1960's, Ford did in fact produce mixed frame and unit body lines in a number of assembly plants. Table 18 indicates that at least four Ford plants, Wixom, Atlanta, Oakville and St. Thomas could be so classified. It is significant, however, that by 1973, at least, this policy was discontinued, although lines of mixed frame, or mixed unit body designs were still assembled in common plants. More importantly, the majority of Ford plants during the 1969 and 1973 model years assembled

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[1]Mr. S. S. Bencuya, Program Planning Manager, Ford Automotive Assembly Division, October 3, 1979.

TABLE 18

CAR LINE, BODY TYPE, WHEELBASE AND PLANT LOCATION, FORD, 1969 AND 1973 MODEL YEARS

CAR LINE	WHEELBASE (INCHES)	BODY TYPE	PLANTS: DEARBORN	WAYNE	WIXOM	KANSAS CITY	ST. LOUIS	LORAIN	LOS ANGELES	SAN JOSE	MAHWAH	METUCHEN	ATLANTA	CHICAGO	DALLAS	TWIN CITIES	LOUISVILLE	NORFOLK	OAKVILLE	ST. THOMAS
1969																				
FORD	121	F*4		•					•		•		•	•	•	•	•	•	•	•
MERCURY	121-124	F4					•												•	
THUNDERBIRD	115-117	F5			•				•											
MARK III	117	F5			•															
LINCOLN	126	UBC**5			•															
MUSTANG	108	UBC7	•							•		•								
COUGAR	111	UBC7	•							•										
FALCON	111-113	UBC8				•		•											•	
FAIRLANE	113	UBC8				•		•		•			•						•	
COMET	116	UBC8						•												
MAVERICK	103	UBC9				•														•
COMMON BODY TYPE (WITHIN FRAME OR UNIT)			•	•			•	•			•	•		•	•	•	•	•		
MIXED BODY TYPE (WITHIN FRAM OR UNIT)						•			•	•										
MIXED BODY TYPE (BETWEEN FRAME AND UNIT)					•								•						•	•
1973																				
FORD	127	F4		•					•		•			•	CLOSED	•	•	•	•	
MERCURY	124	F4					•												•	
LINCOLN	127	F4 DERIVATIVE			•															
MARK IV	120	F6 STRETCHED			•															
THUNDERBIRD	120	F6 STRETCHED			•				•											
TORINO	114-118	F6						•					•						•	•
MONTEGO	114-118	F6						•												
MUSTANG	109	UBC7 DERIVATIVE	•																	
COUGAR	112	UBC7 DERIVATIVE	•																	
MAVERICK	103-110	UBC9	•			•														•
COMET	103-110	UBC9	•			•														
PINTO	94	UBC10								•		•								•
COMMON BODY TYPE (WITHIN FRAME OR UNIT)				•		•	•	•		•	•	•	•	•		•	•	•		
MIXED BODY TYPE (WITHIN FRAME OR UNIT)			•		•				•										•	•
MIXED BODY TYPE (BETWEEN FRAME AND UNIT)																				

Source: Abernathy (1980, Appendix 2); *Ward's Automotive Yearbook* and *Automotive News Almanac Issue*, various years.

*F - Frame construction; **UBC - Unit Body Construction; Numerals after F or UBC indicate specific body design which may be subject to chage (derivative or 'stretched').

cars of common body types of just single body configurations.

The analysis above suggests that mixed car line assembly may indeed be less desirable from the standpoint of scale economies. We also noted in an earlier chapter that equipment and manpower may be underutilized particularly when a line which requires more steps in the assembly process is produced simultaneously with one that requires fewer steps. Further, problems over inventory control and work scheduling may arise. Given the disadvantages what then motivates this form of product mix in assembly plants?

Economies of Separate Assembly Lines

There are presumably certain economies, hitherto undetailed, to be gained by mixed car line assembly. For instance, some plants have two assembly lines producing cars of different body designations. At St. Louis, one line produces the B-body Chevrolet at a line speed of fifty-seven units per hour. A second line produces ten R-body fiberglass Corvettes per hour. At Cadillac's Detroit plant, Sevilles are assembled on a line separate from that producing Eldorado and full-size Cadillacs. During the late 1960's, prior to the debut of the Seville, the front-wheel-drive Eldorado was assembled in a small self-contained operation with its own chassis assembly line, final assembly, final inspection and paint shop, mainly because the car differed from the regular Cadillac line in design as well as assembly procedures (Geschelin, 1967a, 59-61). The Oldsmobile home plant at Lansing also consists of two lines, one of which assembles E-body Toronados exclusively and the other produces A- and B-body lines. Presumably, assembling substantially different models on different lines avoids some of the problems associated with underutilization of plant resources and scheduling. At the same time, generally larger output from two lines, a feature usually true of dual assembly line plants, may be the source of additional product and plant economies.

Economies of Quality Production

Other sources of economies, though somewhat difficult to verify, may reside in the preservation of a product's image, which may be based in large part on product quality and which may in turn depend on its production location. For example, the Cadillac, Buick and Oldsmobile Divisions of GM each produce a common front-wheel-drive E-body car known separately as the Cadillac Eldorado, the Buick Riviera and the Oldsmobile Toronado. Each line is assembled at their respective home plants even though joint assembly in one plant may realize the economies discussed above. Part of the reason for this may be the fact that these cars are equipped with a number of major components, particularly power plants, which are unique to each division. Perhaps, much of this strategy is also due to a certain quality of workmanship and indeed overall production which is associated with one car and not duplicated in others. Cadillac cars, noted for their fine quality, derive this particular characteristic from certain procedures followed during production. For example, exterior Cadillac parts had the reputation of being finished in seven coats of an acrylic lacquer and four wet colour coats. In addition, 'flawless' finishes in paintwork were imperative and often special equipment was used to ensure a high level of quality control (Geschelin, 1965, 56-58). In such instances, the importance of maintaining product reputation and the premium associated with it outweighs substantially, perhaps, the economies derived exclusively from common production.

Transportation Economies

There are of course instances of assembly of mixed-body designations in plants involving non-prestige lines which cannot be explained by the reasons suggested above. In such cases product-mix in plants may have been some corporate response to a variety of other circumstances. For example, both GM and Ford executives[1] interviewed have stated that car lines assigned to specific plants for assembly are in part an attempt to rationalize production and distribution economies. Ford's allocation policies, revealed during the interviews, were quite explicit. Given that the demand for a certain line is more or less uniform throughout North America and that there is sufficient volume to be allocated to, say, three plants, part of the volume will ideally be allocated to a west coast plant, another to a core facility and the remaining part to a facility on the east coast. The allocation planning process is generally aided by sales statistics provided by Ford dealers located throughout the U.S. and Canada. Hence, cars assigned for assembly at a plant reflect partly the decisions to match production with regional demand expectations. The rationale behind this policy is the prohibitive cost of single-line, single-plant sourcing due to a need for extensive cross-hauling of vehicles. The Ford official estimated that a car assembled exclusively in Los Angeles and eventually sold in Dallas may cost on the average $300 more per unit compared to a similar car assembled and shipped from a core area plant. The cost penalty is attributed primarily to the fact that components have to be shipped from Michigan to Los Angeles for

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[1]Mr. E. Lefevere, Director of Forward Planning, General Motors Assembly Division, and Mr. S. S. Bencuya, Programme Planning Manager, Automotive Assembly Division, Ford Motor Company.

assembly and then reshipped to Dallas.

At GM, the significance of the market factor in plant car line assignment decisions is clearly evident in their use of a computerized planning model since 1977 to simulate the most efficient model plant sourcing patterns based on minimum inbound and outbound transport costs. Various patterns of assignment have been simulated, one being absolute diversification on the basis that all plants would assemble all models since all are in fact sold at various regional markets. Attempts to solve this extreme case proved not only exceedingly complex, but led to a rather unrealistic arrangement from a logistic standpoint since components sourcing and inventory requirements proved to be impracticable. Later simulations, involving a maximum assignment of one-third of all GM models, were subsequently solved.

More realistic computer simulations based on a few lines per plant subject to minimum outbound transportation costs proved in fact to be little different from sourcing patterns developed prior to computer modelling. And although these computer solutions produced 'optimal' plant-product-mix patterns based on transportation costs, the final assignment decisions were still based upon certain subjective considerations.

Although officials interviewed acknowledged that there are economies in assembling cars with common body features, they indicated it is not always possible to do so because of geographical variations in demand for different car lines. Economies derived from transportation cost may outweigh the economies of assembling together car lines that have complimentary body designs but which have to be shipped to distant markets.

Hence, it may be more appropriate at times to produce mixed body car lines in plants than to adhere rigidly to complementary body lines. The decision by GM to assemble the Pontiac Firebird, a sports coupe at the Lordstown plant which was already assembling full-size Chevrolets, in 1967 illustrates our point (See Geschelin, 1967b, 63-6). The Firebird, introduced in 1967, was sold throughout North America but sourced exclusively at Lordstown presumably because first year production totalled 82,500 units and the location had excellent accessibility to the continental market. The Chevrolets sourced at Lordstown, however, were mainly for distribution in the sales area close to the plant. It is also worth noting that the 1967 Chevrolet was sourced at eleven different plants, four of which also assembled other cars but with different body designations.

Economies of Capacity Utilization

Notwithstanding the product-, plant- or transport-related economies referred to above, interviews at Ford further revealed that products are also allocated to specific plants because of available in-plant capacity during model changeover periods or during the introduction of new lines. As a result, it is likely that particular car-line assignments and combinations in plants may not represent any simple ideal product-mix, such as lines comprising common-body configurations, but rather a compromise solution suitable for a particular state of the corporate system.

Why is it so important then to utilize available capacity particularly over the short term? Although, over short periods there may be capacity in a plant which is redundant, in the long term there may indeed be a real need for it, especially if the market demand expands and capacity is required to meet this expansion. Mothballing excess capacity may be difficult if not impossible, especially in plants consisting of a single assembly line. It is possible, however, to shut down one line in a plant which consist of two separate lines. On the other hand, the cost of mothballing short term excess capacity must be weighed against several other factors, particularly the likelihood of having to lay off for extended periods a labour force which has already been trained and may not return. When the need arises, getting the plant back into operation quickly may be severely hampered by the need to retrain workers for the assembly line. Extended layoffs are likely to lead to a diminishing percentage of workers returning to their old jobs. The length of time laid-off workers are willing to wait around to be rehired depends upon availability of suitable alternate jobs and their Supplemental Unemployment Benefits (SUB) which together with state/provincial unemployment benefits provide over a certain period up to ninety per cent of their regular income[1]. However SUB funds are known to be depleted more rapidly in some firms than others. Hence, in the event that SUB funds are low, the length of time these benefits are received may be short. If new workers have to be hired and trained for assembly jobs, getting a plant into full operation may be rather expensive because of the initial learning period causing delays in production as well as quality problems. These problems may be magnified if the premium is on getting the products to the consumer as quickly as possible.

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[1]Discussion with Lydia Fischer, Research Department, UAW Detroit; see also United Automobile, Aerospace and Agricultural Implement Workers of America (1976).

Economies of Retooling and Downtime Costs

While Ford's concern with utilizing available plant capacity may have influenced plant car line mix, the 'least total cost' principle upon which GM based its plant investment and downtime costs to accomodate model changeover and assignment[1] has also probably affected product mix at GM plants. Since different plants, because of dissimilarities in age and equipment in place, would require investments of differing amounts for retooling and new equipment for the assembly of new models, decisions to assign car lines to specific plants have no doubt been strongly affected by the value of disbursements necessary to convert the plants involved especially prior to 1977 when the least total cost policy was in effect. Plants in which minimum disbursements for conversions were necessary have received priority. Disbursements would be lower when changeover time is shorter, because shorter downtime would curtail costs caused by losses in production. These considerations have also featured prominently in final decisions to retool specific plants to accommodate new models. The priority attached to how little is spent on altering a plant to accommodate a particular line is likely to produce a product-mix that is rather different from one where the emphasis is simply upon product-related scale economies.

Economies of Plant Performance and Capabilities

Product-plant assignment af GM has been further attributed to the performance record of individual plants. United Automobile Workers (UAW)

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[1]Interview with Mr. E. Lefevere, Director of Forward Planning, General Motors Assembly Division. See also Sloan and Miles (1980).

representatives[1] noted that GM plants are believed to compete against each other for the assembly of new or other car lines. It was suggested that GM's decision to assemble specific models at certain plants is based on individual plant performance based on the record of absenteeism, work quality, labour attitude, productivity[2] as well as plant vintage, equipment and production capabilities.

It is well known that GM rates its plants as well as departments within individual plants. An overall rating is produced on a regular basis to encourage interplant (as well as intraplant) competition and to stimulate and improve work standards amongst management and the work force. While this rating is no secret, details of the criterion used, plants involved and their respective ranking are not available. Whether plant ranking and performance are employed by GM as a criterion to allocate specific car lines, such as those requiring quality workmanship, which may also guarantee job security for workers, is not entirely clear. UAW officials suspect that high plant rankings may be related to the allocation of models which are perceived to have greater chances of success, such as new car lines or designs whose sales are expected to be favourable upon introduction and which would contribute to a steady if not increasing production schedule in comparison to some declining line.

While GM officials interviewed conceeded that plant performances was generally monitored, they declined to clarify what criteria were employed and how ratings were determined. As a variable in product

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[1]Discussion with Mr. Sheldon Friedman of the Research Department and Mr Robert Lopez of the GM Department, UAW, Detroit.

[2]A recent study by Runcie (1980) indicates that worker-related problems continue to be a major concern in auto assembly plants.

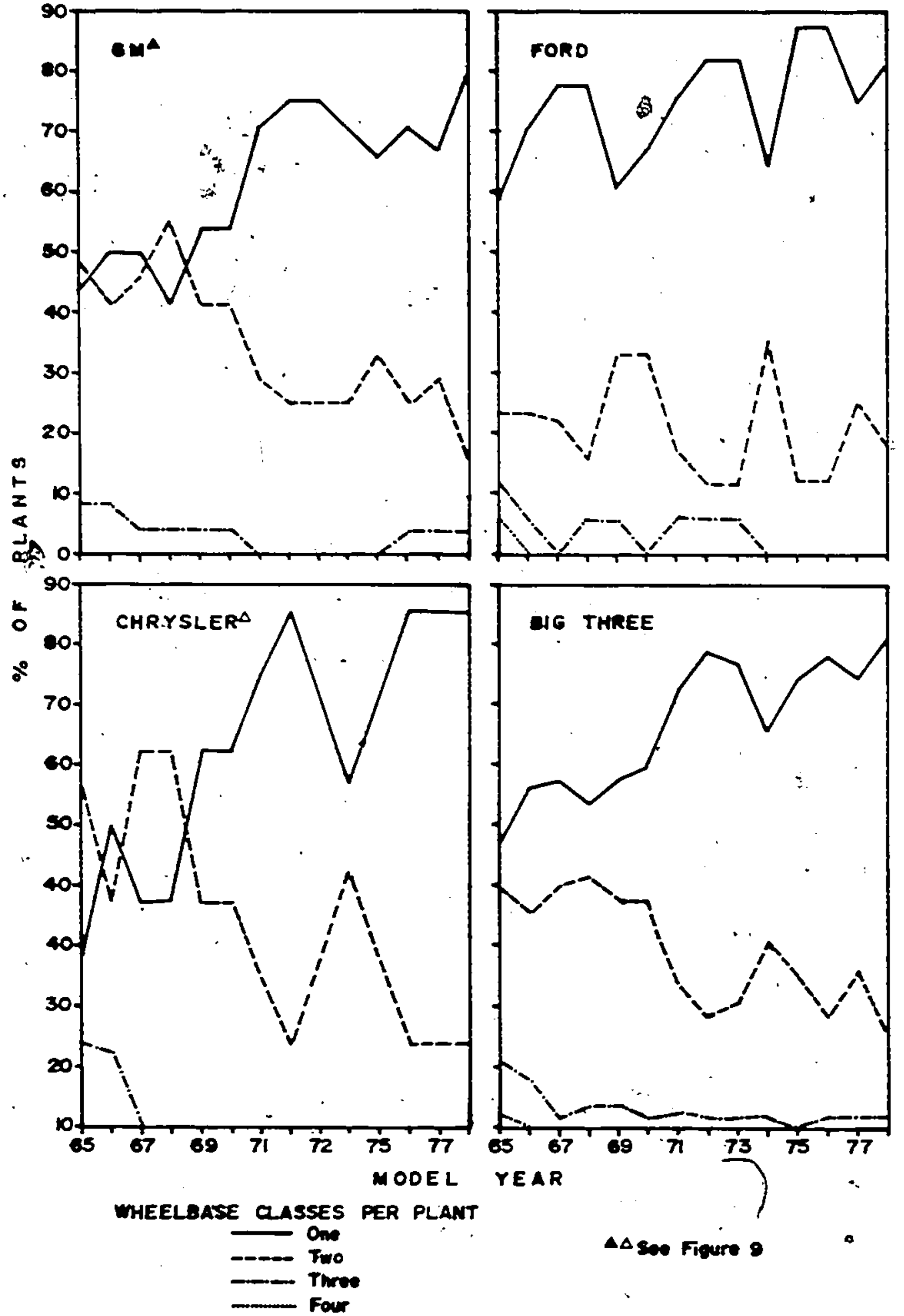
allocation decisions, plant performance and ranking are apparently taken into consideration, but they do not usually feature as a crucial factor. Officials from GM stressed plant ratings are low on the priority list of key considerations and may be important only when all other key factors "are equal". This opinion does, however, appear to be inconsistent with the circumstances surrounding the allocation of GM's then new H-body subcompacts--the Monza, Starfire and Skyhawk--to Ste. Thérèse, North America's sole source of these cars during the 1975 model year. A former GM Canada president, David O. Collier was quoted as saying: "We won the competition because Ste. Thérèse has been building cars of good quality and good workmanship"[1] (Automotive News July 8, 1974, 2). Besides this isolated quote, there is no evidence to indicate that plant ratings play a significant role in product assignment.

Wheelbase Dimensions and Assembly Plants

Another feature of complementarity among diverse car lines produced in one plant is well exemplified in an analysis of vehicle wheelbase-mix. Wheelbase, as noted earlier, also defines in a general way a vehicle's dimensions and market segments. Despite the variety in make and car lines found at individual plants, these facilities are frequently assigned cars belonging to one wheelbase class and possibly two (Figure 14). Plants assembling cars of three or four different sizes or wheelbase dimensions are rare.

[1]The opinion regarding the higher quality of all Canadian- in comparison to American-made cars is also shared by Mr. Donald C. McEwan, Chief, Automobile Division, Ministry of Industry, Trade and Commerce, Ottawa.

