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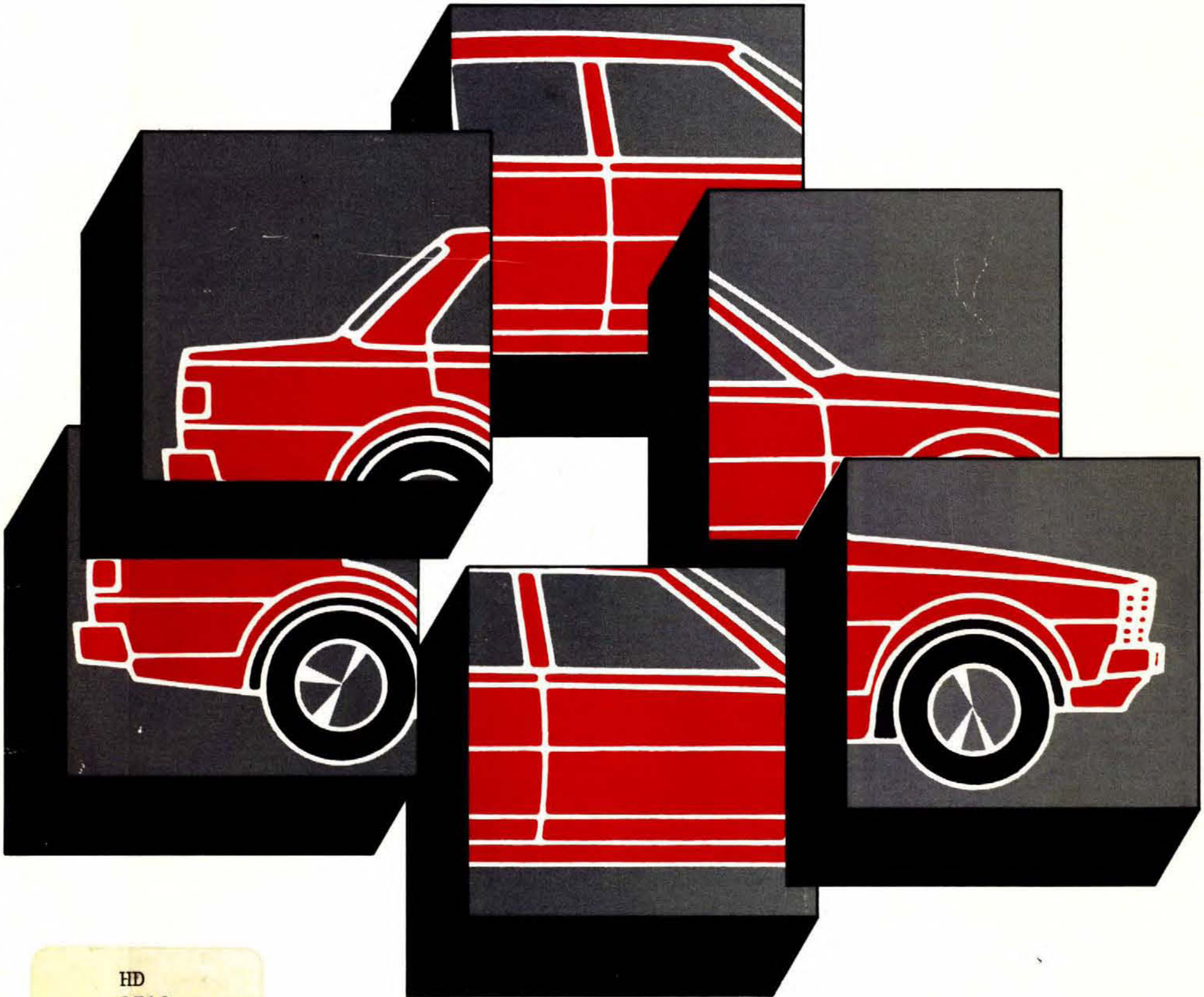
AUTOMOTIVE TECHNOLOGY TRANSFERS:

THE JAPANESE CHALLENGE AND OPPORTUNITY



RESEARCH MANUAL

AUTOMOTIVE TECHNOLOGY TRANSFERS:
THE JAPANESE CHALLENGE AND OPPORTUNITY

Seminar and Reference Manual prepared by Bursey International Consultants, Toronto, Canada for:

THE DEPARTMENT OF EXTERNAL AFFAIRS

THE DEPARTMENT OF REGIONAL INDUSTRIAL EXPANSION

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The Japan Automobile Manufacturers' Association

The Japan Automotive Parts Industries Association

The Japan Automotive Service Equipment Association

HOW TO USE THIS MANUAL

The intent of this reference manual is to give those attending the Automotive Technology Transfer Seminars a number of diverse views on the subject of technology acquisition.

Each of the six sections in this research manual is divided into three parts:

PART ONE gives a series of views by the seminar leaders and/or articles that are relevant to the section topic, but may or may not reflect the actual content of the seminars.

PART TWO, called critical points are those key topics that have been covered both in the research manual and the seminar. They are extremely important and are the crux of each of the six sections.

PART THREE, of each section is a series of questions which you the reader should answer from your own perspective as an existing or potential automotive parts manufacturer.

No one will see what you write in your research manual nor will you be asked to display what you have in there. It is however an opportunity for you the reader and seminar attendee to examine your company's strategic options in light of the changing world automotive market.

The information contained herein is extracted from published articles, information gained by the seminar leaders in Japan, and observations of the seminar leaders in dealing with the automotive industry over the years. It is hoped that this manual will be used in conjunction with the presentations, and serve as a post-seminar reference source. Therefore, space has been made available in various sections for individual comments and observations.

The four speakers in this series of seminars are:

James Bursey, President, Bursey International Consultants, Ontario.

George Howard, Director of Technology, Ontario Centre for Automotive Parts Technology, Ontario.

Remi Kelly, Counsellor, Quebec Ministry of Industry & Commerce, Quebec.

Harley Kelsey, Vice President, Technology and Investments, Discovery Foundation, British Columbia.

SECTION I: OVERVIEW OF AUTOMOTIVE INDUSTRY

The objective of this section is to acquaint the reader with a number of potential changes that are likely to impact the automotive industry in the next five years. Some of these have already been well documented in the form of articles, industry studies and government literature.

JAPAN

(excerpted from Japan Economic Almanac 1985)

Last year underlined the nature of Japan's automobile industry in the sense that it depends heavily on exports. Total production of automobiles in Japan during 1984 was 11,464,920 units, up 3.2 per cent from 1983 and, 285,000 units more than the previous all-time high. Exports hit a record 6,109,184 units, up 7.8 per cent, helped by favorable conditions in overseas markets, especially in the United States, the largest export destination for Japanese motor vehicles.

Rising Overseas Production

In this context, Japan's automakers pushed forward with various overseas projects in order to offset the growing trend toward protectionism in the advanced countries and more energetic local content policies in the developing countries. Some even called 1984 the Japanese auto industry's "first year of internationalism".

Despite early concern that the downward trend seen during the second half of 1983 would continue into 1984, there was growth in the demand among women for personal cars and among men for second cars, which led to an increase in the sales of cars of 550 cc or less displacement. The principal manufacturers of those cars, such as Suzuki Motor Co. and Mitsubishi Motors Corp., introduced full model changes of their main products, which also served to stimulate demand.

For the second year in a row, Japan's automobile production topped 11 million units, with 1984's output breaking the previous record of 11,170,000 units set in 1981. The achievement of this production mark in a situation where the domestic market has matured to the saturation point, at the same time that overseas markets have taken on strong protectionist colorings, attests to the basic strength of the Japanese autombile industry and its ability to challenge the U.S. auto industry for world supremacy.

MAKER-BY-MAKER

PRODUCTION OF

AUTOMOBILES IN 1984

Maker	Units
Toyota Motor	3,581,646
Nissan Motor	2,704,033
Mazda Motor	1,323,541
Mitsubishi Motors	1,165,500

Honda Motors	1,206,176
Suzuki Motors	703,748
Daihatsu Motor	587,074
Fuji Heavy Industries	555,591
Isuzu Motors	460,217
Hino Motors	61,991
Nissan Diesel Motor	37,450
Others	574
Total	12,387,865

A breakdown of maker-by-maker domestic sales in 1984 shows that Toyota Motor Corp. retained the top market share for the second year in a row, at 40.8 per cent, up 0.6 percentage points from 1983. This was also the second consecutive year of Toyota securing a 40 per cent or greater market share. Second place Nissan Motor Co., on the other hand, fell back to 27.0 per cent of the market, down 0.7 per cent. As a result, the spread between the top two makers widened further. The next three makers were Mazda Motor Corp. in third place at 8.2 per cent (down 0.4); Mitsubishi Motors Corp. in fourth place at 6.7 per cent (down 0.7); and Honda Motor Co. in fifth place at 6.3 per cent (no change).

Recovery of Demand for Trucks

Recovery in the truck industry was also noticeable. In the segment of the market for trucks with a payload capacity of 3.5 tons or more, Nissan Diesel Motor Co., Nissan Diesel

Motor Sales Co., Isuzu Motors, Ltd., and Mitsubishi Motors all introduced full model changes to their main trucks in 1983. Not only did the effects of these new models begin to be felt in 1984 but there was also a strong emergence of replacement demand. As a result, total sales in 1984 were 116,000 units, up a large 11 per cent from 1983.

New Models

The Toyota MR2, with its engine mounted in the middle of the car, has no rear seats. In that sense, it marks a 180-degree turn from the moves by Japanese automakers in recent years to gain more roominess in their cars. In sacrificing space in the MR2, Toyota put greater emphasis on increasing the car's performance. Toyota impressed Japanese drivers with the fact that a car is not merely a means for moving about, but that it is also for amusement. Honda's Cabriolet, meanwhile, has gained much attention as a roadster that is easy to drive and a lot of fun. Like the MR2, the Cabriolet is currently playing an important role in raising the level of Japan's motorization.

As a reflection of the popularity of West German cars among Japanese users, the Santana is a car produced and marketed by Nissan under license from Volkswagenwerk AG of West Germany. The Santana retains the strong image that West German cars have of being tough yet of high quality. It has filled a need in Japan among Japanese drivers who have grown tired of the

Japanese cars offered up to now but who cannot afford the luxury of wholly foreign-made cars.

Japan's automakers, in the forefront of market trends, have developed various new kinds of technology and new products and have begun commercializing them, while they struggle to understand where Japanese consumer tastes in cars are headed in the future.

Record High in Exports

Exports, in contrast to the instability felt at the start of 1984, continued at a steady increase during the year, and ended up at an all-time high.

Viewed by principal destinations, 2,798,567 vehicles went to North America (up 14.4 per cent), 1,267,591 vehicles went to Europe (down 0.5 per cent), 428,614 units went to the Mideast (down 31.2 per cent), 659,379 units went to Southeast Asia (up 22.1 per cent), 263,485 units went to Central and South America (up 18.9 per cent), 259.594 units went to Africa (up 24.5 per cent) and 412,874 units (up 19.1 per cent) went to Oceania.

AUTOMOBILE EXPORTS IN 1984 BY DESTINATION

Destination	Unit	Yr-To-Yr Change
Southeast Asia	659,379	+ 22.1%
Mideast	428,614	- 31.2%
Europe	1,267,591	- 0.5%
North America	2,798,567	+ 14.4%
(U.S.A.)	(2,579,439)	(+ 15.4%)
Central America	201,600	+ 23.8%
South America	61,885	+ 12.2%
Africa	259,594	+ 24.5%
Oceania	412,874	+ 19.1%
Others	19,080	+ 64.9%
Total	6,109,184	+ 7.8%

In the United States, the largest overseas market for Japanese cars, the fourth year of quotas on passenger car exports from Japan remained in effect, which held down exports to that country in the year ended March 1985 to 1,850,000 units. Growth in the sales of pickup trucks, however, a popular product in the U.S., helped to support generally favourable overall growth in the American market.

In Europe, the second largest market, strong efforts were made to overcome protectionist moves, and exports were successfully held at about the same level as in 1983. Markets in Oceania, Southeast Asis, and elsewhere, meanwhile, saw either double digit growth or near double-digit growth, which served to raise the overall level of exports.