Figure 14: Plant Distribution by Number of Wheelbase Classes

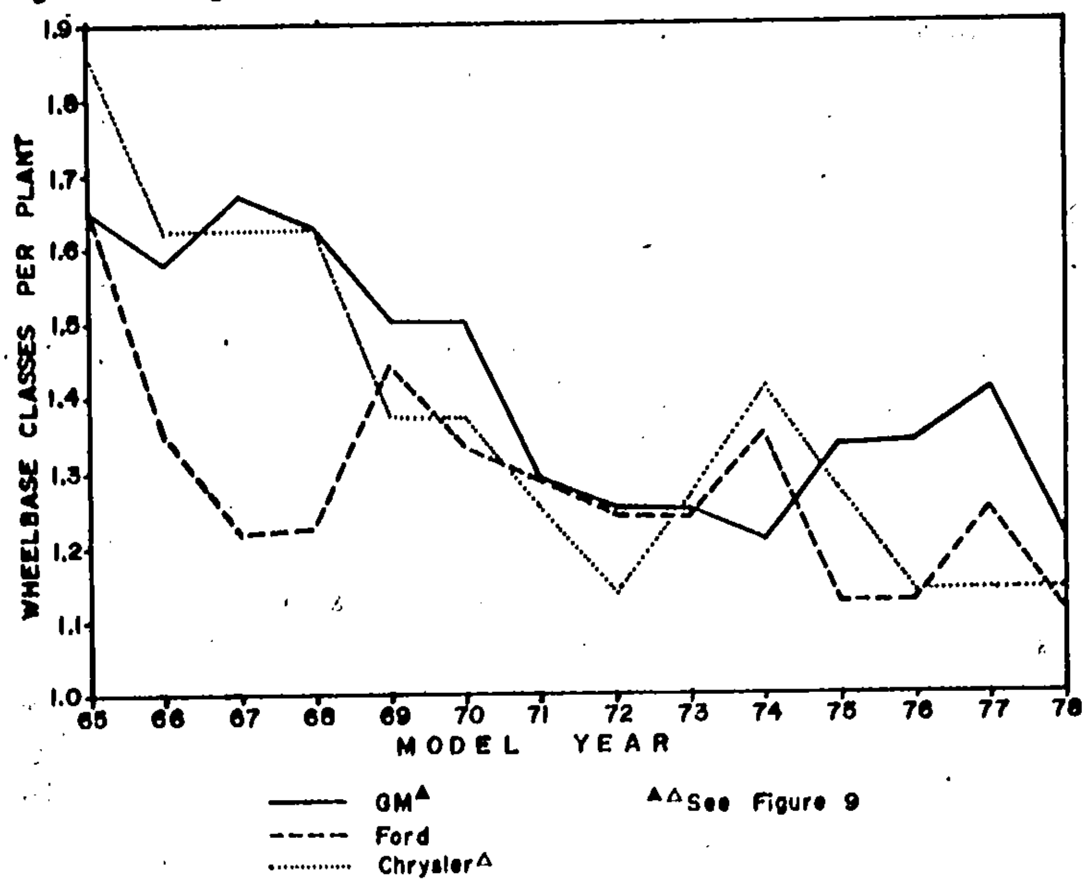


For the Big Three firms over the study period the proportion of plants producing cars of a common wheelbase class increased from about one half to more than three quarters. Plants assembling cars in two different wheelbase classes comprised from thirty-five to forty-two per cent of all plants in the late 1960's but this percentage then declined to less than twenty in 1978. Because of the overwhelming importance of single- and double-wheelbase plants, the proportional increase or decline in one produces an almost perfect inverse pattern in the other, a relationship evident for all three firms.

Although each firm exhibits broadly similar patterns in the increase and a decrease in single- and double-wheelbase plants respectively, there are nevertheless slight variations between the firms. Prior to the 1970's, GM and Chrysler each had periods when cars of two different wheelbases were assigned to more assembly plants than cars of one wheelbase. Ford, placed greater emphasis on plants specializing in cars of the same wheelbase class. Throughout the study period, over sixty per cent of Ford's plants were specialized in single wheelbases and less than forty per cent were double-wheelbased plants. Another feature is the rather greater swings about trend in the percentage distribution of Ford's plants, compared to GM's in these two groups of plants between 1965 and 1978. Two, sometimes three, stable years are followed by a steep decrease then immediate increase in the number of Ford's single-wheelbase plants. Chrysler's plants were subject to fewer but even larger oscillations, particularly in the 1970's, compared to Ford's.

Overall, the weighted average number of wheelbases per plant for all three firms was below two (Figure 15). GM generally had the highest

Figure 15: Weighted Average Number of Wheelbase Classes per Plant



averages, followed by Chrysler and Ford. With the exception of some years, there seems to be a significant degree of convergence in the averages for all three firms. In 1978, the weighted averages ranged from 1.2 to 1.12. Unlike other product criteria such as make and line, where inter-firm differences were in some instances clearly evident, the remarkable similarity in the allocation of cars on the basis of wheelbase size classes underscores perhaps an important technological or engineering constraint in assembly line production technique which is common throughout the industry.

The policy of assembling cars with common wheelbases or at least from common wheelbase classes is of course closely related to that regarding common body types discussed above. Wheelbase classes distinguish the major market segments into which cars generally fall: subcompacts, compacts, intermediates and full-size. Car lines of compatible size and from common market segments also constitute another variable which affects product assignment in auto assembly. The major requirement is to balance the work content of the cars assembled. Although the basic process in building up the frame may not vary significantly, variations in the number of fittings make it difficult to undertake the combined assembly of certain models such as subcompacts and full-size luxury vehicles. Assembly of a luxury vehicle requires a great deal more workers manning the assembly lines, since work content is generally higher. Production of full-size luxury vehicles requires that assembly lines be manned to the maximum. Incorporating lines with few optional fittings or a small subcompact would entail severe underutilization of segments of the assembly. In addition, a great deal more care goes into the production of luxury vehicles to maintain and protect the image of quality so often associated with such cars. For example, a plant producing luxury vehicles will have more quality control checkpoints on the assembly line to ensure and maintain a high standard of work on luxury vehicle features. Such controls are maintained to a lesser extent on production lines of less expensive cars.

CHAPTER VII

PLANT GEOGRAPHY AND CAR LINE ASSIGNMENT

Thus far we have analysed plant-product mix and assignment without explicit reference to similarities and contrasts in a spatial context. This chapter examines the nature of Big Three assignment strategies as revealed in the relationships between plant-product assignment and plant location patterns. For instance, are core area plants more specialized or more diversified than those in peripheral zones? Are product assignment patterns in Canadian plants any different from those located in the United States? In Chapter II we noted some research which indicated for several industries the concern amongst multiplant producers to serve the needs of regional markets efficiently with the least delay and the minimum cross-shipment, a factor that adds weight to multiple product portfolios for peripheral plants. Countering that market pull is the role of product scale economies, which may compel the manufacturers of low-volume products in some specialized, central facility. It was also pointed out that products made at more peripheral plant locations are generally high-volume items. Further, in respect of foreign branch plants, product assignment was often more diversified particularly when trade barriers existed, but in their absence, production was frequently rationalized and not so different from other plants located in the parent country.

The analyses in this chapter will focus mainly on the assignment geography of car lines. It was noted earlier in Chapter VI that plant product mix is largely a function of similarities present in various car lines.

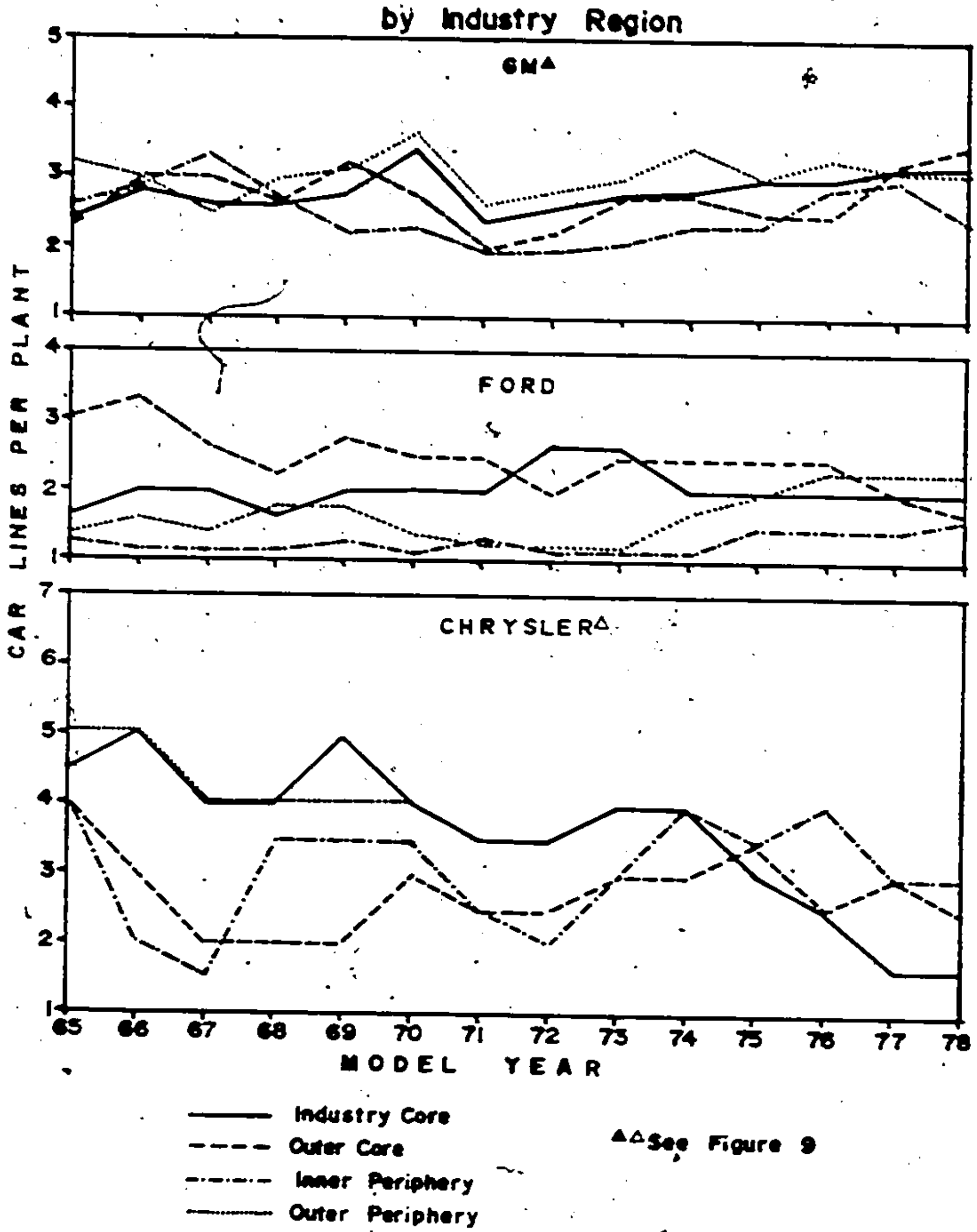
Car Line Assignment: Plants in Different Industry Regions

In this section assembly plants were grouped on the basis of the four industry regions,--industry core, outer core, inner periphery and outer periphery--and weighted averages[1] for each plant were computed. There is little evidence of distinct spatial patterns in this case and there is some overlap among regional averages over the study period (Figure 16). In GM's case, for instance, though plants located in the outer periphery and industry core generally had higher weighted averages in that order, there were brief periods when plants in the inner periphery (1967) and outer core (1977 and 1978) had larger averages. Generally, however, GM plants in the industry core and outer periphery are diversified to a similar degree. The other regions are less diversified but only marginally so, particularly during the early 1970's.

Ford plants located in the two core areas generally had a higher number of lines than those plants in either of the peripheral areas although the numbers for the outer periphery exceeded all other regions in 1977 and 1978. Prior to 1975, Chrysler plants in the industry core had the largest number of car lines per plant than other plants located in other regions with the exception of the outer periphery. Chrysler operated one plant in the outer periphery at Los Angeles until 1971. The number of lines produced there was generally high, averaging four and five per year, when it was operating. Following 1975, however, the inner periphery, outer core and the industry core had the largest values

[1] See Appendix A.

Figure 16: Weighted Average Number of Car Lines per Plant by Industry Region



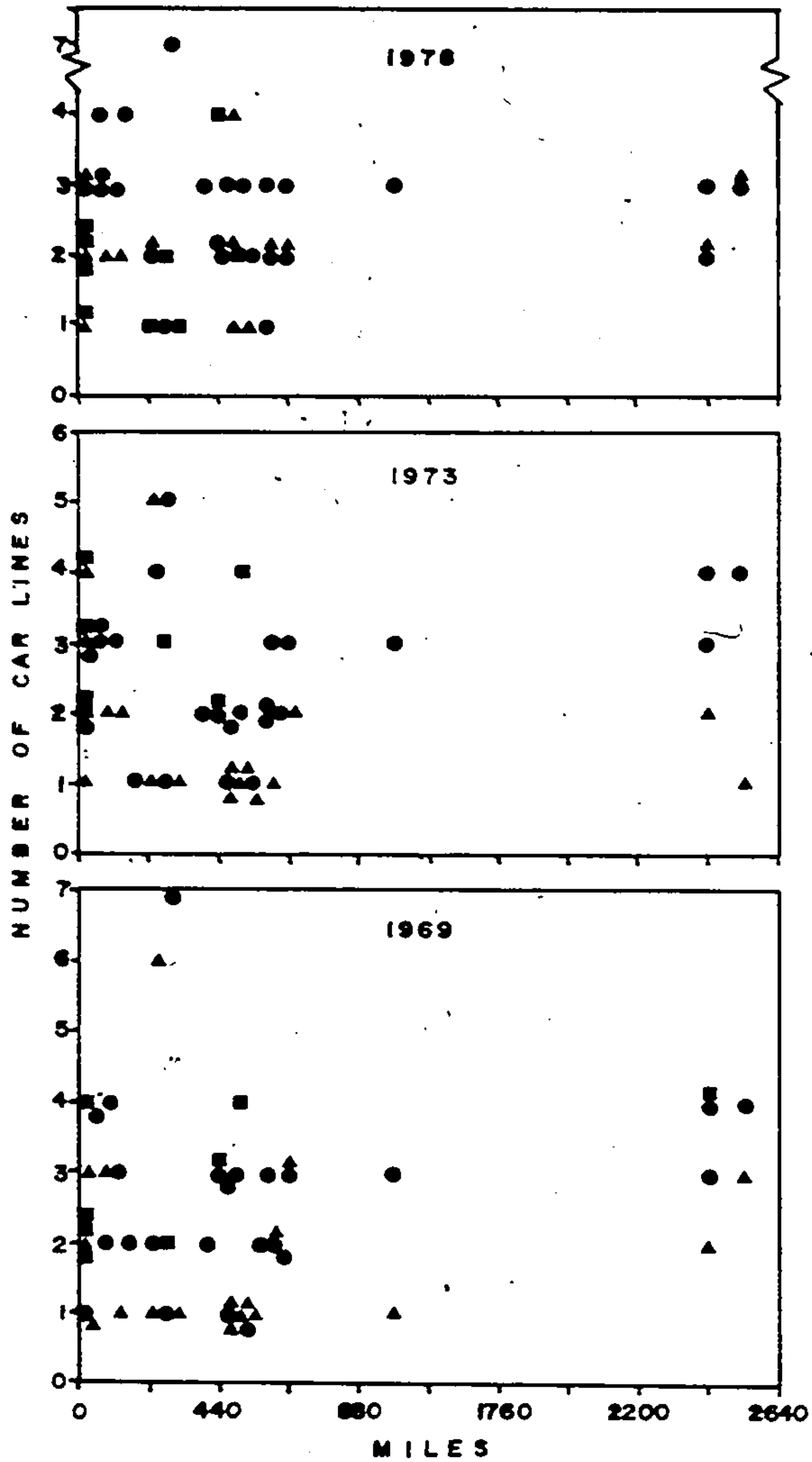
respectively.

As for the Big Three, there are indications that industry core plants assemble a generally high average number of car lines. In Chapter II it was suggested that this may have been the result of firms consolidating production of low-volume lines in 'centralized' plants. Further, the location of these 'centralized' plants in the industry core area is only partially true, as our analysis in the next section indicates. Many lines produced at Michigan-based plants of the Big Three have outputs in excess of 100,000 units and do, in fact, assemble both high- and low-volume models simultaneously. The low-volume models include most of the high-priced luxury cars produced at the home plants of Ford and GM. Assembly at home plants seldom takes advantage of the product-specific economies but rather the economies associated with quality workmanship and assembling prestigeous cars (See Chapter VI). There are nevertheless other plants which assemble multiple low-volume models consisting of common body designs, thus securing certain joint economies of production.

Earlier, it was suggested that peripheral plants may produce multiple car lines as a strategy to secure distribution economies by matching plant product-mix with regional demand expectations. This feature of the outer periphery region is quite evident amongst GM plants and to a lesser extent Ford's plants. It was also suggested that the number of car lines per plant might be expected to be rather large because of the advantages gained from prompt delivery of goods which is more likely to be achieved by local sourcing of products rather than sourcing from distant plants. However, the number of car lines in outer periphery plants is only either marginally greater or sometimes less than that in industry core plants. This may be attributed to the fact that both GM and Ford operated two or more plants in certain peripheral locations. GM had three plants and Ford had two in California. In Georgia, GM operated two plants in the Atlanta area but Ford had only one. Presumably, if a firm had several separate facilities in one regional market area, it had the advantage of rationalizing its car lines amongst these plants, hence making it possible for individual facilities to concentrate on a few lines. In the light of this it is worth noting that before the closure of Chrysler's Los Angeles plant, the facility was assembling four separate car lines for many years after the late 1950's. GM, despite having three plants on the West Coast, assigned a total of six car lines to the South Gate plant during the model years 1961 to 1963.

Figure 17 indicates the number of car lines in plants located by straight line distance from Detroit for the 1969, 1973 and 1978 model years. Distance from the auto industry's heartland, apparently bears no relationship to the number of car lines in individual plant. Big Three plants situated close to or at significant distances from Detroit assemble similar numbers of car lines. This may be suggestive of certain developments of the industry. There appears to be no explicit distance-related reason that leads individual firms to assign more or less car lines to particular plants. Insofar as distant plants are concerned, only one case of a single-line plant out of the sixteen covered was identified. Improvements in transportation since the Sixties may also have reduced any advantages from having a large number of car lines in these

Figure 17: Car Lines per Plant and Distance from Detroit



PLANTS: ● GM, ▲ FORD, ■ CHRYSLER

plants. We noted earlier that it has become just as economical to produce and ship cars to the principal markets including the peripheral areas from plants located in the core. Given this, it has probably been feasible to assign the number of car lines to plants without too much regard for their distance-related location. It does seem interesting, however, that GM's and Chrysler's West Coast plants during the early 1960's prior to the innovations in transportation, were indeed quite diversified in their car line portfolios. Also of interest is the extent GM's Oshawa plant stands out in the diagrams, though less in 1978 than in 1969. It assembles a particularly wide range of lines compared to most American and even other Canadian plants. Some circumstances affecting this particular plant will be examined later.

Volume and Plant Location

Earlier, we indicated that there was an association between production volume of individual car lines and the number of assembly locations. Given, an essentially fixed number of assembly locations, how have the Big Three chosen to assign car lines with differing volumes geographically? Further, to what extent is geographic decentralization common to high-volume car lines and geographic centralization characteristic of low-volume lines? To answer these questions individual car lines offered during the 1969, 1974 and 1978 model years were grouped into three classes based on production volume (over 200,000; 60,000 to 200,000; and below 60,000) and ranked. From each of these classes, five car lines were randomly selected and the number of production plants, their locations by state (or province) and industry region specified (Tables 19 & 20).