For Japan's automakers, dependent to such a very high degree on exports, it is no exaggeration to say that the securing of overseas markets will determine their continued profitability. As mentioned earlier, exports in 1984 were the highest in the history of Japan's automobile industry but Japan's automakers have been caught between protectionist winds blowing in the advanced countries and local content policies in the developing countries.

MAKER-BY-MAKER AUTOMOBILE EXPORTS IN 1984

Maker	Passenger Cars	Trucks	Buses	Total
Toyota Motor	1,100,353	672,082	28,488	1,800,923
Nissan Motor	1,011,920	382,129	9,337	1,403,386
Mazda Motor	561,999	221,447	4,643	788,089
Mitsubishi Motors	343,987	217,820	2,939	564,746
Isuzu Motors	59,539	220,485	5,935	285,959
Daihatsu Motor	58,830	91,655	1,084	151,569
Honda Motor	625,020	8,245	--	633,265
Fuji Heavy Industries	128,624	101,966	--	230,590
Nissan Diesel Motor	--	15,076	1,391	16,467
Hino Motors	--	14,167	2,423	16,590
Suzuki Motor	90,347	127,253	--	217,600
Total	3,980,619	2,072,325	56,240	6,109,184

Given these circumstances, it is no longer possible for Japan's automakers to concentrate on the exports of finished vehicles in order to secure overseas markets. More and more they will have to make direct investments overseas and locate production facilities locally. For that reason, Japanese automakers have been moving forward with their own overseas projects, and one of the characteristics of 1984 was that these movements came to the surface all at once.

North America

The North American industry has obviously undergone tremendous change in the last decade. Little evidence need be presented that is not a daily fact of North American life, more fuel efficient cars, increased use of electronics, lower real (uninflated) costs of parts and components, and an increased Japanese presence.

Yet what of the future? Numerous sources have indicated that North America will be entering a period of vehicle purchase saturation within the next twelve months. Simply put, this means that there will be slower growth in new car, light truck and other commercial vehicle sales. It is even possilbe that the North American consumer has reached the saturation point of new vehicle purchases. Bursey International Consultants concurs with this view and for the purposes of this discussion suggests an 11,500,000 car per year total sales demand as being appropriate for calculating sales and manufacturing strategies over the next five years. In the same period we would expect North American truck demand to fluctuate between 4 and 4.8 million units per year, a reflection of the current uncertainty regarding total minivan sales. We therefore would have a total North American vehicle demand of 15.5-16.3 million units in the 1986-1990 period.

For those supplying the automotive industry as either parts manufacturers, or even service and aftermarket parts suppliers, it is important to break down the structure of this sales volume. Using 1984 statistics we find that 15.765 million vehicles were sold in that year, of which 3,331,000 or 21.1 per cent were imports. For the following discussion, two points must be remembered. One, 1984 was a record year for sales and production. Two, recent consumer studies by a number of companies indicate that without import controls of any sort, the imported vehicles could gain up to forty percent of the North American market. This underlines the continued if not increasing popularity of imported products versus their North American counterparts.

Given the above, we must look forward at the expected new investment in the North American vehicle assembly industry. This new capacity will come fully on stream in 1988-89:

Toyota	
Freemont, CA	250,000 units
Georgetown, KY	250,000
Cambridge, Ont.	50,000
Nissan	
Smyrna, TN	280,000
Honda	
Marysville, OH	500,000
Allison, Ont.	80,000
Mitsubishi	
Bloomington-Normal, IL	180,000
Mazda	
Flat Rock, MI	240,000
Hyundai	
Montreal, Que.	100,000
	1,930,000 units

Therefore the impact on the North American market will be as follows:

TOTAL ASIAN NORTH AMERICAN PRODUCTION	1,930,000 units
ADD IMPORTS (21.1% of mkt)	3,270,500 units
TOTAL VEHICLES CONTROLLED BY FOREIGN PRODUCERS	5,200,500 units
ADD NEW NORTH AMERICAN PRODUCTION (GM SATURN)	500,000 units
TOTAL NEW N.A. MKT ENTRANT BY 1989	5,700,500 units

As illustrated by the above figures, there is a considerable increase in North America's production capability, a highly problematic situation when one considers that there will be relatively stagnant market demand. Thus the production implications are as follows:

TOTAL NEW PRODUCTION BY 1989	5,700,500 units
ADD EXISTING NA PRODUCTION CAPACITY	12,754,000 units
TOTAL NORTH AMERICAN SUPPLY CAPABILITY 1988-89	18,454,500 units
LESS PROJECTED 1988-89 SALES	15,500,000 units
MINIMUM PRODUCTION OVERCAPACITY BY 1989	2,954,500 units

Even assuming a fairly rosy 16 million unit per year North American vehicle market, there will be considerable North American assembly overcapacity. What is of most concern to parts suppliers is that this overcapacity will come entirely from North American manufacturers. Remember, we have assumed no increased import penetration which therefore gives us the minimum industry overcapacity. As compared to 1984, when 12,754,000 units were manufactured in North America by domestic companies (GM, AMC, Ford, Chrysler, and VW), 1988-89 will only have 9,797,500 coming from the same sources. This represents a 23% reduction in existing capacity utilization. We predict that this will be a minimum since the North American companies themselves will increase off-shore sourcing of cars and trucks from Japan, Korea, Taiwan, Brazil, Mexico, Spain and West Germany. This additional import penetration could reduce North American manufactured vehicle production by another one million units by 1988-89, to 8,799,000 units.

From the point of view of the automotive parts manufacturer, this change in the sourcing of the finished assembled vehicles will translate into lower unit and dollar demand for their North American produced products. Also the North American vehicle assemblers will continue to 1. decrease the total number of individual parts suppliers, and 2. to increasingly source parts from an international supplier base as opposed to the current North American supplier base. The net result will be reduced opportunity for North American based parts suppliers.