TABLE 19

ASSEMBLY LOCATIONS OF SELECTED CAR LINES OF DIFFERENT PRODUCTION VOLUME, 1969, 1974 and 1978 MODEL YEARS

INDUSTRY REGION (STATE/PROVINCE)	1969														
	OVER 200,000					60,000-200,000					BELOW 60,000				
	F FORD	GM BUICK	GM NOVA	C MONACO	C FURY	GM CADILLAC	F MONTEGO	GM GRAND PRIX	C VALIANT	F FALCON	F LINCOLN	C BARRACUDA	GM TORONADO	GM ELDORADO	GM CORVAIR
INDUSTRY CORE															
MICHIGAN	•	•	•	••	•	•		•	•		•	•	•	•	•
OUTER CORE															
OHIO							•			•					
ILLINOIS	•				•										
WISCONSIN															
ONTARIO	•		•		•					•					
IMMEDIATE PERIPHERY															
QUEBEC															
MASSACHUSETTS															
NEW YORK															
NEW JERSEY	•														
DELAWARE		•			•										
MARYLAND															
KENTUCKY	•														
MISSOURI				•						•					
KANSAS		•													
MINNESOTA	•														
OUTER PERIPHERY															
GEORGIA	•	•													
TEXAS	•														
CALIFORNIA	•	•		•					•						
VIRGINIA	•														
TOTAL	10	5	2	4	4	1	1	1	2	3	1	1	1	1	1

INDUSTRY REGION (STATE/PROVINCE)	1974														
	OVER 200,000					60,000-200,000					BELOW 60,000				
	F PINTO	GM VEGA	GM CHEVELLE	GM NOVA	GM OLDSMOBILE	GM LE MANS	C SATELLITE	C CHRYSLER	GM GRAND PRIX	GM VENTURA	F LINCOLN	GM ASTRE	GM RIVIERA	C CHALLENGER	C BARRACUDA
INDUSTRY CORE															
MICHIGAN				•	•	•	•	•	•	•	•		•	•	•
OUTER CORE															
OHIO		•													
ILLINOIS								•							
WISCONSIN															
ONTARIO	•		•	•		•	•								
IMMEDIATE PERIPHERY															
QUEBEC		•										•			
MASSACHUSETTS						•									
NEW YORK															
NEW JERSEY	•				•										
DELAWARE															
MARYLAND			•												
KENTUCKY															
MISSOURI			•	•			•								
KANSAS					•										
MINNESOTA															
OUTER PERIPHERY															
GEORGIA			•			•			•						
TEXAS			•												
CALIFORNIA			•	•		•				•					
VIRGINIA															
TOTAL	2	2	6	4	3	5	3	2	2	2	1	1	1	1	1

INDUSTRY REGION (STATE/PROVINCE)	1978														
	OVER 200,000					60,000-200,000					BELOW 60,000				
	GM CUTLASS	GM OLDSMOBILE	GM CHEVETTE	C VOLARE	GM PONTIAC	GM FIREBIRD	GM LE MANS	C CORDOBA	C OMNI	GM PHOENIX	F BOBCAT	GM TORONADO	GM RIVIERA	GM STARFIRE	F VERSAILLES
INDUSTRY CORE															
MICHIGAN	•	•		•	•		•			•		•	•		•
OUTER CORE															
OHIO	•					•								•	
ILLINOIS									•						
WISCONSIN															
ONTARIO					•		•	•							
IMMEDIATE PERIPHERY															
QUEBEC	•														
MASSACHUSETTS	•														
NEW YORK										•					
NEW JERSEY											•				
DELAWARE			•	•											
MARYLAND							•								
KENTUCKY															
MISSOURI		•													
KANSAS		•			•										
MINNESOTA															
OUTER PERIPHERY															
GEORGIA	•														
TEXAS															
CALIFORNIA		•				•					•				
VIRGINIA															
TOTAL	5	4	1	2	3	2	3	1	1	2	2	1	1	1	1

Source: Ward's Automotive Yearbook, Automotive News Almanac Issue, various years.

TABLE 20

DISTRIBUTION OF SOURCING POINTS OF SELECTED CAR LINES BY PRODUCTION VOLUME AND INDUSTRY REGIONS, 1969, 1974 and 1978 MODEL YEARS

INDUSTRY	1969			1974			1978		
REGION	OVER 200,000	60,000 to 200,000	BELOW 60,000	OVER 200,000	60,000 to 200,000	BELOW 60,000	OVER 200,000	60,000 to 200,000	BELOW 60,000
INDUSTRY CORE	6	3	5	2	5	4	4	2	3
OUTER CORE	5	3	-	4	3	-	2	4	1
INNER PERIPHERY	7	1	-	7	2	1	7	2	1
OUTER PERIPHERY	7	1	-	4	4	-	2	1	1
T O T A L	25	8	5	17	14	5	15	9	6

Source: Table 19.

This data indicates that the spatial pattern of assignment of individual car lines is related in part to the output of the lines themselves. It shows that high-volume lines are generally produced in more plants than are lower volume lines and production locations of high-volume lines tend also to be geographically dispersed. Indeed high-volume car lines are frequently assembled in all four major industry regions. Lower volume lines, however, are not only produced in fewer plants, but they are also more likely to be located at the industry core and this is especially evident among car lines with model year production volumes of less than 60,000 units in 1969 and 1974. However, after 1969, there were indications, particularly from the increasingly dispersed assembly locations of car lines in the 60,000 to 200,000 unit range, that such geographic centralization was weakening. Even amongst lines of 60,000 units or less, their assignment to plants outside the industry core was more common in 1974, and increasingly so in 1978. One very evident feature is the strong representation of car lines from all three volume groups in the industry core, with the exception of subcompact lines such as the Pinto, Bobcat, Astre, Vega and Omni, all of which were assembled outside Michigan.

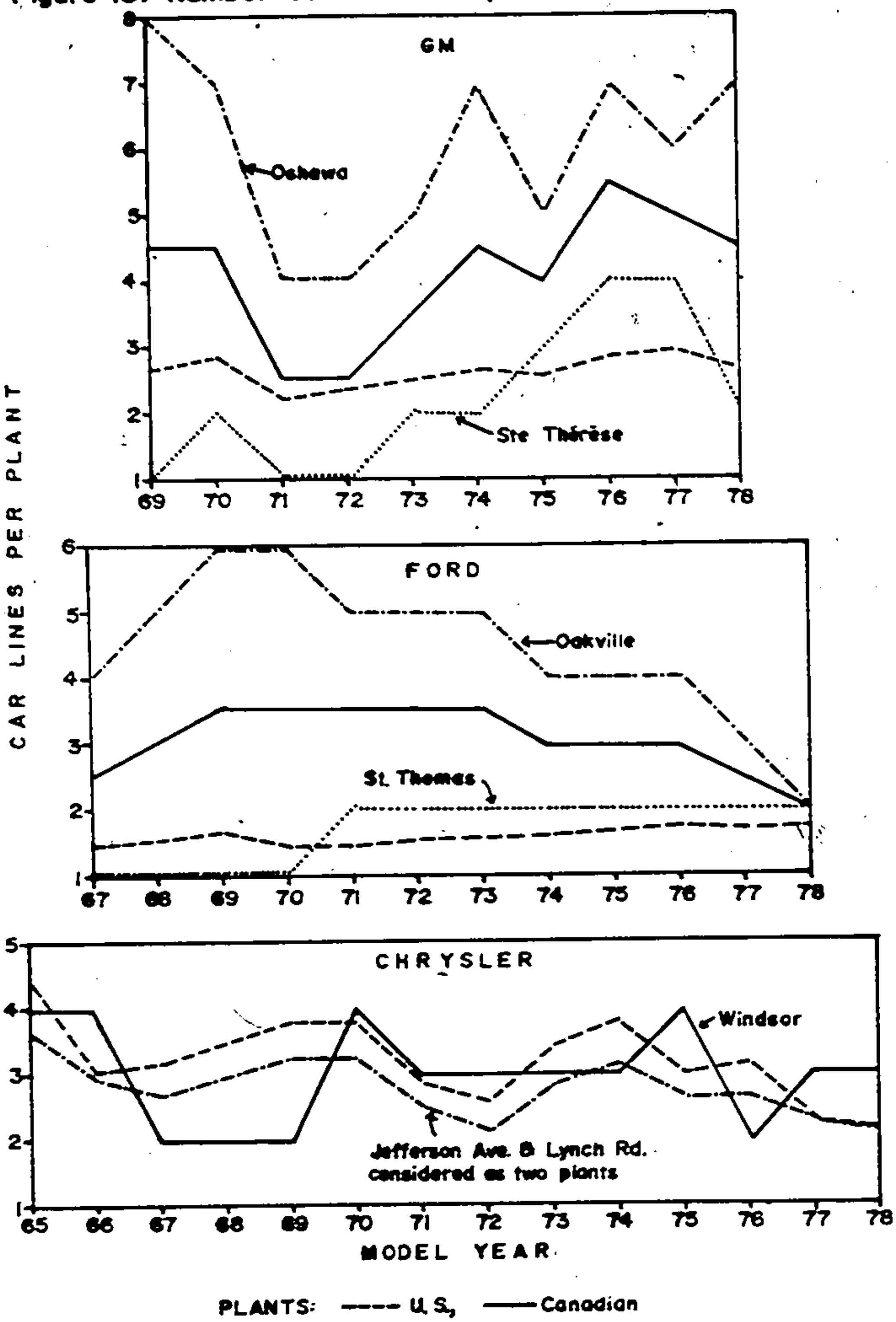
Product Assignment: Canadian Versus American Plants

The Canada-U.S. Automotive Products Trade Agreement of 1965 was designed to integrate the production activities of the industry in both countries. However, certain safeguards were drafted to protect auto production in Canada. They were embodied in what is commonly referred to as the production-to-sales ratios and Canadian content requirements that were to be met by the four domestic producers. In light of this legal instrument governing the industry's functions and activities, and certain inherent differences between the U.S. and Canada what similarities or contrasts, if any, exist between product assignments and plants in both countries? Foreign branch plants of giant multinational corporations operating in Canada generally have a more diversified product portfolio than domestic plants especially in the presence of significant trade barriers. Removal of trade impediments tends to promote inter-country integration and rationalization of production and in particular greater product specialization. The primary concern of this section is to analyse the extent to which product rationalization has occurred.

For this analysis car line data used in previous analyses were disaggregated into two basic groups, consisting of Canadian and U.S. plants, and weighted averages were computed (Figure 18). GM data is presented from the 1969 model year, since prior to that year car line assignment information was not available for the plant at Ste. Thérèse. Data on Ford commences with the 1967 model year, which also marks the opening of the St. Thomas plants.

The 'average' GM plant in the U.S. assembled three or less car lines from 1969 to 1978. Canadian plants, by contrast, had averages ranging from 2.5 to 5.5. For each of the model years studied, however, the averages for Canadian plants were always higher than that for American plants. Of the two Canadian facilities belonging to GM, Oshawa was the more diversified assembling a minimum of four lines and a maximum of eight during the period 1969-78. Ste. Thérèse, the less diversified of the two was assigned single or double lines in the late Sixties and early Seventies. Four lines were produced in 1976 and 1977 but they have since been

Figure 18: Number of Car Lines per Canadian and U.S. Plant



reduced to two lines in the 1978 model year.

Ford's Canadian plants produced from two to 3.5 lines in contrast to sister plants in the U.S. which assembled an average of less than two lines per plant. In Ford's case, as in GM's, the Canadian plants carried more lines, on the average, than American plants between 1967 and 1978. Oakville, like Oshawa, was a rather diversified plant, producing three or more lines for all the model years between 1969 and 1977. Ford's St. Thomas plant, however, is the more specialized of the two and has produced two lines since 1971.

Chrysler's Windsor plant was diversified to a degree comparable to the Canadian plants of Ford and GM. However, Windsor, unlike its Canadian counterparts, is not significantly more diversified than its American sister plants even when both the Jefferson Avenue and Lynch Road plants were regarded as two separate facilities (dotted line, Figure 18).[1] In fact Windsor made fewer models than American Chrysler plants from 1967 to 1969 and also during 1976 and 1977.

The greater diversity in the mix of car lines at Canadian plants compared to American plants is of particular interest especially in view of some of the economies related to car line diversity mix discussed earlier, and the intent of the APTA which was to rationalize production and thereby improve the productivity of Canadian plants. Our analysis compared car line diversity in Canadian plants to all American plants on an

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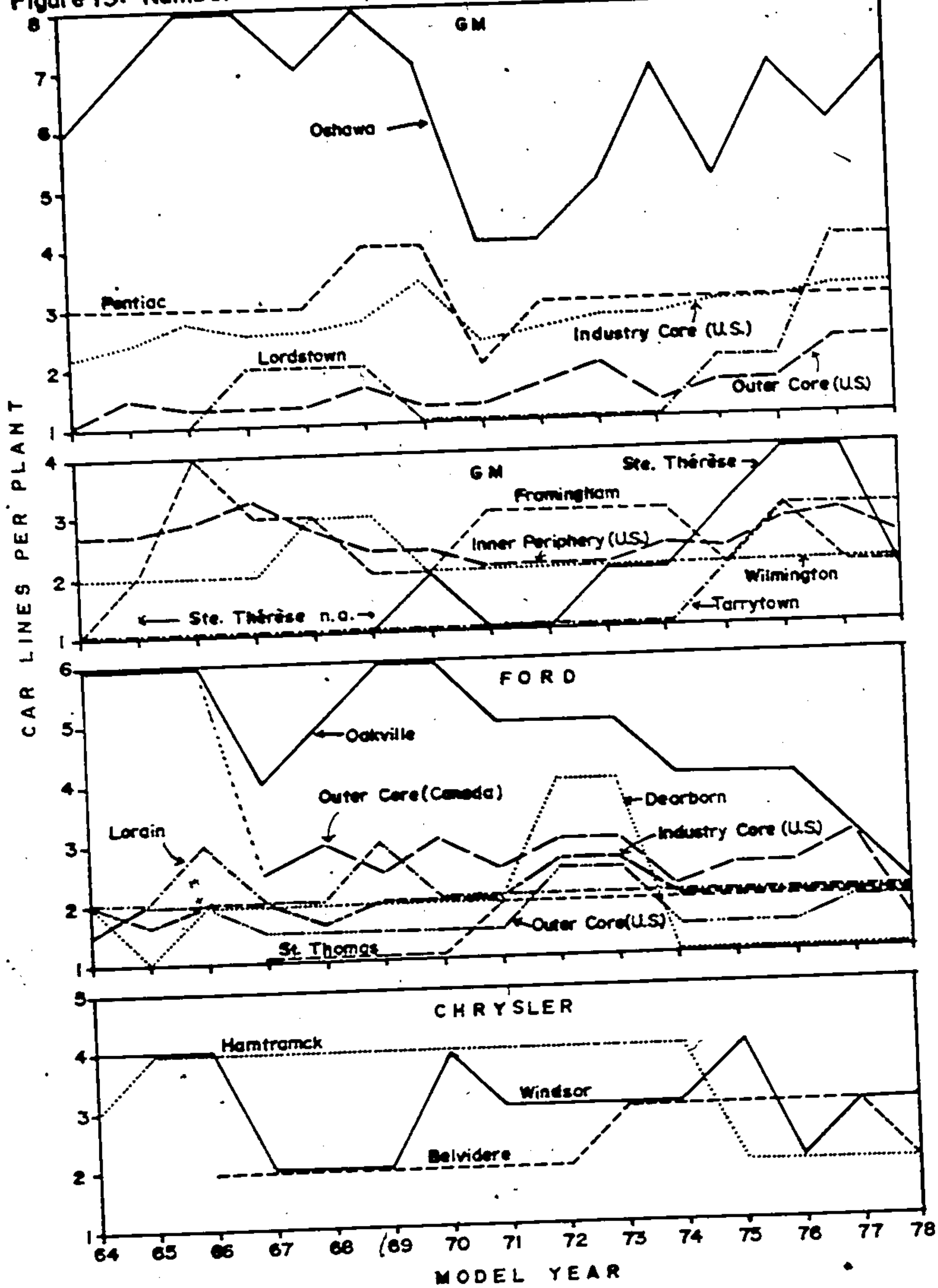
[1]Data for these plants were aggregated for all years before 1977. When considered as a single facility, the average number of lines for Chrysler plants was overestimated. In order to obtain a more accurate set of averages, the two plants were separated on the assumption that when both plants produced a total of odd numbered lines, Lynch Road was assigned one more line than Jefferson Avenue, the ratio is based on 1977 and 1978 evidence when the two plants were reported separately. In the event of even numbered lines, each plant was assigned an equal proportion of lines.

aggregate basis. While analysis of the number of lines per plant reveals the product portfolio of the 'average' plant, it conceals the extent of dispersion. Further, there may well be differences amongst plants in different industry regions, a point we noted in an earlier section of this chapter. An alternative assessment of any contrasts or similarities between Canadian and U.S. plants may be obtained by detailed comparisons on the basis of relative location.

Figure 19 reveals the number of car lines assembled in Canadian plants as well as those assembled in selected U.S. plants located in the same industry regions in geographic proximity to the individual Canadian plants. Weighted averages based on U.S. or Canadian plants for selected industry regions are also included. Consider initially GM's plants. Oshawa is much the most diversified car-line plant in the core area. G.M.'s U.S. plants in the outer core, by contrast produce an average of two or fewer car lines, with the exception of 1977 and 1978 when the average exceed two. Lordstown, another major plant at the outer core produced single or double car lines with the exception of 1977 and 1978 when four lines were assigned there. Pontiac, a Michigan plant assembled three lines for most years, and four during 1969 and 1970. No individual U.S. plant in the core area approaches the diversity that characterises Oshawa's car line portfolio. Ste. Thérèse is far less diversified than Oshawa and with the exception of the period from the mid-1970's, this plant produced fewer models than U.S. plants in the inner periphery. Ford's giant Oakville plant is rather similar to Oshawa in that it is also more diversified than Ford's American plants in the core areas. Few individual U.S. plants come close to producing the number of car lines

Figure 19: Number of Car Lines Produced in Canadian and U.S. Plants



assigned to Oakville. Since 1970, however, the number of lines has shown a steady decline. Both Ford's St. Thomas plant and Chrysler's Windsor plant appear, however, to be similar to other U.S. core area plants in that they assemble fewer car lines generally.

The unusually large number of car lines assigned to Oshawa and Oakville prompts the question: Why did this situation arise, particularly in the light of the Auto Pact? Both Beigie's (1971) and Cowan's (1972) evaluations reveal that the Auto Pact, once implemented, had the effect of reducing the number of car lines assigned to Canadian plants. This change effectively took a period of two years to materialize following the signing of the Agreement. Basic sourcing decisions are generally made well in advance of August 1, when production for a new model year traditionally begins. Since the Agreement was not signed until January 16, 1965, such decisions had already been made for the entire 1965 model year and presumably for the one following. Moreover, the legislation implementing the Agreement on the U.S. side was not actually passed by Congress until October 1965. In short, the relatively brief span of time within which the entire Agreement was proposed, drafted and endorsed by the governments of both countries, and the presence of some opposition to the Agreement on the part of some U.S. Congressmen provided very little time and some degree of uncertainty for the producers to react quickly. Further, each of the major firms, presumably because of differences in size, product diversity, and corporate strategies adopted somewhat different approaches in product-plant assignment, a point which we shall consider in greater detail.

Chrysler

Prior to 1967, Chrylser's Windsor plant produced four different lines. By 1967, however, the company had chosen to rationalize its North American assembly operations by phasing out all Canadian assembly of the Chrysler and Valiant lines, and concentrating on the manufacture of the Dodge and Plymouth Fury lines (Table 21). Since the initial response to the Auto Pact, further changes have occurred. Although, four models were assembled in 1970, the Dodge and Plymouth Fury lines were actually being phased out in favour of the Dart, Valiant and Satellite. A third change involving a switch from Dart and Valiant lines to the Cordoba and Charger SE occurred during the 1975/76 model years.

Rationalization was further highlighted by an increase in the output of the two lines which were retained and produced at Windsor. In 1966, for example, 9.2 per cent of the Chrysler line, 39.2 per cent of all Dodges, 9.3 per cent of Plymouth Furys and 15.3 per cent of Valiants made in North America were sourced at Windsor (Table 22). These lines were individually sourced from three (Chrysler) or four plants (Dodge, Plymouth and Valiant) including Windsor (See Table 23). In 1967, however, Windsor produced over sixty-two per cent of Dodges and twenty per cent of Plymouth Furys. The number of sourcing plants for the above four models was reduced simultaneously. Chrylser, Dodge and Valiant were produced in only two plants and Plymouth in three. It is worth noting, further, that lines assigned to Windsor in 1967 concurred with the withdrawal of the same lines from Michigan-based as well as other plants. Dodge assembly was discontinued at Detroit and Newark and the Plymouth line was removed from Hamtramck following the concentrating of production at Windsor. With

TABLE 21

CAR LINES ASSEMBLED AT CHRYSLER'S WINDSOR PLANT, 1964-1978

CAR LINES	MODEL YEAR														
ASSEMBLED	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
CHRYSLER	*	*	*												
DODGE	*	*	*	*	*	*	*								
PLYMOUTH/FURY	*	*	*	*	*	*	*								
DART							*	*	*	*	*	*			
VALIANT	*	*	*				*	*	*	*	*	*			
SATELITTE								*	*	*	*				
CORDOBA												*	*	*	*
CHARGER S.E.												*	*	*	*
MAGNUM														*	*
T O T A L	4	4	4	2	2	2	4	3	3	3	3	4	2	3	3

Source: Automotive News Almanac Issue, 1969-1978; Motor Vehicle Manufacturers' Association of Canada (1970); Ward's Automotive Yearbook, 1978.