However, to every cloud there is a silver lining. This will come in the form of an increased volume of parts being demanded by the new North American assemblers, Toyota, Nissan, Mazda, Honda, Mitsubishi and Hyundai. It is therefore imperative for any North American parts supplier to develop contacts and thus opportunities with the new vehicle assemblers as soon as possible. Note however, that most industry observers expect 40% of existing parts companies to be out of business by 1990. This is due to overseas sourcing, fewer parts demanded, and mergers.

NOTES ON SECTION I

CRITICAL POINTS

* North American economy mature-limited growth for car sales
* Only sales growth will be by imports and Asian manufacturers producing in the United States and Canada.
* Domestic "Big 4" companies will import cars for sale under domestic trade names.
* Domestic manufactuers sourcing parts outside North America.
* New foreign manufacturers will source few parts in North America.
* New Asian investment in North America will create a 2.9 million car per year production overcapacity, at the expense of North American companies.

THEREFORE:

* Less OEM dollar and volume opportunity for North American parts companies in North America.
* A considerable number of existing parts manufacturers will be out of business by 1990.
* Look at the aftermarket-worth $60 billion in 1985.

QUESTIONS

1. How many of the parts that you supply to North American OEM vehicle assemblers will be affected by production overcapacity in 1988-89?

2. How many contacts do you have with non-North American auto and parts companies? How much importance do you place on these contacts? How much business will these contacts bring?

3. Will you be in the automotive industry in 1990? After market or OEM? Why or why not?

SECTION II: IMPRESSIONS OF JAPAN

Since the bulk of this seminar is focused on Japan and the technology of that country, we feel that it is appropriate to provide the reader with a number of recent impressions. The following therefore is a collection of personal impressions by the seminar leaders.

GENERAL CHARACTERISTICS

The following are some overall observations as a result of company visits, discussions with Japanese and Canadian parts manufacturers, Japanese research agencies, and trade shows including the Tokyo Motor Show, Flexible Manufacturing Systems Exhibition, and the Advanced Materials Seminar.

JAPANESE/CANADIAN JOINT VENTURES/LICENSING

In the meeting at the Japan Auto Parts Industries Association (JAPIA), a list of the technical agreements with foreign companies shows the following: (see attached chart)

The majority of the technical agreements are Japan-to-Country, especially where Japanese auto manufacturers have assembly plants or where there is an auto industry large enough to use components manufactured in Japan (Korea, etc.). It was indicated that in the U.S. and Europe, about 50% of the technical agreements were Country-to-Japan.

In reference to Canada, the lack of Japanese technical associations with Canadian companies probably reflects three

Trend of Foreign Investment of JAPIA Members
(As of 31st December, 1984)

Country	Types of Investment			Technical Agreements
	Manufacturing Plant	Sales Company	Total	
Korea	9		9	31
Taiwan	27	1	28	38
Malaysia	10	1	11	10
Indonesia	10		10	15
Singapore	6	2	8	1
Philippines	5		5	10
Thailand	20	1	21	27
India	2		2	13
China				4
Pakistan	1		1	2
Australia	7	1	8	26
U.S.A.	19	31	50	15
Canada		3	3	1
Mexico	3		3	13
Brazil	8	1	9	2
Venezuela	1		1	2
Ecuador	1		1	2
Argentine				1
U.K.	1	3	4	9
Spain	2		2	5
W. Germany	1	5	6	4
Sweden				3
France	2		2	2
Portugal				1
Italy				1
S. Africa				12
Columbia				1
Belgium		1	1	
Peru	1		1	
Holland	1	2	3	
Austria	1		1	
Tunisia	1		1	
Sri Lanka	1		1	
Tazanzania	1		1	
Total	141	52	193	250

Source: J.A.P.I.A.

factors:

1) The lack (to date) of Japanese automobile manufacturing plants in Canada.

2) Limited contact between Canadian and Japanese parts manufacturers. They are competitors in both the Japanese and North American auto industry.

3) Most Japanese parts manufacturers consider the American market as the U.S. and Canada as the sub-market of the U.S.

Japanese component/parts companies that were visited had, or intended to establish, manufacturing in the U.S.. There was limited awareness of the extent or technology capabilities of the Canadian automobile industry.

It should be noted that this lack of awareness also is apparent in other technologies such as electronics, biotechnology and computer systems. As component suppliers to Japanese industry, their major market is domestic or a Japanese industry developed international market.

TOKYO MOTOR SHOW

" Other than its size, the single largest impression was the well thought out consumer oriented educational displays, especially in the automotive parts pavillion. There we saw considerable emphasis on electronics, not only for entertainment and information systems, but also used in transmissions, 4WD systems, door locks and window lifts on even the least expensive vehicles. Lighting displays showed extensive use of plastics, new high resolution reflector techniques, and fibre optics for tail lights. Very inventive use of accessories for the aftermarket especially in performance and appearance parts. Major trends include antiskid braking systems, and lower weight, more adjustable electronically controlled seating. From a manufacturing point of view, most companies had a much broader range of products than we see in North America or Europe, based primarily on materials' source.

The cars showed two general trends, more luxury in the larger models, and a plethora of smaller, more fuel efficient cars. The best examples were from Toyota in the luxury car field, and the new tiny Honda Today. Also from Nissan and especially Fuji Heavy Industries (Subaru), there was great emphasis on full-time 4WD for sedans, station wagons and sports cars. With Subaru this was also carried over into its smaller, subcompact cars, hinting that production scale efficiencies had considerably reduced Japan's cost of 4WD manufacturing. As a comparison to this, the FIAT Panda 4x4 cost twice as much as its Subaru rival, using a much less sophisticated system. Four wheel steering has appeared on the new Nissan Mid 4, a sportscar which will be introduced to North America in late 1986.

In addition, turbo charging was in evidence on all ranges of vehicles as were four wheel disk brakes, and fully independent suspension. Of considerable note were the numbers and varieties of light trucks being displayed by Toyota, Nissan, Mitsubishi, Isuzu, Daihatsu and Suzuki. From all of these companies assurances were given that testing was underway for North American introduction by 1988.

The commercial vehicle market, trucks and buses, was characterized by two new developments, ceramic engine components and aerodynamic styling. The former was emphasized by Isuzu and Mitsubishi, each of whom had an impressive display of functioning engines and cutaways. The aerodynamic leader was Mitsubishi with a very functional class 7 highway truck and three similarly aerodynamic medium and large buses. Hino, the largest truck manufacturer in Japan, seemed to be concentrating on diversifying and modernizing its bus fleet and seems to have succeeded admirably with its Blue Ribbon intercity bus. From a technical standpoint, the emphasis in buses and trucks was on mechanical and aerodynamic flexibility to maximize operating efficiency. Instances of this were shown through interchangable engines, kneeling suspension systems (electronic not hydraulic), and adjustable body panels for increased aerodynamics.

Of note for the North American market is the probable entrance of cars smaller than the existing subcompact category, and the new competition that will be seen in the commerical vehicle market. The new smaller than subcompacts, microcars, will come from Subaru, Suzuki, Daihatsu and maybe Honda. They present a fuel efficient alternative that could compete at 30-40% below the average price of existing subcompacts. Also, not only will medium and heavy commerical vehicles be introduced to North America but so will new light commercial and microcommercial vehicles. The light commercial vehicles will probably come from Toyota, Nissan and Mazda, while a new class of microsized commercial vehicles will probably come from the microcar companies. "

NAGOYA FLEXIBLE MANUFACTURING SHOW

" The Nagoya show was an exhibition of existing Japanese Flexible Manufacturing Systems, CNC machine tools and various types of manipulators and robots. Attendance seemed to be very high by industry and the general public. Of special note were the large numbers of school children and the Mitsubishi and Hitachi robots that catered to them.

From a manufacturing point of view, Hitachi displayed one of the few workable CAD/CAM FMS systems yet seen, and its first full installation will be a new Nissan plant, testing having been done at Yamazaki Minokamo. Fanuc controls were very much in evidence and seemed to be the industry standard, with the exception of a few Hitachi and Mitsubishi systems. Laser cutting and vacuum forming of sheet products have now become universally accepted across Japan, and it appears that in the automotive industry vacuum forming may replace skin stamping.

From an organization standpoint, clustered machining centres with automated transfer lines controlled by microcomputers seems to be a standard method of handling machined and stamped parts. The main impact of the show underlined the importance of electronics in materials handling and manufacturing, and the overriding importance of work centres as opposed to production lines. "

THE TECHNOLOGY BRIDGE

During the seminar leaders' recent tour of Japan, a number of parts manufacturers were asked where they consider the best basic product research and technology to originate. Without exception they ranked Europe first, the United States a distant second and Japan third. Historically, they have considered the United States as the prime source of new technology, as evidenced by the large number of technology agreements struck between Japan and the United States in the 1950s and 60s. By 1970 however, Europe had gained the upper hand and continues to bring out more innovative technology in the automotive field than any other geographic area.

For the Japanese parts companies, the European source of new technology has lead to a technology bridge. Initial research and development is undertaken in Europe, where Japanese companies buy technology to bring back to Japan for production development and commercialization. The products thus produced are then sold worldwide, and especially to North America. It is important to note that Japanese industry in the automotive field increasingly views North America as simply a market, and not a technology or production centre.

The implications for Canadian companies are profound. If this technology bridge continues to be developed without any participation by North American and Canadian companies, then it is reasonable to expect that Canadian parts producers will be relegated to producing low technology, low margin products at best. Therefore, solutions must be found whereby Canadian companies attract both European and Japanese partners, ensuring some level of profitable parts manufacturing in the future.

NOTES ON SECTION II

CRITICAL POINTS

* Japanese industry has concentrated on applied technology development, reducing the cost of R & D and shortening the time to product commercialization.

* Japanese industry has purchased or acquired foreign technology through international information networks that involve both Japanese industry and the Japanese government.

* Japanese industry has trained manufacturing and technical personnel through domestic joint ventures with foreign companies in products and manufacturing.

* Japanese industry now sells their own technology processes and products in foreign countries where they benefit Japanese companies as:

   1. a source for low labour cost components
   2. a source for local market point assembly and distribution,
   3. a source for strategic materials and low cost energy.

* Japanese industrial development is a result of the preparation and funding of long term product goals through joint projects, involving several industrial sectors with government support.

* The Japanese component and vehicle manufacturers now have FMS systems, machine tools and product production processes to compensate for the lower value of skills productivity and quality control in setting up North American operations.

QUESTIONS

1. As an existing or potential parts manufacturer what commitment in human, financial and technical development will you have to make to compete with the Japanese?

2. What do you currently have in your company that would be attractive to a potential Japanese technology source?

SECTION III: PROCESS TECHNOLOGY

In this and the following two sections we will examine the availability of various types of technology from Japan and elsewhere. This particular section deals with process technology, in short the way in which one produces a product. Although many of us are familiar with the terms, little has been done to show the insights that the Japanese have gained from adapting others' technology and developing their own. We therefore look at this section not as a technical guide, but as a series of opinions which should serve as a catalyst for further discussion.

PLANT AUTOMATION

(extract from Flexible MFG System-Based Factory Automation in Japan; Yano Research Institute Ltd.)

Burgeoning FMS Boom

In 1972, Fuji Xerox Co. installed a then-innovative production system consisting of five machining centers combined with chain conveyors in its Ebina plant, starting automatic machining of die cast parts of copiers. This has been thought to be the first move to incorporate the FMS concept in Japan's industry.

That was followed by several other manufacturers in the machining fields of construction equipment, engines, machine tools, etc., including Yamma Diesel Co., Ishikawajima Harima Heavy Industries, Komatsu Mfg. Co., and so on. In general however, FMS was obviously in its infancy at that time.

At the beginning of 1981, Fujitsu Fanuc Co. constructed a robot-driven plant to manufacture robot parts. Its successful operation stimulated the machining industry as a whole to further develop FMS systems. This trend was especially apparent in the machine-tools and machine parts industry. In the fall of 1981, for example, Yamazaki Mazak Co. launched a FMS-driven work shop at its main plant with a view to full-time unmmanned machining of NC machine-tool parts. These moves were thought likely to be signs of a budding FMS boom, and have proved to be so.