TABLE 22

CAR LINES ASSEMBLED AT WINDSOR,[1] AS A PROPORTION OF TOTAL NORTH AMERICAN LINE OUTPUT, CHRYSLER, SELECTED MODEL YEARS

CAR LINE	MODEL YEAR 1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
CHRYSLER	9.2												
DODGE	39.2	62.4	36.5	55.2	16.7								
PLYMOUTH/FURY	9.3	20.4	33.8	32.7	4.9								
DART					83.6	50.9	48.8	30.8	29.3	12.5			
VALIANT	15.3				4.3	27.6	22.6	17.4	20.9	10.6			
SATELLITE						32.2	45.5	50.5	20.8				
CORDOBA										100.0	100.0	100.0	100.0
CHARGER S.E.										100.0	100.0	100.0	100.0
MAGNUM													100.0

Source: Ward's Automotive Yearbook, 1967-1979; Automotive News Almanac Issue, 1966-1978.

[1]Based on production from August 1 of one year to July 31 of the following year.

TABLE 23

SOURCING OF SELECTED CAR LINES: CHRYSLER, 1966 AND 1967 MODEL YEARS

PLANTS	1966				1967			
	CHRYSLER	DODGE	VALIANT	PLYMOUTH	CHRYSLER	DODGE	VALIANT	PLYMOUTH
DETROIT	*	*			*			
NEWARK	*	*		*	*			*
BELVIDERE		*		*		*		*
HAMTRAMCK			*	*			*	
ST. LOUIS			*					
LOS ANGELES			*				*	
WINDSOR	*	*	*	*		*		*
NUMBER OF PLANTS	3	4	4	4	2	2	2	3

Source: Ward's Automotive Yearbook, 1967 and 1968; Automotive News Almanac Issue, 1965 and 1967.

the exception of those years when car lines were in the process of being phased out, the proportion of North American production for individual lines assembled at Windsor was generally from twenty to fifty per cent during the early 1970's. Since 1975, Windsor has been designated the sole source of the Cordoba, Charger and, recently, the Magnum lines.

Total output at Windsor declined slightly following rationalization but increased to over 212,000 units in 1968. Since then model year output has fluctuated from a high of 274,000 units in 1973 to a present low of approximately 206,000 cars. Following the adjustments made in 1967, Windsor's share of Chrysler's North American output has also increased. However, annual percentages vary considerably, from 11.3 per cent in 1967 to a high of 20.5 per cent in 1975 (Table 24).

Early rationalization and assignment of car lines to Windsor were not, however, based on product lines which were totally complementary. Both the Dodge Polara and Plymouth Fury were large cars, but the former was a full-size vehicle with a 122 inch wheelbase while the latter was an intermediate with a wheelbase three inches shorter. Rather similar circumstances existed when the plant switched to the Valiant, Dart and Satellite lines. The first two lines were compacts but with different wheelbase dimensions, and the latter was an intermediate. In later years, however, the Dart and the Valiant were in fact identical cars except for some minor design features and the nameplate. The Cordoba, Charger and Magnum, like late model Darts and Valiants, shared a number of identical features.

Another factor which may have had some influence on the particular car lines assigned to Windsor is the structure of demand for Chrysler

TABLE 24

CHRYSLER AUTOMOBILE PRODUCTION* AND PROPORTION SOURCED AT CANADIAN PLANT, 1966-1978 MODEL YEARS

MODEL YEAR	WINDSOR^	TOTAL U.S.	TOTAL NORTH AMERICA	WINDSOR % OF N.A.
1966	167,268	1,448,224	1,615,492	11.4
1967	160,389	1,253,637	1,414,026	11.3
1968	212,566	1,588,572	1,801,138	11.8
1969	212,430	1,505,554	1,717,984	12.4
1970	248,093	1,301,412	1,549,505	16.0
1971	207,229	1,256,259	1,463,488	14.2
1972	265,773	1,365,517	1,613,290	16.3
1973	274,293	1,623,469	1,897,762	14.4
1974	234,316	1,319,025	1,553,341	17.8
1975	252,181	975,448	1,227,629	20.5
1976	253,243	1,088,637	1,341,880	18.9
1977	225,688	1,355,266	1,580,954	14.3
1978	205,832	1,133,996	1,339,828	15.4

Source: Ward's Automotive Yearbook, Automotive News Almanac Issue/Market Data Book Issue, various years.

*Number of Cars.

^Based on production from August 1 of one year to July 31 of the following year.

cars. The four lines produced during 1966 (model years 1965 and 1966) were also the top four selling cars (Table 25).[1] Lines which were subsequently retained or added, generally involved those that had substantial sales expectations, though not necessarily amongst the highest. Overall, the Auto Pact did provide the basis for rationalization at Chrysler's Canadian plant, particularly through the reduction in the number of car lines and an increase in the output of lines that were retained.

Ford

Two years after the signing of the Auto Pact, some reorganization of Ford's car lines produced in Canada did occur but to what extent this constituted North American rationalization seems debatable. During the 1967 model year, the assembly of Falcon and Comet cars was discontinued. The former line was produced at Ford's new Canadian plant at St. Thomas during the 1967 and 1968 model years. From 1969, St. Thomas stopped being the source of these cars but Oakville resumed as the Canadian source in the 1969 and 1970 model years. At Oakville following the removal of the Falcon and Comet, little else changed insofar as the structure of production was concerned. The North American share of the other lines (Fairlane, Ford, Mercury and Meteor) remained essentially the same as in the 1966 model year (Table 26). Overall output at Oakville declined from about 196,000 to approximately 120,000 units or only five per cent of Ford's total North American output, because removal of Falcon and Comet production was not offset by increases in the production of the

[1]The analysis of automobile demand on the basis of model years is not feasible because new car registration data is published on the basis of calender years.

TABLE 25

CHRYSLER: NEW CAR REGISTRATIONS AND OUTPUT IN CANADA,
BY PRINCIPAL CAR LINES 1966-1971 CALENDER YEARS

YEAR	1966		1967		1978		1969		1970		1971*	
LINE	REG.	OUTPUT	REG.	OUTPUT	REG.	OUTPUT	REG.	OUTPUT	REG.	OUTPUT	REG.	OUTPUT
DODGE	43,100	101,600	31,700	78,200	30,500	77,600	22,200	62,500	16,000		14,700	
PLYMOUTH/FURY	39,400	44,800	30,400	108,500	29,600	141,500	25,400	77,300	20,200		19,600	
VALIANT	21,200	44,600	9,300		10,200		11,900	7,800	24,100	35,200	27,400	59,400
CHRYSLER	25,000	12,000	26,800		28,400		24,300		18,200		20,700	
DART	2,400		14,300		16,700		19,100	53,500	18,000	172,500	21,300	130,000
CORONET/CHARGER	N.A.		12,300		11,800		12,100		6,900		5,900	
BELVEDERE	N.A.		11,400		13,500		13,300		9,900		N.A.	
BARRACUDA	N.A.		3,800		N.A.		N.A.		N.A.		N.A.	
SATELLITE	-		-		-		-		-	30,900	11,000	42,600

Source: Motor Vehicle Manufacturers' Association of Canada, 1966-1971.

N.A.--indicates registration data not published but model is still on the market.

*Registration for Manitoba incomplete.

TABLE 26

PLANT AND LINE OUTPUT,* AS A PERCENTAGE OF NORTH AMERICAN PRODUCTION
FORD, MODEL YEARS 1966-1978

PLANT AND	1966		1967		1968		1969		1970	
CAR LINE	#	%	#	%	#	%	#	%	#	%
OAKVILLE										
FAIRLANE/TORINO	15,488	4.9	3,528	1.5	2,304	0.6	2,640	0.7	79,983	19.6
FALCON	36,344	18.3					60,272	45.9	1,680	3.6
FORD	88,924	8.5	81,652	8.5	80,990	9.3	109,220	10.9	48,740	5.7
COMET	12,164	7.1								
MERCURY	10,221	5.8	7,660	5.9	8,609	6.8	42,081	23.0	19,420	13.1
METEOR	32,665	100.0	29,800	100.0	26,107	100.0	25,015	100.0	15,931	100.0
MUSTANG					1,248	0.4	1,944	0.6	696	0.4
T O T A L	195,806	7.3	122,640	5.2	119,258	5.1	241,172	9.7	166,450	6.9
ST. THOMAS										
FALCON	not		67,858	47.0	104,311	77.4				
MAVERICK/FAIRMONT	opened						79,215	62.0	240,652	53.3
PINTO										
ZEPHYR										
T O T A L			67,858	2.9	104,311	4.5	79,215	3.2	240,652	10.0

PLANT AND	1971		1972		1973		1974		1975	
CAR LINE	#	%	#	%	#	%	#	%	#	%
OAKVILLE										
FAIRLANE/TORINO	1,032	0.3	140,671	28.1	155,843	32.0	116,757	26.8	4,776	2.4
FALCON										
FORD	112,530	12.1	26,103	3.2	5,040	0.6	18,985	4.1	146,277	41.1
COMET										
MERCURY	34,253	21.1	23,681	13.6	33,264	18.1	5,840	6.6	5,074	6.5
METEOR	18,251	100.0	15,281	100.0	16,980	100.0	11,215	100.0	10,522	100.0
MUSTANG	720	0.5	1,056	0.8	1,992	1.5				
T O T A L	166,786	6.6	206,792	7.3	213,119	7.0	152,797	5.6	166,649	7.7
ST. THOMAS										
FALCON										
MAVERICK/FAIRMONT	123,220	45.9	121,477	47.0	96,673	32.4	85,845	28.8	65,549	33.0
PINTO	97,001	27.5	115,535	24.9	159,047	31.8	134,692	25.5	102,925	43.6
ZEPHYR										
T O T A L	220,221	8.7	237,012	9.1	255,720	8.4	220,537	8.1	168,474	7.8

PLANT AND	1976		1977		1978	
CAR LINE	#	%	#	%	#	%
OAKVILLE						
FAIRLANE/TORINO	9,360	4.6	4,128	1.7	7,512	4.2
FALCON						
FORD	164,121	40.7	194,896	42.6	96,638	29.8
COMET						
MERCURY	18,930	16.9	10,000	6.3		
METEOR	10,526	100.0				
MUSTANG						
T O T A L	202,937	8.0	209,224	7.9	104,150	3.7
ST. THOMAS						
FALCON						
MAVERICK/FAIRMONT	45,503	30.0	37,461	26.4	169,743	35.2
PINTO	140,373	48.7	111,698	53.9		
ZEPHYR					68,717	44.0
T O T A L	184,876	7.3	149,159	5.7	238,460	8.4

Source: Ward's Automotive Yearbook; Automotive News Almanac Issue/ Market Data Book Issue, various years.

*Production figures from August 1 of one year to July 31 of the following year.

car lines which were retained. Plant output did rise in 1969 in part because the Falcon was reinstated and output of the Ford and Mercury lines was increased.

Generally, it is difficult to suggest without some reservations that Oakville's production lines were rationalized because line reduction was only temporary. The situation was complicated because St. Thomas became operational at that particular period. What rationalization did occur appeared to be between Canadian plants rather than between Canadian and U.S. plants. In Table 27, we note that the withdrawal or assignment of a car line to Oakville is seldom accompanied by corresponding changes (increase or decrease) in U.S. sourcing points during the period when rationalization was most likely to have occurred. Further, the assignment of Mustang production in rather low volumes certainly represents a departure from rather than a move towards rationalization. Yet a third point is the rather large fluctuation in output of particular lines such as the Fairlane, Ford and Mercury which suggest that Oakville was a rather uncertain source of these cars. From 1976 on, there seems to be some trend towards fewer car lines, first with the removal of the Meteor line in 1977 and then the Mercury Marquis in 1978. During the 1978 model year only the Ford and LTD (previously the Fairlane/Torino) were assembled. For 1979, the Ford was withdrawn from Oakville leaving a single line, the LTD. These developments were no doubt associated with the decline in full-size car output and centralization of these lines in fewer plants. St. Thomas unlike Oakville has been specialized from the beginning. During the first four years of production it assembled a single line but has been producing two since 1970.

TABLE 27

U.S. SOURCING POINTS OF CAR LINES PRODUCED ALSO AT OAKVILLE AND ST. THOMAS, MODEL YEARS 1966-1969

CAR LINE	PLANT	REGION	1966	1967	1968	1969
FAIRLANE	OAKVILLE	CANADA	•	•	•	•
	KANSAS CITY	WNC	•	•	•	•
	LORAIN	ENC	•	•	•	•
	ATLANTA	SA	•	•	•	•
	SAN JOSE	PACIFIC				•
TOTAL			4	4	4	5
FALCON	OAKVILLE	CANADA	•			•
	DEARBORN	ENC	•			
	KANSAS CITY	WNC	•	•	•	•
	LORAIN	ENC	•	•		•
	ST. THOMAS	CANADA		•	•	
TOTAL			4	3	2	3
FORD	OAKVILLE	CANADA	•	•	•	•
	WAYNE	ENC	•	•	•	•
	MAHWAH	MA	•	•	•	•
	LOS ANGELES	PACIFIC	•	•	•	•
	ATLANTA	SA	•	•		•
	DALLAS	WSC	•	•	•	•
	CHICAGO	ENC	•	•	•	•
	ST. PAUL	WNC	•	•	•	•
	LOUISVILLE	ESC	•	•	•	•
	NORFOLK	SA	•	•	•	•
TOTAL			10	10	9	10
COMET	OAKVILLE	CANADA	•			
	LOS ANGELES	PACIFIC	•	•		
	LORAIN	ENC	•	•	•	•
TOTAL			3	2	1	1
MERCURY	OAKVILLE	CANADA	•	•	•	•
	ST. LOUIS	WNC	•	•	•	•
	WAYNE	ENC		•		
TOTAL			2	3	2	2
MUSTANG	OAKVILLE	CANADA			•	•
	DEARBORN	ENC	•	•	•	•
	METUCHEN	MA	•	•	•	•
	SAN JOSE	PACIFIC	•	•	•	•
TOTAL			3	3	4	4
MAVERICK	ST. THOMAS	CANADA				•
	KANSAS CITY	WNC				•
TOTAL						2

Source: *Ward's Automotive Yearbook*, 1967-1970; *Automotive Almanac Issue*, 1967-1970; *Automotive Industries*, July 1, 1966, 104.

ENC - East North Central
SA - South Atlantic
MA - Middle Atlantic
WSC - West South Central
ESC - East South Central
WNC - West North Central

Further, output of each line frequently comprises in excess of thirty per cent of North American production (Table 26).

Depite the multiplicity of car lines made at Oakville, there has been some degree of internal rationalization from a different perspective, however. The different lines produced at the plant share two and perhaps not more than three common body types (Table 28). The Meteor shared the same body, the UBC 6, with the Fairlane when it was produced in the U.S. Production of this line was stopped in the U.S. but proceeded in Canada and presumably it continued to share a common body with the Fairlane. If the Mustang, which was produced in very small quantities, was excluded Oakville with the exception of 1965 in effect assembled cars of only two body types. This suggests that certain product scale economies were already in place when the Auto Pact was signed. However, further economies may have been possible if the output of each line was increased and stabilized. We noted earlier that although car lines share common body types, the extent of differentiation in numerous details can seriously affect productivity and product quality.

General Motors

When the Auto Pact was signed, GM already had two plants in Canada, Ste. Thérèse having been established in 1965. The Quebec-based plant is in many ways like Ford's St. Thomas plant in that it was specialized from the start. For example, it began by producing two lines and later specialized in one, the Chevrolet. Eventually, it increased the number of separate lines but on each occasion the plant concentrated on cars from common body groups (See Tables 29 and 30). Prior to 1972, full-size B-body Pontiacs and Chevrolets were made. In the late 1960's the plant

TABLE 28

FORD CAR LINES AND BODY TYPES ASSEMBLED AT CANADIAN PLANTS, MODEL YEARS 1965-1974

PLANT AND CAR LINE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
<u>OAKVILLE</u>										
FAIRLANE/TORINO	UBC6	UBC8	UBC8	UBC8	UBC8	UBC8	UBC8	F6	F6	F6
FALCON	UBC3	UBC8			UBC8	UBC8				
FORD	F4	F4	F4	F4	F4	F4	F4	F4	F4	F4
COMET	UBC3	UBC8								
MERCURY (MARQUIS)	F4	F4	F4	F4	F4	F4	F4	F4	F4	F4
METEOR*				UBC7	UBC7		UBC7	UBC7	UBC7	
MUSTANG										
NUMBER OF BODY TYPES▲	3	2	2	3	3	2	3	3	3	3
<u>ST. THOMAS</u>										
FALCON	NOT	NOT	UBC8	UBC8						
MAVERICK	OPENED	OPENED			UBC9	UBC9	UBC9	UBC9	UBC9	UBC9
PINTO							UBC10	UBC10	UBC10	UBC10
NUMBER OF BODY TYPES	-	-	1	1	1	-	2	2	2	2

Source: <u>Automotive News Almanac Issue</u>/<u>Market Data Book Issue</u>, 1965-1978; <u>Automotive Industries</u>, July 1, 1968, 45-7; Abernathy (1978).

*Discontinued in the U.S., but production continued in Canada. Used to share common body (UBC6) with Fairlane.

▲Excluding the Meteor.

UBC--Unit Body Construction; F--Frame Construction. Numeral following 'UBC' or 'F' indicates distinctive body features, dimensions, etc.

TABLE 29

PLANT AND CAR LINE OUTPUT* AND AS A PERCENTAGE OF GM NORTH AMERICAN PRODUCTION, SELECTED MODEL YEARS

PLANT AND	1969		1974		1975		1976		1977		1978	
CAR LINE	#	%	#	%	#	%	#	%	#	%	#	%
STE. THÉRÈSE												
CHEVROLET	100,000	8.0										
VEGA			122,401	24.9								
ASTRE			26,796	100.0								
MONZA					76,837	53.6	48,183	56.3	30,141	82.9		
SKYHAWK					35,171	100.0	19,951	55.9	10,078	100.0		
STARFIRE					31,081	100.0	16,881	57.9	8,021	100.0		
SUNBIRD							29,334	54.2	18,111	72.1		
CUTLASS											98,751	18.7
GRAND PRIX											11,996	5.2
T O T A L	100,000	2.0	149,197	3.3	143,089	3.6	114,349	2.2	66,351	1.2	110,747	2.0
OSHAWA												
PONTIAC	56,825	12.9	23,217	11.7	23,305	15.6	21,046	13.3	32,494	13.8	31,667	13.6
OLDSMOBILE	61,098	14.2										
CHEVROLET	40,500	3.2	50,907	7.5	121,334	25.6	149,545	30.9	94,851	14.4	178,425	26.1
CHEVELLE/MALIBU	49,566	10.1	102,914	26.1	78,223	21.8	74,229	19.4	67,944	18.9	76,880	19.2
CHEVY II/NOVA	3,000	1.1	400	0.1			3,432	1.0			3,744	1.3
BEAUMONT	16,748	100.0										
TEMPEST/LE MANS			39,205	23.3	25,392	20.7	22,150	18.7	18,650	21.1	26,241	19.8
MONTE CARLO			109,463	32.8	21,687	7.7	49,594	13.1	33,434	8.2	57,362	15.0
CAMARO	1,128	0.4	216	0.1								
BUICK SPECIAL/ SKYLARK	61,846	24.7					3,600	1.1	672	0.2	4,512	2.4
T O T A L	290,711	5.8	326,402	7.2	269,941	6.9	323,596	6.4	248,045	4.4	301,951	5.4

Source: <u>Ward's Automotive Yearbook</u>; <u>Automotive News Almanac Issue/Market Data Book Issue</u>, various years.

*Production figures from August 1 of one year to July 31 of the following year.

TABLE 30

GM CAR LINES AND COMMON BODY GROUPS AT OSHAWA AND STE. THÉRÈSE, MODEL YEARS 1969-1978

CAR LINE	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
STE. THERESE										
CHEVROLET	B	B								
PONTIAC		B	B	B						
VEGA					H	H				
ASTRE					H	H				
MONZA							H	H	H	
SKYHAWK							H	H	H	
STARFIRE							H	H	H	
SUNBIRD								H	H	
CUTLASS										A
GRAND PRIX										A
NUMBER OF GROUPS	1	1	1	1	1	1	1	1	1	1
OSHAWA										
PONTIAC	B	B			B	B	B	B	B	B
OLDS. F85 (CUTLASS)	A									
CHEVROLET	B	B	B	B	B	B	B	B	B	B
CHEVELLE/MALIBU	A	A	A	A	A	A	A	A	A	A
CHEVY II/NOVA	X	X				X		X		X
BEAUMONT	?									
TEMPEST/LE MANS		A	A	A	A	A	A	A	A	A
MONTE CARLO			A	A	A	A	A	A	A	A
CAMARO	F	F				F				
BUICK SPECIAL	A	A								
SKYLARK								X	X	X
NUMBER OF GROUPS*	4	4	2	2	2	4	2	3	3	3

Source: Automotive News Almanac Issue/Market Data Book Issue, 1968-1979; Motor Trend, January, 1980.