The following points provide solid evidence of that burgeoning boom:

a) Many manufacturers are moving to employ high-performance FMS which incorporates the latest advanced technology such as fiber optics and so on.

b) Based on the relatively widespread use of assembly robots, the trend in factory automation (FA) is likely to be towards automated assembly processes as well as automatic machining process.

c) In advanced plants (mostly FA system producers' own plants), the "CAD/CAM combined FMS" has emerged, giving practical effect to unmanned operations from designing to machining to assembly.

d) There is an increasing trend toward FA in various fields of manufacturing industry.

From a different viewpoint, the FMS concept has been embodied principally in the field of machining--especially cutting process--in Japan. Today, however, the scope of the FMS utilization is becoming wider, involving such areas as sheet metal and assembly processes. Examples of FMS for sheet metal processing are seen in the Omika plant of Hitachi and the Inagawa plant of Mitsubishi Electric Co. In the field of FMS assembly, the electrical fan-assembly system of Toshiba's Nagoya plant and Fujitsu Fanuc's Fuji are good examples.

At Toshiba's Fuchu plant, six machining centers, eight NC lathes, the automatic warehouse, unmanned carriers and five work-mounting-and-dismounting robots are connected to a computerized operation-control system by means of a fiber optic cable network. The plant was formerly operated by seventy-five workers, but it is now running with four workers during the day and three at night since the installation of the integrated system. The result: Productivity has been remarkably improved.

Today Japan's advanced FMS such as the CAD/CAM-combined type or the assembling robot-involved type are attracting attention from all over the world. Obviously, Japan is becoming a major FMS supplier to the worldwide market. According to an estimate by the Machinery Engineering Association, Tokyo, the total number of FMS installed in the world was 192 as of October, 1981. As the largest user, Japan accounted for 49 systems, followed by the United States with

44 systems and West Germany with 35 systems. (See Table I-1)

On the other hand, a 1982 survey on FMS conducted by the Nikkei Mechanical magazine revealed that 200 FM-systems were in operation in the first half of 1982 in Japan, though the figure involves that for FMC (flexible manufacturing cell), a compact type of FMS that is employable for manufacturing a wide range of products in small quantities in a small-sized plant. If one considers this type of FMC as a kind of FMS, Japan is far ahead of the United States and West Germany in FMS utilization.

Table I-1 No. of FMS Installed in Major Industrial Countries
(As of October, 1981)

Country	No. of systems
Japan	49
U.S.A.	44
W. Germany	35
U.K.	10
E. Germany	9
U.S.S.R.	8
Hungary	8
Norway	8
Czechoslovakia	7
Poland	4
Bulgaria	3
Sweden	3
Italy	2
Rumania	1
Switzerland	1
Total	192

Source: The Machinery Engineering Association, Tokyo

(extract from 6-85 Ward's Auto World by D. Smith)

By simply changing computer software, a new machining line in Italy can change engine configurations with no downtime.

The highly automated and extremely flexible line sits in one corner of Officine Alfieri Maserati Automobil S.p. A.'s engine plant. Designed and engineered by Maserati, the new equipment was built by Saimp S.p.A. of Padova, Italy.

"We wanted flexibility," plant manager Francesco Verganti tells WAW.

"Normally you design an engine, try out a few prototypes and then you have to wait a year and a half or two years to test the engine and buy machines to make them. Using flexible machines, it now takes only one month from zero to full production. We only have to change the clamping pieces and software."

Maserati is secretive about the new machining line because it can be copied easily, Mr. Verganti notes; outsiders are carefully screened and cameras are forbidden. But he's not bashful in explaining its attributes.

Capable of fully machining blocks, heads and camshafts, the system can use up to 100 different spindles, he says. At one end of the line, four cutters can perform their programmed tasks simultaneously. When a tool change is necessary, the proper new tool is delivered and installed automatically. While that's happening, a single tool at the line's other end continues to drill, grind or cut the workpiece.

"This means we have no downtime for tool changes," Mr. Verganti explains, citing a major advantage of the advanced equipment.

When in full production on a 24-hour basis, the new engine line will be capable of machining components for 80 engines per day-not big by U.S. mass-production standards, but far greater than Maserati's requirements. By contrast, a second, less-automated line adjacent to the new equipemnt in Modena can produce 43 engines on three shifts using three men per shift.

(extract from 6-85 Ward's Auto World by A. Wrigley)

Not all automakers or their divisions are adopting high technology at the same rate. In some cases, they're weighing the benefits of one installation or another before making any sweeping changes in the way things are done.

Consider, for example, General Motors Corp's light truck assembly facilities in Oshawa, Ont., and Pontiac, MI.

Oshawa has ordered 425 automatically guided vehicles (AGVs)-an investment of $20 million plus-for use in engine dress, trim and chassis lines when it retools to produce GMC C/K series trucks as 1987 models. No other assembly system in the world is known to have that many AGVs in use.

But at Pontiac, where GM's Truck & Bus Group will produce the same vehicles, relatively few AGVs are expected to be used.

The computerized, wire-guided carts will be used at Oshawa several ways, including transporting engines and accessory components through assembly operations. They also can serve as work platforms.

Oshawa will give GM its best opportunity to date to evaluate AGV technology, and the high contrast between Oshawa and Pontiac should help in making that evaluation.

In its high-volume GM10 program (midsize W-cars that debut in 1988), GM is expected to make its widest use of computer-aided design and manufacturing (CAD/CAM), transfer stamping presses and programmable robots. Projects now under way at tool-and-die plants will enable GM to generate many of the production dies for the new front-drive models automatically from computer programs.

Computer-numerically controlled (CNC) die-making machines will be linked to robots, which will select cutting tools from tool carts and load them into auxillary spindle assemblies. After tools are used, the robots will place them back onto the carts.

GM plans to use advanced coordinate-measuring, computerized electrical-discharge machining systems and laser machining in production of dies, patterns, die components, details and other items in this $200-million-plus modernization program.

The automaker also is expected to use an unusually large number of robots (2,000-3,000) at all levels of W-car production, including engine manufacture, axle production and body assembly. Transfer presses also are due to be used extensively for the W-car and subsequent programs.

Transfer presses, enhancing productivity and quality, are an important part of automaking's reindustrialization. Because it can combine several forming operations, one transfer press can replace a dozen or more conventional presses.

Ford Motor Co. will use transfer presses to craft body components for its Lincoln Continental replacement (1988), redesigned '89 Thunderbird and Cougar and the new Lincoln Mark models, due for 1990.

Ford recently bought two large, 40-ft. (12.2m) transfer presses to make door panels for '86 Taurus/Sable at Buffalo, NY. The machines, Ford says, allow consistently tighter fit on body panels.

FMS IMPRESSIONS IN JAPAN

" Japan is the world's largest manufacturer of Numerical Controlled (NC) machines and Computerized NC (CNC) machines. Of 40,000 units/year, 70% goes into Japanese industry. The demand for accuracy is reducing the machining tolerance level from .001 mm to submicron levels. Industry demands this to manufacture products that are lighter, thinner, shorter, smaller, and more complicated. Accuracy and tolerances are becoming so critical that machining operations are being installed in clean-room plants, similar to the electronic industry.

Electronics and computer systems have triggered this applied technology development in manufacturing industries, and the Japanese automobile industry is the prime user. The application reflects in the new automotive developments in the Tokyo Motor Show.

The most significant factor in looking at some of the FMS and Computer Intergrated Manufacturing (CIM) operations was that they were at least 2 years old. Even the demonstration FMS layout (now being dismantled) at the Mechanical Engineering Laboratory of the Tskuba Science and Research Center was set up two years ago. This would indicate that Japanese auto-parts manufacturers locating in Canada/U.S.A. will be using a well-developed operating technology.

In terms of manufacturing tolerances, three FMC/CIM type operations were visited represtative of the range of manufacturing technologies in Japan, and the level of integration of plant and production systems:

FLEXIBLE MANUFACTURING OPERATIONS

	Plant	Tolerances	FMS Operations
1)	Honda	+/- .1 mm	Auto assembly
2)	JKC	+/- .01 mm	Auto parts
3)	Yamazaki	+/- .001 mm	CNC machining centers/tools

The Honda 1900 unit/day plant illustrated the well-organized Japanese auto assembly plant operation. It was interesting to note that the production of large plastic injected molding (bumpers) are now integrated into assembly plant operations. Robots are still primarily used in the body welding operations (600 weld points). Die change on the metal body-component forming 250 ton press lines is 10 minutes.

Jidosha Kiki Co. has developed a well co-ordinated (and profitable) FMC system that integrates operators in clustered machining and assembly operations. These clusters are assembled on the plant floor, based on the product requirement. Very little CNC equipment was evident. Most clusters had only NC/preset vertical/horizontal machining units. A key factor, however, was that in some clusters, one operator worked up to 10-20 operations/machines in a cluster, moving the product from one operation to the next. Only one robot (spray painting on steering assembly cases) was in operation in the entire plant. Production/sales have increased 15-20% per year with almost no increase in employees for several years now.

Yamazaki Mazak was a revelation in the state of second generation NC machining systems for small/medium scale FMS operations. The company uses their own equipment to produce their products. As users, their aim has been to develop practical "user-friendly" systems. This even required development of their own software so operators can program machining operations with a minimum of training. An operator uses a conversational type (9 languages) FMS computer to program machining schedules and production control. Multi-colour graphic displays are used. Their main FMS operation replaced 200 machinists with 12 operators on two shifts and there are no operators on the third shift.

Yamazaki Mazak indicated three areas that have become factors in FMS operations involving metal machining:

1) For accuracy and precision tolerances, the machining operations must have sophisticated waste/shavings removal, especially machining cast irons.

2) High-volume machining has reduced the time between operations and piece distortions created by heat build-up requires special clamping controls and chiller systems to relieve the pressures.

3) Even in small/medium production scale operations, the demand for more tooling capacity (a 368 tool storage bin was shown), is more evident in the market.

The coming wave in precision machining created by the technology developments in FMS and CIM systems is an industrial direction that Canadian companies must become involved with to keep pace with international industry. "

ROBOTS

(extract from Digest of Japanese Industry & Technology)

Growth of Industrial Robots in Japan

1) Background of Advent of Industrial Robots

Industrial robots were introduced primarily to improve the quality of products; to raise productivity; and, to enhance the labour environment by assigning to machines those dangerous and difficult jobs unsuitable for humans. In terms of labour, furthermore, factories with inferior working environments found it increasingly difficult to attract workers and, to a lesser extent, factory management came to realize that, for considerations of cost reduction, it was unreasonable to assign workers to jobs which could be performed by machines.

2) Introduction of Industrial Robots in Japan

Industrial robots were first imported into Japan from the United States in 1967. In the same year, Toshiba Seiki Co., Ltd., a machine tool manufactuer, developed Japan's first robot.

Robots were first put on the Japanese market on a commercial scale in 1968, when the robot called "Unimate," manufactured by Unimation Inc., began to be imported into Japan. That was the beginning of the so-called first robot boom with research and development being actively undertaken through the introduction of technology from abroad and by domestic technological development.

In 1972 robots capable of constant and reliable operation appeared on the market, at a time when the economy was growing steadily and the demand for robots was increasing. That was the year of the second robot boom.

Thereafter, the economy slowed down as a result of the oil crisis and the demand for robots stagnated. In 1977, with the recovery of business, there was renewed plant investment in labour saving devices and factory automation in order to raise productivity and to cope with the sharp rises in labor costs. Under such circumstances, various industrial robots were put into practical application.

The year 1980 saw the third robot boom with the start of robot lease system, heralding the age of full-fledged robotization in Japan.

Introduction of Industrial Robots

The utilization of industrial robots has been advanced by a number of factors including market, labor and costs.

a) Market: In the domestic market, rising prices, a sluggish economy and intensified competition were major factors. Competition in overseas markets has intensified, especially due to the inroads made by producers in developing countries with low-priced products. In order to survive such cut-throat competition both at home and abroad, businesses have realized the necessity of improving and stabilizing the quality of their products, of adjusting their production and diversifying their product lines by introducing the robots.

b) Labour: The factors to be cited here are shortage of skilled workers, the rise in labour costs and the need for a better working environment.