B-body--Full-size cars; A-body--Intermediates; X-body--Compacts; H-body--Subcompacts; F-body--Sports Compacts.

*Excluding the Beaumont.

assembled Chevrolets for the Northeastern region of the U.S. (Campbell, 1968, 45-7). From 1973 to 1977, a significant percentage, and in some instances all, of the H-body subcompact line--Vega, Astre, Monza, Skyhawk, Starfire and Sunbird--were sourced here. Since the 1978 model year, all subcompacts were transferred to Lordstown and replaced with A-body intermediates.

Production at Ste. Thérèse has fluctuated between 60,000 and 149,000 units during the years for which data is available (1969; 1974-78) or between 1.2 and 3.6 per cent of GM's total North American output. Judging by the plant's output and size of cars produced, it appears to be operating far below Toder's economies of scale estimates. Nevertheless, it is of the same vintage as other plants such as Lordstown (GM) and Belvidere (Chrysler). This has led authors such as White (1971) to argue that the operating scale of these plants, which is similar to Ste. Thérèse, represents an efficient size.

Oshawa, the larger of GM's plants, is also more diversified in terms of car lines and body groups produced. Regarding the extent of product rationalization, commentary on the situation at Oshawa is made difficult by the limited data available. Model year output data for individual car lines, aggregated particularly for Chevrolet and Pontiac, made it hard to assess the true structure of production from 1965 to 1968 and from 1970 to 1973. Model year statistics are important because if steps were taken to rationalize production, they would likely occur during a model changeover at the start of the new model year. The calender year data which is available suffers not only from aggregation but possibly inflates the number of lines produced.

However, information pieced together from various sources does provide an adequate picture of the car line diversity at Oshawa. From 1964 to 1969, seven and sometimes eight different lines were produced. The number declined rapidly to four in 1971 and 1972, then fluctuated between five and seven thereafter (Table 31). Thus, Oshawa plant output was twice or triple the size of that at Ste. Thérèse. Oshawa also produced far more lines than U.S. plants of comparable size. If, however, lines with production runs of less than 5,000 units are excluded, Oshawa produced marginally fewer lines. Five major car lines accounted for the largest proportion of the vehicles produced there.

Purely on the basis of car lines assembled, it is reasonable to suggest that no rationalization took place until 1971. Even so this did not occur on a permanent basis because, as noted above, the number of lines increased again after 1971. If, however, the North American share of output accounted for by individual lines produced at Oshawa is taken into consideration there is indication of inter-country reorganization of production (See Table 29). In the 1969 model year, only one line, the Buick Special, had barely a quarter of North American production sourced at Oshawa, excluding the Beaumont which was produced exclusively for the Canadian market. By 1974, however, there were at least three lines (Chevelle, Le Mans and Monte Carlo) which had a significant share of North American output sourced at Oshawa. Likewise, in 1975, there were three other 'high percentage' lines, the Chevrolet, Chevelle and Le Mans. In recent years, Oshawa has been a major source of full-size Chevrolets, the intermediate Malibu and Monte Carlo.

Further evidence of rationalization, or lack of it, may be sought

TABLE 31

CAR LINES ASSEMBLED AT GM'S OSHAWA PLANT, 1964-1978

CAR LINES ASSEMBLED	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
PONTIAC	*	*	*	*	*	*	*			*	*	*	*	*	*
ACADIAN		*	*	*											
OLDSMOBILE	*	*	*	*	*	*									
BUICK SPECIAL/ SKYLARK	*	*	*	*	*	*	*						*	*	*
CHEVROLET	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CHEVELLE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
CORVAIR			*												
CHEVY II/NOVA	*	*	*	*	*	*	*				*		*		*
BEAUMONT				*	*	*									
TEMPEST/LE MANS							*	*	*	*	*	*	*	*	*
MONTE CARLO								*	*	*	*	*	*	*	*
CAMARO						*	*				*				
TOTAL ALL LINES	6	7	8	8	7	8	7	4	4	5	7	5	7	6	7
PRINCIPAL LINES ONLY	NA	NA	NA	NA	NA	6	NA	NA	NA	NA	5	5	5	5	5

Source: Motor Vehicle Manufacturers' Association of Canada, various editions; Automotive News Almanac Issue/Market Data Book Issue, 1965-1979.

in the role of Oshawa as a regional source of particular car lines. If Oshawa was to be rationalized to serve U.S. markets it is to be expected the obvious markets it would serve would be in neighbouring regions. In 1969, however, it did not appear as though Oshawa performed this role mainly because car lines produced at the plant were also sourced in at least one, if not more, plants in neighbouring regions such as the East North Central region (Table 32). Also, four of the seven lines made at Oshawa were sourced at plants located in the North East region. During the 1972 model year, Oshawa produced four separate car lines. However, only two, the Chevrolet and Le Mans, were each made in single plants located in the East North Central and North East regions. This feature of assignment suggests that Oshawa may have been a major source of car lines, particularly the Chevelle and Monte Carlo, for both those American regions. Later in 1977, no other plant located in both neighbouring regions produced those two lines.

There is additional evidence of internal rationalization occurring at Oshawa, besides that relating to a gradual reduction of car lines and it being a larger North American source of these lines. Despite the variety of car lines assigned to Oshawa, most, however, have common body configurations (Table 30). For instance, A- and B-body cars have been produced consistently at the plant since the Auto Pact, though F- and X-body vehicles were added during particular years.

TABLE 32

U.S. ASSEMBLY SOURCING OF CAR LINES ALSO PRODUCED AT OSHAWA
MODEL YEARS 1969, 1972, 1977

REGIONS & PLANTS / CAR LINES	CANADA	EAST NORTH CENTRAL								NORTH EAST			NORTH-WEST CENTRAL			SOUTH ATLANTIC				WEST-SOUTH CENTRAL	PACIFIC		
	STE. THERESE	DETROIT	PONTIAC	FLINT	LANSING	WILLOW RUN	LORDSTOWN	NORWOOD	JANESVILLE	FRAMINGHAM	TARRYTOWN	LINDEN	FAIRFAX	ST. LOUIS	LEEDS	BALTIMORE	WILMINGTON	LAKEWOOD	DORAVILLE	ARLINGTON	FREMONT	VAN NUYS	SOUTH GATE
1969																							
PONTIAC			*									*	*							*			*
OLDSMOBILE F85					*																*		
BUICK SPECIAL				*								*			*		*				*		
CHEVROLET	*			*			*		*		*			*			*		*	*		*	*
CHEVELLE			—							*					*	*		*			*		
NOVA						*																	
CAMARO								*														*	
1972																							
CHEVROLET									*		*			*			*		*				*
CHEVELLE															*	*				*		*	
LE MANS			*							*								*			*		
MONTE CARLO															*	*				*		*	
1977																							
PONTIAC			*										*										
BUICK SKYLARK						*					*				*							*	
CHEVROLET									*					*									*
CHEVELLE															*	*			*	*	*		
LE MANS			*													*		*					
MONTE CARLO															*	*			*	*	*		

Source: Ward's Automotive Yearbook, 1970, 1973, 1978; Automotive News Almanac Issue, 1970.

CHAPTER VIII

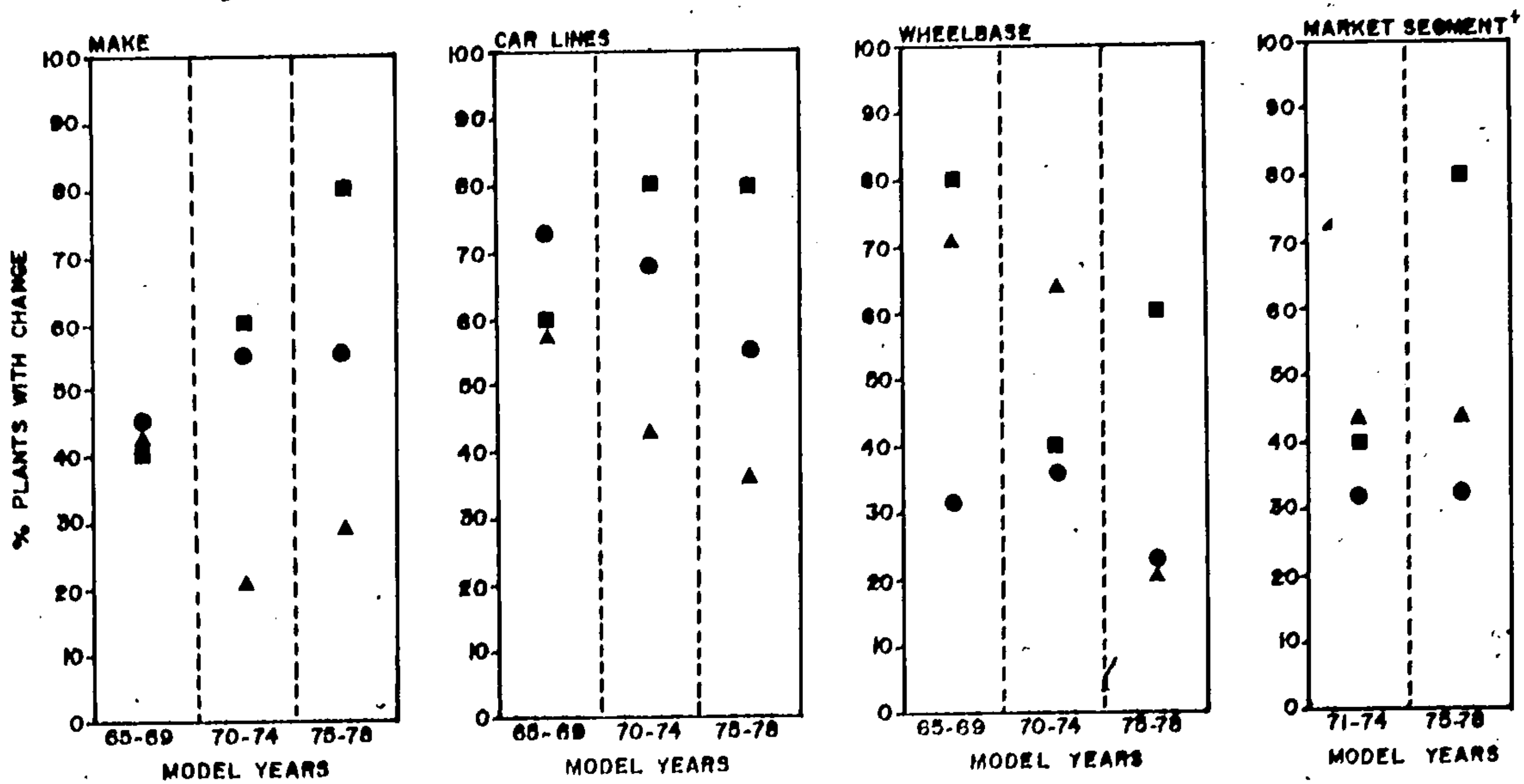
PRODUCT CHANGE IN AUTOMOBILE ASSEMBLY PLANTS

Products assigned to plants seldom remain unaltered for any significant time period, a point noted earlier. This chapter attempts to reveal a number of features relating to product change in automobile assembly plants. Of particular importance are three principal questions: first, what is the pace and nature of product change in Big Three assembly plants? Second, what circumstances lead to plant product change, particularly the role of plant and product turnover and output fluctuations of individual car lines? Third, what are some geographic consequences of plant product mandate changes?

The Pace of Product Change

During periods as brief as four or five years, an assembly plant may produce a wide-ranging number of car makes, lines, and wheelbases and cars for various market segments. The frequency of product change will be considered from the evidence for twenty-two GM, fourteen Ford and five Chrysler plants, which have assembled cars continuously since 1965 and which have either increased or reduced the number of makes, lines and wheelbases during three periods, 1965-69, 1970-74 and 1975-78. Data on changes in market segments were available only during the latter two periods (Figure 20). The sample of plants, which includes eighty per cent of all Big Three and eighty-eight per cent, seventy-eight per cent and sixty-three per cent of GM, Ford and Chrysler plants respectively,

Figure 20: Plant Product Change: Make, Car Line, Wheelbase and Market Segment



PLANTS
GM ●
Ford ▲
Chrysler ■

PLANT SAMPLE
GM 22
Ford 14
Chrysler 5

Selected plants have been operating since 1965.

+ Data prior to 1971 not available.

Source: <u>Ward's Automotive Yearbook</u>, various years.

suggests that the proportion of plants with some type of change over relatively short periods is indeed quite substantial, particularly for the smaller firms. Over half the Ford and Chrysler plants sampled either increased or dropped the number of car makes during the periods 1970-74 and 1975-78 and between a fifth and a third of GM plants did likewise. That the proportion of Big Three plants adding or dropping car lines is generally higher than that for car makes, wheelbase and market segments is not unexpected since car lines are subject to regular changes in design and are frequently discontinued or substituted by new lines, an important component of marketing strategy.

More surprising, perhaps, is that wheelbase dimension, does not constitute a serious constraint on product change. Further, the allocation of cars into four wheelbase classes tends, however, to understate the dimensions of change. A plant which switches from one wheelbase class to another without altering the number of classes, obscures a shift in production emphasis from cars of one weight and size to another. GM's Tarrytown plant, for instance, shifted from assembly of full-size vehicles from 1971 to 1974 to compact cars for the duration 1975-78. Though the plant produced only cars from one wheelbase for each of the periods identified, the plant was nevertheless retooled to assemble cars of a different wheelbase size. Similar shifts were experienced, for example, at Fairfax (1975-78) and Kansas City (1975-78).

The aggregate measures of change over, a period lasting four to five years obscure the fact that there may be substantial changes even within shorter periods such as from one year to the next. ~~Two~~ plants which illustrate this point are GM's Van Nuys plant located near Los Angeles and Chrysler's St. Louis plant in Missouri (Table 33). At Van

TABLE 33

LINE CHANGES IN TWO ASSEMBLY ~~PLANTS~~, MODEL YEARS 1965-1978

CAR LINES	MODEL YEAR													
	65	66	67	68	69	70	71	72	73	74	75	76	77	78
<u>VAN NUYS</u> <u>(GENERAL MOTORS)</u>														
CHEVROLET	*	*	*	*	*									
CORVAIR	*	*												
CAMARO			*	*	*	*	*					*	*	*
FIREBIRD				*	*	*	*							*
CHEVELLE						*	*	*						
MONTE CARLO						*	*	*						
NOVA								*	*	*	*	*	*	
VENTURA								*	*	*	*	*	*	
OMEGA								*	*	*	*	*	*	
APOLLO/SKYLARK									*	*	*	*	*	
<u>ST. LOUIS</u> <u>(CHRYSLER)</u>														
VALIANT	*	*							*	*	*	*		
BARRACUDA	*													
DART	*	*							*	*	*	*		
BELVEDERE	*	*	*	*	*	*								
CORONET	*	*	*	*	*	*	*	*	*	*	*	*		
CHARGER				*	*	*	*							
SATELLITE								*	*	*	*			
FURY												*	*	
VOLARE													*	
ASPEN													*	
LE BARON													*	*
DIPLOMAT													*	*

Source: <u>Ward's Automotive Yearbook</u>, 1966-1979.

*Indicates year car line assembled.

Nuys in 1965 GM assembled two car lines. Over the fourteen years 1965-1978 it assembled a total of eleven different lines, although in 1978 it produced only two lines. Between 1965 and 1978, each year it produced usually from two to five lines. Three of the lines, which were introduced or re-introduced during that period but not in production in 1978, had a life span of six years; three lasted for five years and one for four years. Three other lines were produced for three consecutive years while one was produced for only a year. During the same fourteen-year period, Chrysler's St. Louis plant assembled a total of 12 car lines, but between two and five separate lines were assembled during single model years. In 1965, for example, the Valiant, Barracuda, Dart, Belvedere and Coronet were produced. In contrast two lines, the Diplomat and Le Baron were assembled during 1978. There is also a great contrast in the life span of individual lines produced at St. Louis. The Coronet, first assigned there in 1965, was sourced at St. Louis for twelve years. Other lines had life spans lasting six years (Belvedere), four years (Charger and Satellite) and two years (Fury). The Valiant and the Dart, first assigned to St. Louis in the early Sixties were withdrawn in 1966 but re-introduced in 1973.

Dynamic Product Differentiation, Assignment and Geography

Some spatial patterns and circumstances surrounding such changes will be the focus of the remainder of this chapter. The analysis will concentrate on car lines exclusively since car lines embody not only car make but also dimensions of size, design and market niche frequently associated with wheelbase and market segments. Car lines especially their design, internal and external dimensions, and nameplate are altered on a regular basis for reasons already indicated. In addition, entirely new car lines are added to replace discontinued or soon-to-be-discontinued lines or to complement and expand existing car lines.

New Car Lines

New and separate car lines include: (a) those produced to serve a market segment not previously sought by a firm; although such a line may be new to the firm, it is not necessarily new to the industry, (b) those introduced to expand the firm's product portfolio, and, (c) those designed specifically as replacements for soon-to-be-discontinued lines. Unlike cases involving nameplate changes, these new lines may be produced concurrently with those due to be replaced. The debut of a new, separate car line does not automatically coincide with the demise of another. Indeed, new products are usually assigned to plants where one or more car lines are already produced. Thus new lines generally constitute an addition to a plant's product portfolio (Table 34) often with no immediate disarrangment to the existing product-mix. At San Jose, for example, the Mustang line was added to the Falcon and Fairlane lines which were already produced there during the 1974 model year. Similar situations are found at Metuchen, St. Thomas and Lordstown. There are other cases, however, when existing lines were 'displaced' or assigned elsewhere, their removal possibly being necessary to accommodate new product lines. Such displacement seems most likely to occur when the output of new lines is substantially different from lines previously in existence--such as Belvidere's switch from full-size vehicles to the new front-wheel-drive subcompacts. However, from the available data there is little reason to suggest that

TABLE 34

DEBUT OF ENTIRELY NEW CAR LINES AND EFFECTS ON PLANT PRODUCT CHANGE

PLANT	CAR LINES	YEAR		DISPLACED CAR LINES
		63	64	
DEARBORN	FAIRLANE	•	•	METEOR
	METEOR	•		
	MUSTANG		•	
SAN JOSE	FALCON	•	•	NONE
	FAIRLANE	•	•	
	MUSTANG		•	
		66	67	
LORDSTOWN	CHEVROLET	•	•	NONE
	FIREBIRD		•	
VAN NUYS	CHEVROLET	•	•	CORVAIR
	CORVAIR	•		
	CAMARO		•	
BLOOMFIELD	BUICK	•		BUICK
	SPECIAL	•		SPECIAL
	CHEVROLET	•	•	
	CHEVELLE	•	•	
	CHEVY II	•	•	
	F-85	•	•	
	CORVAIR		•	
	TEMPEST		•	
	CAMARO		•	
NORWOOD	CHEVROLET	•		CHEVROLET
	CHEVY II	•		CHEVY II
	CAMARO		•	

PLANT	CAR LINES	YEAR		DISPLACED LINES
		70	71	
METUCHEN	MUSTANG	•	•	NONE
	PINTO		•	
SAN JOSE	MUSTANG	•		MUSTANG
	FAIRLANE	•		FAIRLANE
	PINTO		•	
ST. THOMAS	MAVERICK	•	•	NONE
	PINTO		•	
		70	71	
LORDSTOWN	CHEVROLET	•		CHEVROLET
	SPORTVAN		•	
	VEGA		•	
		77	78	
BELVIDERE	GRAN FURY	•		GRAN FURY
	ROYAL MONACO	•		ROYAL MONACO
	CHRYSLER	•		CHRYSLER
	OMNI		•	
	HORIZON		•	

Source: *Ward's Automotive Yearbook*; *Automotive Yearbook, Almanac Issue*, various years.

*Indicates year car line assembled.

Entirely new car lines are underlined.

the allocation of new car lines to plants usually displaces other lines; indeed as a later section suggests, to the extent displacement occurs, it may be the effect of output contraction and the reduction in number of plants to which the contracting line is assigned.

Assignment of New Car Lines and Plant Location

There is a body of theory based on the product life cycle which argues that new product lines in large corporations will be introduced at the corporate core area, for a variety of reasons. Frequently, the presence of external economies such as skilled production labour, and specialists who could be called upon to resolve rapidly problems arising from lack of standardization in new products and/or associated production processes, binds the manufacture of new products to the industrial core regions. Following broad consumer acceptance and standardization of product design and specifications and production techniques, actual manufacturing may then "filter-down" or be dispersed to non-core area plants, including foreign branches. A more recent theory pertaining to multinational product strategies suggests that the manufacture of new products may be non-core oriented from the start and in general new product manufacturing locations need not necessarily follow the geographic sequence outlined in the theory above. What then are the spatial dimensions of new car line assignment and assembly? In order to examine this proposition on product age and location, a list consisting of new car lines introduced since 1964 and their initial production sites was compiled (See Table 35). This list consists of the categories of new car lines referred to earlier (see page 218). A summary of the initial locations of those new lines by firms is presented in Table 36. New car

TABLE 35

NEW CAR LINES AND INITIAL ASSEMBLY LOCATIONS, MODEL YEARS 1964–1978[1]

FIRM	CAR LINE	MAKE	INITIAL OUTPUT	YEAR OF DEBUT	INDUSTRY REGION[2]				GEOGRAPHIC REGION[3]				
					IC	OC	IP	OP	W	NC	S	NE	Ca.
GENERAL MOTORS	TORONADO	OLDSMOBILE	40,963	1966	•								
	CAMARO	CHEVROLET	220,906	1967		•	•	•	•	•		•	
	FIREBIRD	PONTIAC	82,560	1967		•				•			
	ELDORADO	CADILLAC	17,930	1967	•					•			
	GRAND PRIX	PONTIAC	112,486	1969	•					•			
	MONTE CARLO	CHEVROLET	145,975	1970	•		••			••	•		
	VEGA	CHEVROLET	269,905	1971		•				•			
	ASTRE	PONTIAC	13,910	1973			•						•
	APOLLO	BUICK	32,793	1973		•		•	•	•			
	OMEGA	OLDSMOBILE	60,363	1975	•			•	•	•			
	SEVILLE	CADILLAC	16,355	1975	•					•			
	MONZA	CHEVROLET	143,459	1975			•	•	•				•
	STARFIRE	OLDSMOBILE	12,278	1975			•						•
	SKYHAWK	BUICK	15,768	1975			•						•
	SUNBIRD	PONTIAC	54,137	1976			•	•	•				•
	CHEVETTE	CHEVROLET	187,830	1976			•				•		
	ACADIAN	PONTIAC	7,523	1976			•				•		
					6	4	10	5	5	11	3	1	5
CHRYSLER	BELVEDERE	PLYMOUTH	159,535	1965			•	•	•	•			
	CORONET	DODGE	209,393	1965	•	•	•		•	••			
	CHARGER	DODGE	288,186	1966	•					•			
	CHALLENGER	DODGE	83,032	1970	•			•	•	•			
	CORDOBA	CHRYSLER	131,746	1975	•								•
	ASPEN	DODGE	219,389	1976	•					•			
	VOLARE	PLYMOUTH	291,959	1976	•					•			
	LE BARON	CHRYSLER	54,851	1977			•			•			
	DIPLOMAT	DODGE	37,553	1977			•			•			
	OMNI	DODGE	81,611	1978		•				•			
	HORIZON	PLYMOUTH	106,772	1978		•				•			
	MAGNUM XE	DODGE	25,511	1978		•							•
					5	5	4	2	3	11	–	–	2
FORD	COUGAR	MERCURY	150,893	1967	•					•			
	MARK III	LINCOLN	7,770	1968	•					•			
	MAVERICK	FORD	48,619	1969			•			•			
	COMET	MERCURY	83,000	1971			•			•			
	PINTO	FORD	309,292	1971		•	•	•	•			•	•
	BOBCAT	MERCURY	38,650	1975			•					•	
	ELITE	FORD	123,372	1975		•				•			
	GRANADA	FORD	302,649	1975	•		•			•		•	
	MONARCH	MERCURY	103,936	1975	•		•			•		•	
	VERSAILLES	LINCOLN	15,434	1977	•					•			
	FAIRMONT	FORD	524,467	1978		•	••	•		•	•	•	•
	ZEPHYR	MERCURY	152,732	1978		•	••			•		•	•
					5	4	10	2	1	10	1	6	3

Source: Ward's Automotive Yearbook; Automotive News Almanac Issue/Market Data Book Issue, various years

[1]Includes those introduced as separate or entirely new car lines. Excluded are nameplate changes to existing lines, i.e., those lines with no production overlap.

[2]Industry Region: IC – Industry Core; OC – Outer Core; IP – Inner Periphery; OP – Outer Periphery.

[3]Geographic Region: W – West; NC – North Central; S – South; NE – Northeast; Ca. – Canada.

*Symbol indicates one plant in Industry or Geographic Region.

TABLE 36

NEW CAR LINES AND INITIAL ASSEMBLY LOCATIONS: SUMMARY

FIRM	CAR LINES AND PLANT LOCATION	INDUSTRY REGION IC	OC	IP	OP
GM	Number of Car lines with plants in:	6	4	9	5
(17)[1]	Percentage of Car Lines with plants in:	35	24	53	29
Chrysler	Number of Car Lines with plants in:	5	5	4	2
(12)	Percentage of Car Lines with plants in:	42	42	33	17
Ford	Number of Car Lines with plants in:	5	4	8	2
(12)	Percentage of Car Lines with plants in:	42	33	67	17
Big Three	Number of Car Lines with plants in:	16	13	21	9
(41)	Percentage of Car Lines with plants in:	39	32	51	22
GM	Number of single-plant Car Lines produced in:	4	2	5	-
(11)[2]	Percentage of single-plant Car Lines produced in:	36	18	46	-
Chrysler	Number of single-plant Car Lines produced in:	3	4	2	-
(9)	Percentage of single-plant Car Lines produced in:	33	44	22	-
Ford	Number of single-plant Car Lines produced in:	3	1	3	-
(7)	Percentage of single-plant Car Lines produced in:	43	14	43	-
Big Three	Number of single-plant Car Lines produced in:	10	7	10	-
(27)	Percentage of single-plant Car Lines produced in:	37	26	37	-
GM	Number of multiple-plant Car Lines produced in:	2	2	4	5
(6)[3]	Percentage of multiple-plant Car Lines produced in:	33	33	67	83
Chrysler	Number of multiple-plant Car Lines produced in:	2	1	2	2
(3)	Percentage of multiple-plant Car Lines produced in:	66	33	66	66
Ford	Number of multiple-plant Car Lines produced in:	2	3	5	2
(5)	Percentage of multiple-plant Car Lines produced in:	40	60	100	40
Big Three	Number of multiple-plant Car Lines produced in:	6	6	11	9
(14)	Percentage of multiple-plant Car Lines produced in:	43	43	78	64

Source: Table 35.

[1]New car lines sourced initially at a single or multiple plants.

[2]New car lines sourced initially at one plant.

[3]New car lines sourced initially at two or more plants.

IC—Industry Core; OC—Outer Core; IP—Inner Periphery; OP—Outer Periphery.

lines are further distinguished by the number of plants (single or multiple) in which initial assembly takes place. Consider first all car lines which were produced in either single or multiple plants and their distribution by industry region. For the Big Three as a whole, more new car lines are produced in the inner periphery (fifty-one per cent) than either the industry core (thirty-nine per cent), the outer core (thirty-two per cent) or outer periphery (twenty-two per cent). At Ford, sixty-seven per cent of the new lines are sourced at inner periphery plants in contrast to forty-two per cent and thirty-three per cent from the industry and outer core areas, respectively. Like Ford, most new GM lines are also sourced from the inner periphery (fifty-three per cent) with a smaller proportion from the two core areas. Unlike the other firms, however, nearly a third of new lines were produced initially at plants located in the outer periphery. Chrysler also deviates from the industry's patterns in general in that a larger proportion of new lines is sourced at each of the two core regions (forty-two per cent) and only a third comes from the inner periphery. Overall there appears to be some geographic preference for producing new car lines initially at the inner periphery. After the inner periphery, the preferred region is the industry core.

For lines which were sourced initially from one plant only, an equal percentage (thirty-seven per cent) was assigned to plants in the industry core and inner periphery, whereas twenty-six per cent were sourced initially in the outer core. None was sourced at the outer periphery. As for individual firms, however, GM's most important initial source of new cars was again the inner periphery, followed by the industry and outer core area, respectively. For Chrysler the major locational source was the outer core where forty-four per cent of all new car lines introduced from 1965 to 1978 were initially produced. Both the industry core and immediate periphery were attractive to an equal degree for new Ford lines during the same period. However, the two core areas collectively, formed the major initial location for new car lines. Over sixty per cent of all new Big Three car lines was produced there upon introduction. For lines which were sourced in two or more plants initially, there seems to be a tendency on the part of the firms to choose locations in the inner periphery and the outer periphery. However, for three lines--the Monte Carlo, Fairmont and Zephyr--assembly was performed in two separate plants in the inner periphery.

Evidently North American automobile firms do not behave in the fashion predicted by product cycle theory. Plants located in the periphery have as much, and perhaps even a greater, chance of being assigned the production of new car lines as core plants.

In automobile assembly there may be a number of reasons associated with this non-core orientation of the initial production of new car lines. New car lines, for instance, rarely represent dramatic departures in product and production technology. Rather, incremental innovation is more characteristic of the industry. Further, a substantial proportion of the innovations come from independent parts and machinery equipment manufacturers, many of whom are within the core area. Presumably, much of the technical uncertainties surrounding new products would have been reduced by the time they are assembled in new cars, following elaborate testing, which itself may of course be predominantly done at the core. As a result there is really little need to produce such lines at the core area in proximity to specialists skilled in testing and problem-solving. Individual firms may have different means to minimize potential production problems--though not necessarily product-related defects. For example, at Allen Park, Michigan, Ford operates a pilot assembly plant which is designed primarily to undertake pilot assembly and to identify and correct potential production problems.

Assignment of New Car Lines and Canadian Plants

What has been the Canadian experience with new product assignments? In our review of multinational corporate product strategies, it was indicated that there are two major views regarding the manufacturing diffusion of new product lines. The product life cycle theory suggests that only mature, standardized products are produced in foreign branch plants. A more recent and opposing view argues that new product lines may as readily be introduced in a foreign location. They may even be produced abroad initially and imported into the parent country.

Table 37 lists the car lines which have been introduced in Canada since 1965, the model year first assigned to a Canadian plant, the year when those car lines were first introduced and the lapse in years from the time when a line made its American debut and when it was assembled in Canada. (For several lines, unfortunately, it has not proved feasible to determine the year they were assigned to Canadian plants.)

Generally, on the basis of the time lapse measured from the year when the new models were introduced and when they were assigned to Canadian plants, our evidence indicates that the further back in time a line was introduced, the longer it took before the line was produced in Canada. This lapse has how diminished quite considerably especially for new car lines introduced in the past decade. The number of new lines produced simultaneously in U.S. as well as Canadian plants at the time

TABLE 37

THE TIMING OF NEW CAR LINE ASSIGNMENT TO CANADIAN ASSEMBLY PLANTS SINCE 1965

CAR LINE	MODEL YEAR NEW LINE INTRODUCED	MODEL YEAR ASSIGNED TO CANADIAN PLANT	TIME LAPSE IN YEARS	PRODUCTION
GENERAL MOTORS				
CAMARO	1967	1969	2	Small quantity produced at Oshawa, 1969, 1970 and 1974.
SPECIAL	1961	1969	8	Produced at Oshawa 1969-70 and discontinued.
TEMPEST	1961	1970	9	Produced at Oshawa since 1970.
NOVA	1970	1970	-	Small quantities and intermittent assembly at Oshawa; Chevy II, predecessor to Nova was assembled at Oshawa by mid-1960's.
MONTE CARLO	1970	1971	1	Produced at Oshawa since 1971.
VEGA	1971	1973	2	Produced at Ste. Thérèse until 1974.
ASTRE	1973	1973	-	Produced at Ste. Thérèse 1973-74.
MONZA	1975	1975	-	
SKYHAWK	1975	1975		Produced at Ste. Thérèse until 1977 after which lines were reassigned in Lordstown, Ohio.
STARFIRE	1975	1975		
SUNBIRD	1976	1976		
CUTLASS	1972	1978	6	Assembled at Ste. Thérèse.
FORD				
TORINO	1968	1969	1	Assembled at Oakville to present; Torino since replaced by LTD II.
MAVERICK	1969	1969	-	Produced at St. Thomas to 1977; since replaced by Fairmont.
MUSTANG	1964	1969	5	Small quantities produced 1969-73.
PINTO	1971	1971	-	Production at St. Thomas, 1971-77.
FAIRMONT	1978	1978	-	Replaced Maverick line at St. Thomas.
ZEPHYR	1978	1978	-	Production at St. Thomas; shares identical body with Fairmont.
CHRYSLER				
DART	1960	1969	9	Produced at Windsor until 1975.
SATELLITE	1971	1971	-	Production discontinued at end of 1974 model year.
CORDOBA	1975	1975	-	Production continues to present; Windsor—exclusive source.
CHARGER S.E.	1966	1975	9	Shares common body with Cordoba.
MAGNUM	1978	1978	-	Shares common body with Cordoba and Charger.

Source: Ward's Automotive Yearbook, Automotive News Almanac Issue/Market Data Book Issue, Motor Vehicle Manufacturers' Association of Canada, various years.

of introduction has increased. Moreover, the entire line of GM's new subcompact cars--the Monza, Skyhawk, Starfire and Sunbird--was assembled exclusively in Canada when first introduced in 1975 and 1976 before they were reassigned to Lordstown, Ohio. More importantly, there are only a few new lines, such as Chrysler's Cordoba, Charger and Magnum in particular, which are sourced exclusively from one of the company's Canadian plants. As far as the 1970's are concerned, this particular evidence suggests that Canadian plants of the Big Three are assessed no differently than U.S. plants in the assignment of new car lines.

Discontinuation of Car Lines and Plant Product Change

Car lines, as noted earlier, are like other consumer products in that they go through a typical life cycle which is occasionally extended by design alterations and nameplate changes. In some instances, they are pulled from the market when sales are no longer viable. The life span of some car lines like the Corvair has of course been ended abruptly, following disputes over performance and adverse national publicity resulting from consumer advocate Ralph Nader's allegation that it was unsafe. Others, like the Vega and its sister line the Astre, were eventually withdrawn from the market because of a generally poor mechanical performance and declining sales. The Edsel was an example of a major marketing mistake, a car introduced into the market at the wrong time when it had insufficient appeal for consumers. It died a natural death when production was stopped after only four years of production, from 1957 to 1961.

Does discontinuation of car lines affect product change in plants through a reduction in the number of lines in those plants which once carried the discontinued lines? Table 38 documents such effects. The excess capacity made available because of the removal of lines is not necessarily utilized by other lines assigned to replace the discontinued line, as is evident in the cases of Willow Run, Hamtramck, Newark Jefferson Avenue, Kansas City and Chicago. Removal of the discontinued line may also contribute to or trigger the withdrawal of other lines, especially if the latter share common body configurations, as was the case of the Falcon and Fairlane at Kansas City, and the Elite and Torino at Chicago. In other instances, however, the removal of discontinued lines paved the way for the introduction of other car lines which were generally designed as eventual replacements for the discontinued series. This development is evident at Lordstown where the subcompact Monzas and Sunbird were phased in during the final model year for the Vega and Astre. In the following year, production for both the Sunbird and Monza was enormously increased and two complementary lines, the Skyhawk and Starfire, were added. At Chrysler's St. Louis and Newark plants, similar strategies were evident following the withdrawal of the popular Valiant and Dart lines. The Aspen and Volare, two lines which were developed shortly prior to the discontinuation of the Dart and Valiant lines, were phased into St. Louis and Newark to substitute for the latter two lines. At St. Louis, the Le Baron and Diplomat, two luxury lines, and derivatives of the Aspen and Volare were also produced. Finally, removal or withdrawal of a discontinued line clears the way for retooling of affected plants to accommodate a new line of cars which complement lines already in place (the Cougar and Torino/LTD II at Lorain) or which share little or no common design traits (the Comet/Montego and Maverick lines at Kansas City).

TABLE 38

DISCONTINUED CAR LINES AND EFFECTS ON PLANT PRODUCT CHANGE

DISCONTINUED LINE & F.M.Y.[1]	ASSEMBLY PLANT[2]	LINES ASSEMBLED	YEAR BEFORE F.M.Y.	F.M.Y.	YEAR AFTER F.M.Y.
CORVAIR; 1969	WILLOW RUN	CHEVY II/NOVA	187,263	258,728	315,122
		CORVAIR	15,399	6,000	-
		TOTAL	202,662	264,728	315,122
VEGA; 1977 ASTRE; 1977	LORDSTOWN	VEGA	160,592	78,402	-
		ASTRE	50,384	32,788	-
		SPORTVAN	23,332	37,595	30,696
		SUNBIRD		7,014	86,769
		MONZA		6,230	138,829
		SKYHAWK			59,700
		STARFIRE			17,321
		TOTAL	234,308	162,009	333,335
FALCON; 1970	KANSAS CITY	MAVERICK	48,618	210,885	145,371
		FAIRLANE	75,872	-	-
		FALCON	38,775	15,694	-
		COMET, MONTEGO	-	-	83,000
		TOTAL	163,265	226,579	228,371
	LORAIN	FALCON	32,383	29,290	
		FAIRLANE	118,619	115,915	115,895
		COMET, MONTEGO	117,421	103,873	57,094
		CLUB WAGON			57,056
		TOTAL	268,423	249,078	230,045
ELITE: 1976	CHICAGO	TORINO	13,491	18,844	-
		ELITE	123,372	146,475	-
		THUNDERBIRD	-	-	235,884
		TOTAL	136,863	165,319	235,884
COMET/MONTEGO: 1976	LORAIN	TORINO/ELITE	123,112	124,309	170,993
		COMET/MONTEGO	65,180	51,095	-
		COUGAR	-	-	70,024
		TOTAL	188,292	175,404	241,017
BARRACUDA: 1974 CHALLENGER: 1974	HAMTRAMCK	VALIANT	297,345	260,856	169,902
		DART	159,180	135,482	118,349
		BARRACUDA	22,213	11,734	-
		CHALLENGER	32,596	16,437	-
		TOTAL	511,334	424,509	288,251
IMPERIAL: 1975	JEFFERSON AVE.	CHRYSLER	109,179	94,789	75,711
		IMPERIAL	14,426	8,830	-
		TOTAL	123,605	103,619	75,711
VALIANT; 1976 DART; 1976	ST. LOUIS	VALIANT	24,437	61,770	-
		DART	17,159	43,975	-
		FURY	54,105	12,640	-
		CORONET	29,139	10,476	-
		VOYAGER	13,603	10,819	19,395
		SPORTSMAN	47,215	39,679	66,259
		VOLARE	-	-	52,830
		ASPEN	-	-	37,725
		LE BARON	-	-	54,851
		DIPLOMAT	-	-	37,553
		TOTAL	185,748	179,299	268,613
	NEWARK	VALIANT	46,534	24,000	-
		DART	48,421	24,589	-
		VOLARE		87,467	122,555
		ASPEN		67,633	103,880
		TOTAL	94,955	203,689	226,435

Source: Ward's Automotive Yearbook, various years.

[1]F.M.Y.—Final Model Year refers to the final year car line was produced before assembly ceased completely.

[2]Only assembly plants which produced the discontinued car line during its final model year are listed.

Discontinued Car Lines and Final Assembly Locations

Table 39 shows eleven different GM, Ford and Chrysler car lines which have since been discontinued and their final assembly locations by industry region. A total of ten plants, two GM, four Ford and four Chrysler plants, produced car lines which were dropped from the industry between the 1969 and 1977 model years. Of these ten plants, three (one GM and two Chrysler) were in the industry core, four were situated in the outer core (Lordstown, Oakville, Chicago and Lorain) and three others were in the inner periphery (Kansas City, St. Louis and Newark). The evidence indicates that car lines, in their final stages of their life cycle are usually produced in core area plants and to a lesser extent, peripheral plants.

Nameplate Change

Dynamic product differentiation may involve a change 'only in name' and little else, or there may be a substantial redesign of the entire car; its components and dimensions. Generally, nameplate changes alone are not accompanied by changes in plant product-mix. A car with a new nameplate is most frequently assembled in the same plant which produced the predecessor line. Product change under these circumstances is largely superficial and mainly in name, although the product itself may have undergone extensive design, weight and size alterations.

Changing Volume and Location

The foregoing analysis revealed the link between car line introduction, withdrawals and nameplate changes, plant product-mix and geography. What other factors trigger plant product-mix changes and what is the

TABLE 39

DISCONTINUED CAR LINES AND AFFECTED PLANTS

DISCONTINUED CAR LINES	FINAL MODEL YEAR	PLANTS ASSEMBLING DISCONTINUED LINES DURING FINAL MODEL YEAR	INDUSTRY REGION IC	OC	IP	OP
GENERAL MOTORS						
CORVAIR	1969	WILLOW RUN	*			
VEGA; ASTRE	1977	LORDSTOWN		*		
FORD						
FALCON	1970	KANSAS CITY: LORAIN; OAKVILLE		**	*	
ELITE	1976	CHICAGO		*		
COMET/MONTEGO	1976	LORAIN		*		
CHRYSLER						
CHALLENGER; BARRACUDA	1974	HAMTRAMCK	*			
VALIANT; DART	1976	ST. LOUIS; NEWARK			**	
IMPERIAL	1975	JEFFERSON AVENUE	*			

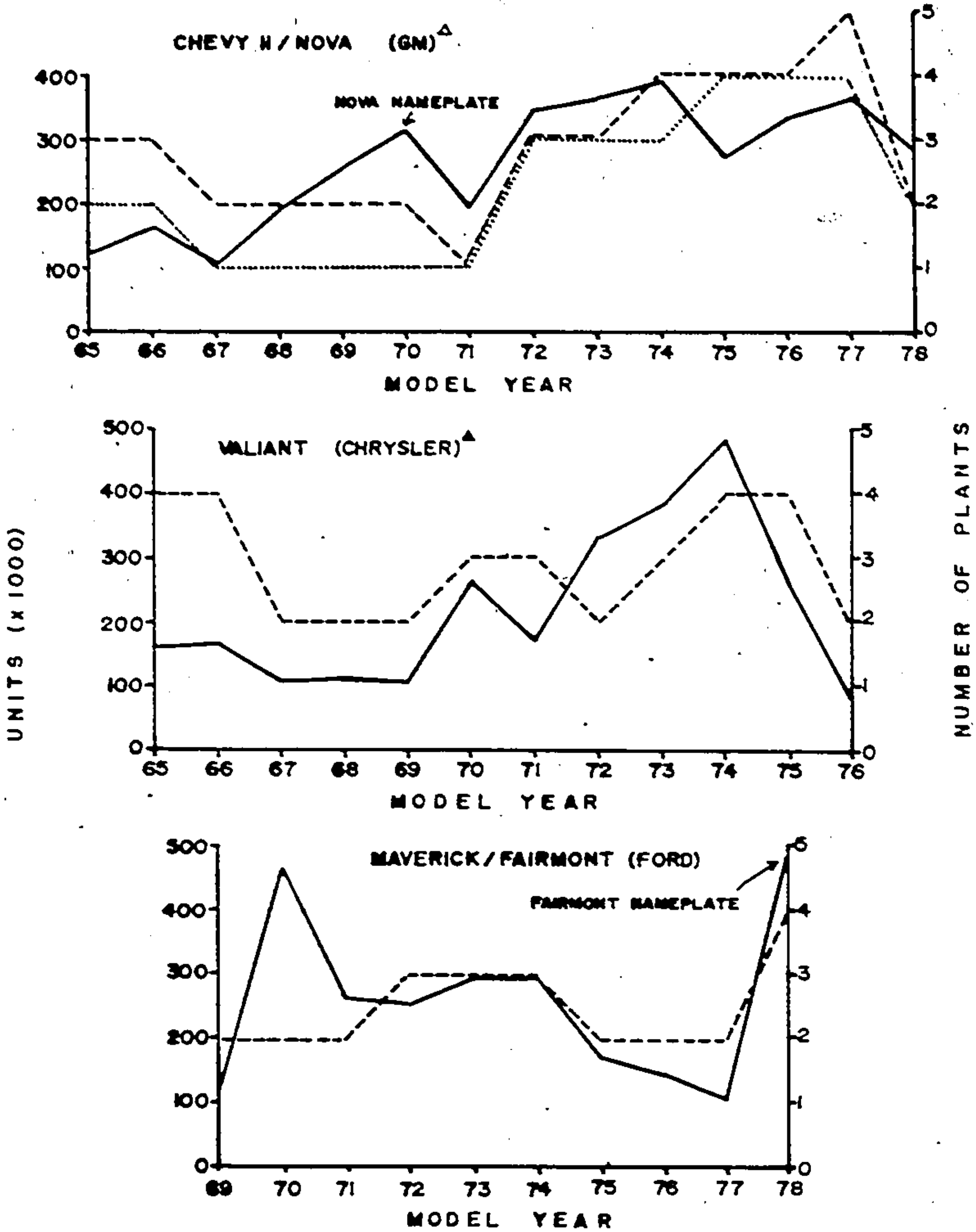
Source: Ward's Automotive Yearbook; Automotive News Almanac Issue/Market Data Book Issue, various years.

IC--Industry Core; OC--Outer Core; IP--Inner Periphery; OP--Outer Periphery.

geography of this change? Our review of the theoretical literature suggests that perhaps the most pervasive factor yet is the effect of the shifting popularity of models which is the main factor contributing to temporal variations in the output of individual car lines. In particular, the life cycle of a product is characterized by periods of increasing, peak or declining sales. Given the shifts in sales, which are ultimately reflected in output volume because the principal firms are known to produce on the basis of what dealers order (Meadows, 1979, 55), and the presence of product-, plant- and firm-related scale economies, the number of plants in which a product line is made is a function of output volume. Further, the manufacture of a product during periods of high projected output will be allocated to a larger number of plants including those which are geographically decentralized, such as in the peripheral regions. A decline in output will be characterized by a gradual withdrawal of production from several dispersed plants and concentration of manufacturing activities in fewer, perhaps only one centrally located facility. The relevance of these points to automobile assembly are examined below.

Increases or decreases in car line output may be substantial and occur sometimes rather dramatically over a short period of a year or two from one model year to the next. As output expands or shrinks, there is usually a corresponding change in the number of sourcing plants as indicated by the cases of three popular compact models (Figure 21). This relationship, however, is not perfect and there is frequently a lapse between increases or decreases in output and sourcing from more or fewer plants respectively. Nameplate changes are normally associated with production increases hence there is better anticipation in terms of the decision to source the line from the appropriate number of plants. Most

Figure 21: Output and Number of Sourcing Points: Selected Compact Lines, 1965-78 Model Years



——— Output (Left Scale)

– – – – Plants, including Canadian (Right Scale)

·········· Plants, excluding Canadian

△Canadian output excluded.

▲1965 Canadian output not available.

Source: Word's Automotive Yearbook, Automotive News Almanac Issue, various years.

common is a lag in sourcing as increases in the number of sourcing points usually trails initial increases in output. Likewise a decrease in the number of plants tends to come after a production decline has already set in. It takes a model year, normally, for the appropriate response to come into effect, but by then market conditions may have steered production in a different direction. Such uncertainty over market prospects is obviously a major factor complicating corporate assignment, withdrawal and perhaps reassignment decisions for individual car lines to certain plants.

Generally, there is uncertainty over the duration for which any car line will be assigned to a particular plant. For the individual car line, however, there is normally one plant which is assigned uninterrupted production of the line while other plants may produce the same line intermittently or when output warrants their function as sourcing points. The example of Ford's Mustang production and sourcing points provides a good indication of this behaviour. Over a fifteen-year period the Dearborn plant was the main source of Mustangs each year (Table 40). San Jose was also a source in all but three years, 1971-73. Metuchen, a third source, built the car only for seven consecutive model years, 1965 to 1971. This Mustang case appears representative of many other individual lines not only from Ford but also from GM and Chrysler. That a decline (or increase) in output corresponds to a focus of production at fewer (or more) plants raises the question of where sourcing points are most likely to be situated under conditions of declining production or increasing output.

Is there any distinct association discernable between output changes and location? The data presented in Table 41 is an attempt to shed some light on this question. Information provided in the Table

TABLE 40

FORD MUSTANG PRODUCTION AND SOURCING POINTS, MODEL YEARS 1964-1978

MODEL YEAR	U.S. PRODUCTION	SOURCING POINTS*					
		DEARBORN (MICHIGAN)		METUCHEN (NEW JERSEY)		SAN JOSE (CALIFORNIA)	
		MUSTANG	OTHER LINES	MUSTANG	OTHER LINES	MUSTANG	OTHER LINES
1964	121,538	117,832	Fairlane	-	Falcon, Comet	3,706	Fairlane, Falcon
1965	559,451	356,958	-	69,193	Falcon, Comet	133,300	-
1966	607,568	282,639	Falcon	183,775	-	141,154	-
1967	472,121	132,094	Cougar	199,546	-	140,481	-
1968	317,404	119,589	Cougar	125,879	-	71,936	Cougar
1969	299,824	125,310	Cougar	118,228	-	56,282	Cougar, Fairlane
1970	190,727	105,735	Cougar	68,484	-	16,508	Fairlane
1971	149,678	129,566	Cougar	20,112	Pinto	-	Pinto
1972	125,093	125,093	Cougar, Comet Maverick	-	Pinto	-	Pinto
1973	134,867	134,867	Cougar, Comet Maverick	-	Pinto	-	Pinto
1974	385,993	349,309	-	-	Pinto	36,684	Ford
1975	188,575	164,594	-	-	Pinto, Bobcat	23,981	Pinto
1976	187,567	162,711	-	-	Pinto, Bobcat	24,856	Pinto, Bobcat
1977	153,173	131,016	-	-	Pinto, Bobcat	22,157	Pinto, Bobcat
1978	192,410	174,165	-	-	Pinto, Bobcat	18,245	Pinto, Bobcat

Source: Ward's Automotive Yearbook, 1965-79.

*Oakville exclude, production negligible.

TABLE 61

LOCATION OF SOURCING POINTS FOLLOWING MODEL YEAR OF LOWEST AND HIGHEST OUTPUT, 1965–78[a]

FIRM	CAR LINE[d]	LOWEST OUTPUT MODEL YEAR	LOWEST OUTPUT NUMBER OF UNITS	SOURCING POINTS (INDUSTRY REGION) LOWEST OUTPUT EC	CC	SP	CP	HIGHEST OUTPUT EC	CC	SP	CP	HIGHEST OUTPUT NUMBER OF UNITS	HIGHEST OUTPUT MODEL YEAR
GENERAL MOTORS[b]	VEGA	1977	78,400		1				2	1	1	395,300	1973
	CORVETTE	1970	17,300			1				1		49,200	1977
	CHEVY II/NOVA	1967	106,400	1				1		2	1	391,300	1974
	CHEVELLE/MALIBU	1977	230,900			1	3	1	1	2	2	439,600	1969
	MONTE CARLO	1971	112,600			2	2			2	3	374,300	1977
	CAMARO	1972	68,700		1				1		1	272,600	1978
	CORVAIR	1969	6,000	1				1			1	206,700	1965
	CHEVROLET	1976	334,000		1	1	1	1	3	3	5	1,647,600	1965
	VENTURA/PHOENIX	1975	66,300	1		1	1	1			1	96,300	1973
	FIREBIRD	1972	29,300		1				1		1	187,300	1978
	TEMPEST/LE MANS	1977	69,900	1		2		1		1	1	359,100	1966
	GRAND PRIX	1971	53,300	1			1	1			1	288,400	1977
	PONTIAC	1975	125,600	1		1		1		2	3	495,000	1965
	OMEGA	1975	41,300	1			1	1				64,000	1977
	F-85/CUTLASS	1965	272,300				1	1		1	2	632,700	1977
	TORONADO	1967	21,300	1				1				56,200	1973
	OLDSMOBILE	1974	208,300	1		2		1		2		477,300	1973
	APOLLO/SKYLARK	1973	32,300			1	1	1		2	1	116,500	1976
	SPECIAL/SKYLARK/CENTURY	1975	153,500	1		2	1	1		1	1	325,300	1977
	RIVIERA	1975	17,300	1				1				52,900	1964
	BUICK	1975	217,300	1		2		1		2	1	453,300	1973
	ELDORADO	1967	17,900	1				1				49,200	1976
	CADILLAC	1977	161,200	1		1		1		1		256,100	1977
TOTAL GENERAL MOTORS				14	4	17	12	15	3	27	23		
FORD[c]	PINTO	1978	183,900			1	1		1	1	1	550,000	1974
	MUSTANG	1972	125,100	1				1		1	1	607,600	1966
	MAVERICK/FAIRMONT	1977	109,900		1	2	1		1	2		481,300	1978
	FALCON	1967	110,100		1				1			42,200	1965
	FAIRLANE/TORINO/LTD II	1978	175,100		1		1		2		1	500,900	1972
	FORD	1978	324,000		1	1	1	1	2	1	3	1,040,300	1966
	THUNDERBIRD	1977	36,100	1	1		1		1		1	352,300	1978
	COMET/MONARCH	1975	51,100		1				1		1	165,100	1965
	COUGAR/XR7	1978	55,700	1					1			213,300	1978
	MONTEGO/CYCLONE	1977	21,500		1	2			1	1		156,100	1978
	MERCURY	1975	73,300			1		1		1		181,700	1965
	LINCOLN	1977	35,600	1				1				95,600	1977
	MARK III/IV/V	1962	7,800	1				1				80,300	1977
TOTAL FORD				3	6	7	5	5	11	10	3		
CHRYSLER[b]	VALIANT	1976	35,700			2		1	1	2		482,100	1974
	BARRACUDA	1974	11,700	1				1				62,300	1967
	SATELLITE/BELVEDERE	1978	37,600	1				1	1	1		257,500	1973
	FURY/GRAND FURY	1975	50,800		1			1	2	1		430,400	1962
	DART	1976	70,800			2		1	1	2		554,000	1974
	CHALLENGER	1974	16,400	1				1				83,000	1970
	CORONET/MONACO	1975	54,900	1				1		1	1	250,500	1966
	POLARA/MONACO/ROYAL MONACO	1976	40,000		1				2			224,700	1966
	CHRYSLER	1978	53,500	1				1		1		264,900	1962
	IMPERIAL	1975	8,800	1				1				22,100	1969
TOTAL CHRYSLER				5	2	-	-	9	7	5	1		
GRAND TOTAL				25	12	22	17	32	26	45	34		

Source: Ward's Automotive Yearbook; Automotive News, Almanac Issue/Market Data Book Issue, various years.

[a]Number and location of sourcing points based on model year following that with the highest or lowest output.

[b]Includes Canadian sourcing points.

[c]Includes Canadian sourcing points.

[d]Only models which were on the market for five consecutive years between 1965 and 1978.

includes the model years indicating lowest and highest outputs for each car line and number and location of sourcing points one model year following the period of lowest and highest output. Comparing output and sourcing points one model year apart is based on the assumption that it takes at least a year to respond to changes in expected output levels.

As noted earlier in Chapter VI, the relationship between output and number of sourcing points is not strong in aggregate. For some car lines it is stronger than others, a feature which is also evident in our present analysis. There are situations in which a car line with a lower output is sourced from more plants than one with higher output. However, at the extremes very small or large outputs are normally sourced from one and multiple plants respectively. Generally, during a period of low production, lines tend to be sourced from fewer points, not infrequently one plant. With a few notable exceptions, like the Corvette, Cutlass and Mercury, single sources of an individual line are most frequently located at the industry core or outer core areas. At the time of lowest output, the number of single-plant GM lines located at the core area was four times those at the periphery; at Ford and Chrysler it was six and three times respectively.

At the peak of production, however, when car lines are sourced from several plants, it is usual to have one source plant located in the core area and the rest in the peripheral zones. While this broad observation is applicable for the aggregate of the 46 lines considered, it holds most strongly in the situation of General Motors, which had allocated seventy-eight per cent of its lines to plants in the industry core. For GM, however, the number of sourcing points located at the outer core is under-represented because of the omission of Canadian plants which was necessary as a result of incomplete production data. Most notable is the point that at the peak of output the number of core-oriented sourcing points is greater by fifty per cent than at the time of lowest output; however, the number of sourcing points in the inner periphery is sixty-one per cent greater and in the outer periphery just over one hundred per cent. Evidently, higher volumes are disproportionately to the advantage of the periphery, at least insofar as number of sourcing points is concerned.

According to our evidence, it does appear that core plants are more likely to retain the responsibility of producing those car lines when output level is low, but peripheral plants are usually deprived of making those same lines. During periods of high output, however, car lines are sourced from peripheral plants, in addition to those from the core.

Plant Turnover and Product-Plant Assignment

Consider now the situation of plant closures and some effects on car line allocation in the automobile industry. Since 1965, when there was a total of forty-eight plants, there have been only three plant closures: GM's Bloomfield plant ceased operation after the 1968 model year, Ford's Dallas plant in 1970 and Chrysler's Los Angeles facility in 1971. In addition, there were two plants which were converted to truck assembly--Chrysler's Jefferson Avenue plant in 1978 and Ford's Norfolk plant in 1974. Since assembly data for 1979 is not available, the consequences of the Jefferson Avenue plant's closure will not be considered further, although it seems that the car line Chrysler previously assembled at

Jefferson Avenue was reassigned to the other Detroit plant on Lynch Road, to replace the Plymouth Fury and Dodge Monaco lines which have been withdrawn from production.

Table 42 clearly indicates that plant closures have virtually no effect whatsoever upon the number of car lines in other Big Three plants. The number of other plants assembling the same lines previously allocated to the closed plant has remained the same in the year after the closure, with two exceptions. Following the closure of Bloomfield, Firebird cars were sourced at Norwood, besides Van Nuys and Lordstown. It is doubtful whether the closure of the New Jersey plant played much of a role in the assembly sourcing of Firebirds at Norwood since output of these cars during Bloomfield's final operating year was small. The production at Bloomfield could have been easily absorbed at Van Nuys or Lordstown. It seems surprising, however, that Norwood became the third source of Firebirds, 'replacing' Bloomfield, during a period when output of those cars was declining (Table 43). During the 1970 model year, Lordstown ceased to be an assembly source of Firebirds. It appears that the assignment to Norwood was undertaken to integrate the assembly of both the Firebird and Camaro, basically identical cars.

The closure of Bloomfield also concurred with a shift in the assembly of Tempest cars from Leeds, Missouri, to Lakewood, Georgia. This change in plants was probably not directly related to Bloomfield's closure, which had been anticipated for some time. Production allocated to several car lines each with a very low output towards the late Sixties signalled the plant's impending closure. The year after closure, 1969, also saw a significant decline in the output of Tempests. The change from Leeds to Lakewood may have been a response to other factors, perhaps

TABLE 42

PLANT CLOSURES/CONVERSIONS AND IMPACT ON CAR LINE ASSIGNMENT

PLANT & YEAR CLOSED	CAR LINE	NUMBER OF OTHER PLANTS TO WHICH LINE ASSIGNED*		PLANTS LISTED UNDER (A) AND (B) SIMILAR (YES/NO)△
		YEAR PRIOR TO CLOSURE (A)	FIRST YEAR OF CLOSURE (B)	
BLOOMFIELD 1968	CHEVY II	1	1	YES
	CAMARO	2	2	YES
	FIREBIRD	2	3	NO
	TEMPEST	6	6	NO
DALLAS 1970	FORD	8	8	YES
LOS ANGELES 1971	VALIANT	2	2	YES
	DART	2	2	YES
	SATELLITE	2	2	YES
	CORONET/CHARGER	2	2	YES
NORFOLK 1974▲	FORD	7	2	YES

Source: <u>Ward's Automotive Yearbook</u>; <u>Automotive News Almanac Issue/Market Data Book Issue</u>, various years.

*Excludes 'closed' or 'converted' plant.

△Plants prior to and after closure, similar.

▲Converted to truck assembly.

TABLE 43

FIREBIRD PRODUCTION AND PLANT ASSIGNMENT

MODEL YEAR	PRODUCTION	% OF PRODUCTION	VAN NUYS (OP/W)	LORDSTOWN (OC/NC)	NORWOOD (OC/NC)	BLOOMFIELD (IP/NE)
1967	82,560	1.10	-	82,560[Δ]	-	-
1968	107,112	1.30	12,148[c,*]	94,892[Δ]	-	72[c,*]
1969	87,708	1.10	21,366[c,*]	42,826[Δ]	23,516[c]	-
1970	48,739	0.60	11,524[c,*]	-	37,215[c]	-
1971	53,124	0.70	14,866*	-	38,258[c]	-
1972	29,951	0.30	-	-	29,951[c,*]	-
1973	46,313	0.50	-	-	46,313[c,*]	-
1974	73,729	0.91	-	-	73,729[c]	-
1975	84,068	1.28	-	-	84,063[c]	-
1976	110,775	1.37	-	-	110,775[c]	-
1977	155,736	1.71	-	-	155,736[c]	-
1978	187,285	2.09	90,272[c]	-	97,013[c]	-

Source: <u>Ward's Automotive Yearbook</u>, 1968-79.

[Δ]Firebird and Chevrolet.

[c]Firebird and Camaro.

*Firebird, Camaro and other lines.

<u>Industry Regions</u>: OC--Outer Core; IP--Inner Periphery; OP--Outer Periphery.

<u>Geographical Regions</u>: W--West; NC--North Central; NE--Northeast.

output and market shifts, rather than the closure, per se. Lakewood, however, assembled Tempests for only one model year, 1969, before the line was transferred again.

Since 1965, five new plants have been established: Lordstown, 1966; Belvidere, 1966; Ste. Thérèse, 1965; St. Thomas, 1967; and Oklahoma City, 1979. The four plants built during the mid-1960's were all located close to the core area of the automobile industry. This pattern of new plant locations is a notable contrast to the closures or conversions, which affected plants located mainly in the peripheral zones.

What product lines were assigned to these new plants? Our analysis indicates that Lordstown commenced with the assembly of full-size Chevrolets, and so did Ste. Thérèse which also built the Pontiac line besides the Chevrolet. Chrysler's Belvidere facility produced two lines, the Dodge Polara and Plymouth Fury during the first five years of operations. The Falcon was the first and only car line assigned to St. Thomas when it started producing automobiles in 1967 (Table 44).

Again, there is little to indicate that the establishment of new assembly plants had the effect of altering product lines in other plants. The opening of new plants was not accompanied by a reduction in the number of plants which assembled the same car lines allocated to the new plants, with the exception of St. Thomas. Ford Falcons, produced in four locations during the 1966 model year, were sourced from only two other locations, Kansas City (Missouri) and Lorain, besides St. Thomas during 1967. As noted earlier, this reassignment may have been linked to the rationalization of product lines at Ford following the Auto Pact. Regarding the effects Oklahoma City will have on product assignment

TABLE 44

NEW PLANT AND EFFECTS ON CAR LINE ASSIGNMENT▲

PLANT & MODEL YEAR OPENED	CAR LINE	NUMBER OF OTHER PLANTS TO WHICH LINE ASSIGNED△		PLANTS LISTED UNDER (A) AND (B) SIMILAR (YES/NO)
		YEAR PRIOR TO OPENING (A)	FIRST YEAR OF OPENING (B)	
LORDSTOWN 1966	CHEVROLET	14	14	YES
BELVEDERE 1966	FURY	3	3	YES
	POLARA	3	3	YES
STE. THERESE 1965	CHEVROLET	12	13	YES
	PONTIAC	6	6	YES
ST. THOMAS△ 1967	FALCON	4	2	YES

Source: <u>Ward's Automotive Yearbook</u>; <u>Automotive News Almanac Issue</u>, various years.

▲Excludes Oklahoma City.

△Excludes newly opened plant.

amongst GM plants, currently available information is too sparse to warrant much comment, but it appears that GM's new generation of front-wheel-drive X-cars produced previously at Willow Run and Tarrytown will also be sourced from the Oklahoma City plant. With this example, evidently new plants were not entrusted with entirely new models, nor with models not assembled elsewhere.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The spatial product assignment strategies of large geographically dispersed, multiplant enterprises in differentiated oligopolies have a major impact on the industrial geography of developed countries. This thesis documented and analysed car line sourcing patterns and policies of one such oligopoly, North America's three major automobile producers, GM, Ford and Chrysler. A number of questions served as the focus of the research. First, what are the consequences of product differentiation strategies, in respect of the geographic form and basis of product assignment to manufacturing plants? Second, is there a relationship between product-mix, product age and product volume on the one hand and plant location in industrial core or peripheral areas, in the U.S. and Canada on the other? Third, how frequent are product-assignment decisions and what is the role of product and plant locational inertia and turnover affecting such decisions?

Chapter II outlined the key economic elements of firms in differentiated oligopolies, product differentiation and economies of scale and the relationships affecting product plant manufacturing assignment patterns, geography and change. Three forms of product differentiation were distinguished; static differentiation which embodied features of style and quality, dynamic differentiation which underscored the importance of product change and market segmentation which is differentiation predicated upon the heterogeneous character of demand. Product differentiation as a form of corporate strategy highlights the importance of product variety and turnover in large enterprises. Three kinds of scale economies were also noted. Product-specific scale economies are usually associated with product volume and length of production runs. Plant-specific economies accrue when a firm operates an optimal size plant. Firm-specific scale economies are related to a number of elements including non-production functions as well as production activities of the firm. Regarding the latter, certain pecuniary advantages are believed to exist for the large firm operating multiple production units. In essence the presence of scale economies imposes certain constraints on the nature and location of corporate product activities. The interaction of product diversity and scale economies may lead individual plants to produce a single product, several or even a complete range of products sold by the parent firm. Further, product mandates may differ according to plant location. Finally, it was noted that the dynamic nature of both product differentiation and scale economies may be linked to shifts in product plant manufacturing assignment.

Chapter III traced the development and evolution of the U.S. and Canadian automobile industries from the late 19th Century until the mid-1960's. It noted the growth of the principal producers and the increasing market concentration which resulted partly from the acquisition policies of the Big Three and the gradual demise of smaller competitors and also the development of competitive strategies based on product differentiation. An important turning point in the industry was the signing of the Auto Pact in 1965 which provided the legal basis for intrafirm integration of the U.S. and Canadian operations. Highlights of the Agreement and their particular relevance for rationalization were noted. In addition, the recent structure of the North American industry was also discussed.

The product differentiation strategies of the principal automobile producers were the focus of Chapter IV, which noted that each firm produces and competes in the North American car market with a wide variety of cars which are differentiated on the basis of make, line, model, vehicle size and price. Another major feature of the industry is the regular pace of product turnover which includes alterations in the style and engineering features of automobiles and the introduction of new car lines and the removal of dated models. The net result of this competitive strategy is product diversity and a high degree of product turnover.

Chapter V examined the nature of final assembly plant operations in the automobile industry. It noted that assembly plants were generally quite flexible in that several different car lines could be produced under the same roof although there were important product-specific economies to be gained through product specialization. Plants which specialized in the production of cars of particular sizes (that is, subcompacts, compacts, intermediates or full-size) were seldom found to attain the estimated minimum efficient scale at least as derived in a recent study. However, the failure in obtaining minimum efficient plant scale may have been compensated for by a geographically decentralized system of multiple plants which apparently provides tangible savings in final distribution costs and more efficient means of serving a spatially extensive and diverse North American market. Final assembly plants of the Big Three are concentrated largely in the Great Lakes States and Southern Ontario.

Other assembly locations include the U.S. Northeast, the Atlantic, the South and Pacific regions. Plant locations were further grouped into four industry regions, consisting of the industry core, the outer core, the inner periphery and outer periphery.

Chapter VI, which focussed on product-plant manufacturing assignment patterns and rationale indicated that few plants produced single car lines. The majority produced a combination of lines. None made the complete range. By contrast, a large percentage of plants specialized in cars with one wheelbase, considerably less in more than one, while only a handful produced all four simultaneously. The three firms contrasted in the number of product lines assigned to their respective plants. Indices based on weighted averages revealed that Chrysler plants often produced more car makes, lines or wheelbase groups than either GM or Ford. The company's product strategy of competing 'across-the-board' with its larger rivals, but producing cars in far fewer plants is probably the key reason for its generally higher product mix.

Assignment decisions based upon make of car alone constitute the major factor in product plant assignment in the case of GM, whose assignment decisions appear to be influenced by its system of home and 'B.O.P.' plants and those controlled by the assembly division. Assignment decisions also appear to be heavily influenced by product-related economies of scale. The larger the production run of an individual car line, for example, the greater the chance of it being assigned to a larger number of plants. This is further substantiated by the higher level of capacity replication of car lines among the two larger firms. Further, several car lines of different makes assembled in one plant simultaneously usually share common body designs, major components and sheetmetal. The allocation strategy enables firms to realize important product-specific scale economies. Not all plants, however, are able to meet this important condition. Even so, there may be important economies associated with the simultaneous assembly of car lines which share few physical and technical similarities. Such economies may arise from a plant having two separate assembly lines, each producing different types of car. Other plants are specially designed to undertake the production of several low-volume but high quality, expensive car lines. Another factor that may necessitate mixed car line assembly is the substantial savings derived from reducing excessive cross-shipment of cars from assembly plants to the final consumer. Under yet other circumstances there may be pecuniary advantages in utilizing a plant's excess capacity even though it may involve producing different cars with little in common. At GM, in particular, assignment decisions were in the past affected by policies associated with minimizing downtime and retooling costs, and the performance record of individual plants. Overall, the analysis in this chapter revealed the relevance of other factors besides important product-related scale economies in product plant manufacturing assignment.

Chapter VII dealt with product mix variation in different plant locations. The available evidence indicates that plants located in each of the four industry regions were not substantially different in terms of their product mix. Further, plants located at substantial distances from the auto heartland were as diverse as plants near to the heartland. Car lines produced in small volumes were often assigned to plants in the industry core but at increasingly larger outputs sourcing occurred at the core and decentralized locations as well. At the international scale, the 'average' Canadian plant generally produced more car lines than an 'average' American plant. American plants located within the same industry region or in geographical proximity did not match the diversity that characterized Canadian plants. Two plants, GM Oshawa and Ford Oakville, contributed largely to this condition. Other Canadian plants were generally quite specialized in the number of lines produced. The multiplicity of car lines at both Oshawa and Oakville raised doubts regarding the nature and extent of intrafirm and inter-country rationalization of production brought about by the Auto Pact. However, detailed analysis of the individual plants revealed a high degree of similarities in the models produced and also a general reduction in the number of lines occurring some years following the Agreement. Further, there were noticeable increases in the proportion of North American output of car lines that was sourced at both plants, Oakville and Oshawa. That these plants were the principal sources of certain car lines in the U.S. Northeast and East North Central regions is further indication of some degree of rationalization. The existence of two separate assembly lines at Oshawa and the greater flexibility of both plants designed originally to accommodate a multiplicity of car lines are reasons which may explain their maintenance of a diverse product mix for several years.

Chapter VIII focussed upon the geography and circumstances in plant product assignment change. ~~It~~ revealed that a rather large percentage of assembly plants underwent some form of change in their product lines during periods as brief as five years or less. Some changes that did occur were attributable to product turnover, which was tied to the introduction of new car lines, or the discontinuation of old products. These particular circumstances may affect only those plants to which new lines have been assigned or from which discontinued lines have been removed. Although it was not improbable that product turnover also created the circumstances for rearranging product mix in a wider set of plants, there was no means to verify this. Contrary to some expectations, the majority of new car lines was sourced initially from plants in the inner periphery and to a lesser extent from the industry core. Core plants, however, were more likely than peripheral plants to experience product change resulting from the discontinuation of a product line. No evidence was found to suggest that Canadian plants of the Big Three are discriminated against insofar as product age and manufacturing assignment is concerned. In recent years Canadian plants have, in fact, been assigned several brand new lines and some, like Windsor, were even designated the sole North American source. The major factor leading to plant product change is apparently fluctuations in car line volume. The presence of product-specific scale economies encourages firms to source output at fewer locations during periods of low output and at more plants when output expands. Frequently, however, there is a year's lag between output changes and some appropriate adjustment in number of producing plants. Further, during periods of low output, production is often centralized in core plants, whereas peripheral plants are brought in as additional sourcing points when output grows. Finally, the role of plant openings, closures and conversions have had no apparent impact on plant product change, presumably because closures frequently occur during economic recessions and new capacity arises with an expanding market.

A study such as this, with a narrow focus on a case study of very few firms and their peculiar problems in one industry segment, may seem to be little more than a personal curiosity. Industrial geographers and perhaps planners and regional administrators concerned as they must be with the location of industries may entreat: "Does it really matter where Chevrolets or Fords are built?" But it is important, as our Brampton example indicates. In perspective, this study provides ample support for the increasing, though recent, concern of some geographers that for many firms the problem appears "to be much less one of 'given the production, where shall the entrepreneur locate?' than one of 'given the location, what and how much shall he produce?'" (Hamilton, 1974, 7). Moreover, while there is disagreement among geographers concerning the frequency of plant location decisions in the traditional sense (See Hamilton, 1974, 23 and Townroe, 1974, 287) this thesis provides additional support concerning the rather frequent decisions regarding product turnover in plants (Berry, 1967). In addition, there are certain parallels between spatial product assignment and the rationale of where a particular plant fits into its broader corporate system particularly insofar as corporate strategies, plant infrastructure, organizational structure and external relations are concerned (See Chapman, 1974). However, the product cycle model, employed increasingly to explain the "filter-down" process of industrial location, offered little insight into manufacturing assignment of differentiated products in this sector. The example of automobile assembly suggests a greater degree of change in local manufacturing plants than is frequently realized. That a firm is able to "substitute production flows within its organization without actually closing facilities" (Hamilton, 1974, 15) and the change in product line may have a significant impact on employment indicate a serious need for greater understanding of corporate product assignment strategies, a topic to which this study has made a modest contribution.

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APPENDIX A

ABERNATHY'S WEIGHTED AVERAGE INDEX: EXAMPLE OF MAKES PER PLANT

GENERAL MOTORS--MODEL YEAR 1978

MAKES/PLANT	NO. OF PLANTS	WEIGHTED AVERAGE
1	8	8/24 x 1 = .33
2	10	10/24 x 2 = .83
3	4	4/24 x 3 = .50
4	2	2/24 x 4 = .33
	24	1.99

AVERAGE NUMBER OF MAKES/PLANT = 1.99.

APPENDIX B

ABERNATHY'S AVERAGE CAPACITY REPLICATION INDEX

EXAMPLE: CHRYLSER, 1978 MODEL YEAR

NO. OF PLANTS PRODUCING	CAR LINES	DEVOTED FRACTIONAL PLANT CAPACITY		FRACTIONAL CAPACITY	PLANTS CAPACITY WEIGHTED
1	HORIZON	0.57	=	0.57	0.57
2	VOLARE	0.49 + 0.56	=	1.05	2.11
1	FURY	0.62	=	0.62	0.62
1	MAGNUM	0.28	=	0.28	0.28
1	OMNI	0.43	=	0.43	0.43
2	ASPEN	0.37 + 0.44	=	0.81	1.62
1	MONACO/ CORONET	0.39	=	0.39	0.39
2	DIPLOMAT	0.04 + 0.31	=	0.35	0.70
1	CHARGER	0.04	=	0.04	0.04
1	CHRYSLER	1.00	=	1.00	1.00
1	CORDOBA	0.68	=	0.68	0.68
2	LE BARON	0.10 + 0.56	=	0.66	1.31
1	TRUCKS	0.13	=	0.13	0.13
				7.00	9.88

R (degree of capacity replication) = 9.88/7 = 1.41.

ABSTRACT

The emergence of large multiplant, multiproduct, oligopolistic corporations in modern western industrial economies has aroused a great deal of interest and concern over their spatial behaviour and impact. Much academic research and public solicitude have accented issues dealing with how firms choose to invest, locate new plants or suspend production operations. Little explored are corporate strategies regarding spatial form and shifting allocation of differentiated product lines within a system of plants; conduct which may have extensive favourable or adverse economic repercussions upon communities, regions or even sovereign nations.

This dissertation focusses upon assignment of products to plants on a domestic and international basis. It explores the relationship between the nature of locational behaviour and the structural context within which that behaviour is produced. Product differentiation is a key competitive strategy in oligopolies, and dynamic product differentiation has an important effect on the product life cycle. A firm's varied product portfolio raises the question: What plant should be assigned what product(s)? The study suggests that product assignments are influenced by the nature of dynamic product differentiation and market segmentation strategies along with product-, plant- and firm-specific scale economies and transport costs, as well as certain political factors and elements of inertia and competition within the system of corporate plants.

The dissertation focusses on GM's, Ford's and Chrysler's final assembly operations of passenger automobiles in the United States and

Canada. With their extensive multiplant systems and widespread impact on the continental economy, the Big Three provide an interesting case study of oligopolistic competition through dynamic product differentiation. The study reviews the evolution of the industry and the nature of its scale economies and transport costs. It draws upon several industry publications and a series of interviews with auto industry officials as well as labour and government representatives. Analyzing conduct over the past fourteen years, it compares and contrasts plant product mix by firm according to (a) four 'industry regions'--the industry core, outer core, inner periphery and outer periphery--and (b) the U.S. and Canada. Product mix refers to the number of car makes, lines and wheelbase classes.

The study documents a wide range of plant assignment strategies. It finds plants specializing in the production of cars of particular sizes seldom attain the estimated efficient scale. However, failure to obtain that scale may be compensated for by a geographically decentralized system of multiple plants which can provide savings in distribution costs and more efficient means of serving a spatially extensive and diverse North American market. Individual plants may produce a single, a variety or even a complete range of the firm's products. However, each firm differed, sometimes substantially, in its revealed strategy of assignment, a function perhaps of the range of products and size of its multiplant system. Chrysler, the smallest firm, produced an extensive range of cars but in fewer plants, and consequently had more product lines per 'average' plant. In contrast, Ford plants are generally more specialized than either GM's or Chrysler's. At GM, product assignment and mix are related, in part, to the structure of control exerted over assembly plants by different corporate divisions. A feature common to all three firms was that, as product volume increased, production was generally allocated to a larger number of plants. Although low volume lines were generally produced in core areas and large volume lines in both core and peripheral plants, no discernible difference in the product mix of plants located in the four industry regions was detected. The major Canadian plants of GM (Oshawa) and Ford (Oakville), however, were somewhat more diversified than American plants, even those in the same industry region, but the disparity has narrowed in recent years. The mix of product lines in individual plants changed rather frequently.

The study indicates that plant-product assignment decisions are influenced not only by mainly product -specific scale economies, but also by a variety of other factors, including corporate organizational structure, product image and quality, distribution economies, plant investment policies, availability of plant capacity and plant performance rating. Canadian plants, besides the exceptions noted above, were found to be neither significantly different, nor regarded as such from a corporate perspective, from American plants. Following the Auto Pact, Canadian plants were indeed gradually integrated into the larger North American assembly system. No evidence was found, either, of Canadian plants being discriminated against in the manufacture of brand new product lines. The product life cycle model and filter-down process, relating age of product and location, do not fit the behaviour of this sector within North America over recent decades. Core area plants were not necessarily the first source of new products. However, frequently they were the last source of declining lines, a feature indicating an association between production volume and location. The study indicates the need to view product assignments within their particular historical context and the prevailing organizational structure and system of corporate plants.