On top of this, there is the practice of lifetime employment in Japan, and surplus labour, resulting from the introduction of robots, can be absorbed within the same company by means of reassignment to other jobs.

c) Costs: Although the introduction of robots is a negative factor in terms of plant investment cost, there are schemes such as government financing and special depreciation allowances for industrial robots, although the benefits have not been entirely satisfactory. Leasing through private companies can also be undertaken.

d) Other Factors: These include labor unions being cooperative in the introduction of robots; the positive attitude of workers in their self-imposed control activities; and the eagerness of workers to participate in technical education and training.

ELECTRONIC COMMUNICATIONS

North American industry has always been smug (and complacent) about the problems Japanese have with computer software. Software is an English-language based conceptual system that is difficult to translate into other languages, even under reasonable conditions. Whatever the Japanese computer industry is using in software, industry, and especially the Japanese automotive industry, has applied computer software into a well integrated system in R&D, production, and management.

A key factor in this growth of software production has been the Japanese need for machinery to replace people. Since the country is short of people in almost all job categories, robotization and electronic controls have become a necessity, not just a cost-cutting tool. However, due to the complexity of the Japanese language, and the need for a consistent technological language, major problems have emerged that until recently have hampered software development.

In other areas of electronic communications, Japan has pioneered the use of worldwide telecopy (facisimile or FAX) useage. This is a highly advanced marketing and information tool used by Japanese multinationals and trading companies. Photocopy quality documents can be sent around the world in minutes, by conventional telephone lines. This has helped maintain a competitive edge in response time and information exchange that is equalled by few non-Japanese companies.

In the North American automotive industry, the use of on-line electronic communication is increasing. Parts order terminals in the vehicle assembly plants are hooked up to the production scheduling departments of the parts companies. This allows for rapid development of production schedules, order confirmation and eases the JIT delivery in each production system. This technology is rapidly becoming essential in North America, especially if a parts company wishes to become a preferred supplier to the "Big 4". Although Japan is still behind in its plant-to-plant electronic communication systems, they are expected catch up soon.

BAR CODING

Bar coding has become a major issue in the field of automotive parts production and delivery to vehicle assemblers. In theory, bar coding of individual products or batches allows a diverse number of parts to be sorted and delivered to various assembly areas on time. In practice, additional virtues have come to light including cost control and ease of inventory management and shippping.

Various manufacturers have used bar codes to more effectively control the operations of the plant floor. Raw materials scheduling, wastage control, and even employee productivity can now be monitored. A comprehensive bar coding system hooked-up to a computer will generate reports on all aspects of the parts or vehicle assembly plant. For the vehicle assemblers it is a quick, non-labour intensive way to check delivery times of parts suppliers, as well as generate performance records. For the parts producer, bar codes enable rapid integration of his products in the vehicle assembler's plant, helping improve the supplier-OEM relationship. As an added bonus to all, detailed reports can be generated to evaluate contractual obligations. In a situation where product traceability is needed, for mandated recalls or product liability, bar coding has become indispensable. The system allows for product tracking, after sales monitoring, and ongoing data collection for reliability testing.

The main purpose, however, still remains. That is to decrease the reaction time of the vehicle assembler for parts delivery and sorting in-plant. Also, it aids in keeping track of the thousands of different parts that are used for each vehicle. Interestingly enough, bar coding has not found much favour in Japan yet. To date the Japanese use computer generated control cards to monitor inventory, work-in-progress and accepted quality production. Given that automated bar coding has on occasion decreased routing and product monitoring time it is felt that the development of North American bar coding technology could give a productivity boost to the whole North American automotive industry.

NOTES ON SECTION III

CRITICAL POINTS

* The Japanese automotive and parts industries have attained a high level of technology through a combination of technology transfers, copying and innovating.
* The Japanese have applied FMS technology to advantage in a number of industry sectors.
* The Japanese are leaders in the use of robots and automation.
* The Japanese have achieved significant levels of quality through a highly motivated workforce and the use of programs like SPC or similar ones.
* The Japanese have selectively utilized to their advantage technologies such as JIT, QDC, and CAD/CAM.
* The Japanese have optimized management/employee relationships and the commitment of employees to their companies.
* The Japanese are behind North America in the relevant technologies of plant to plant electronic communication and bar coding.
* The North American vehicle manufacturers expect cost reductions by their suppliers of 25-30% by 1990.

QUESTIONS

1. Are you committed to a progressive automation program in your company?

2. Will you be able to achieve a level of quality in your product that will allow your customer to put your shipments directly on their assembly lines?

3. Will you be able to achieve cost reductions of 25-30% by 1990?

SECTION IV: PRODUCT TECHNOLOGIES

As the reader goes through the following section, it will be noted that both automotive product technologies and materials technologies will be covered. The relationship between these two technological areas is extremely close and certain new materials developments have ushered in a significant number of entirely new types of parts.

NEW MATERIALS TECHNOLOGY

(extract from Digest of Japanese Industry & Technology by S. Suzumoto)

Composite Materials

Paricularly noticeable in the field of materials has been a recent trend towards the application of composite material.

The basic aim is to use the superior qualities of each material in combinations such as "metals and fabrics" or "resins and fabrics", etc. Fiber reinforced metal (FRM) and fiber reinforced plastics (FRP) both belong to a family of composite technology-applied products.

At present, reinforced textile used for FRP is mainly glass fiber but in the foreseeable future carbon fiber is expected to be more widely used. In addition, a hybrid combination of glass fiber and carbon fiber is used often to optimize materials useage with strength requirements.

Fiber Reinforced Metal (FRM) has been used as a reinforced material framework in the space shuttle, and is designed to increase strength, durability and anti-abrasive properties by fortifying textiles with a matrix of light alloys.

Fibers that have been used include alumina, silica, carbon and boron, while the light alloys used for reinforcing include aluminum, magnesium, etc. FRM is a type of product that allows users to adjust material characteristics for a number of different uses. One application in the automotive industry has been pistons with FRM anti-abrasive rings. This diesel piston has been compound-forged to its top ring groove area. The ring is made of aluminum alloy reinforced with alumina and silica fiber (ceramic fiber), thus maintaining required clearance between the piston and cylinder by minimizing thermal expansion. Material benefits have included improving anti-burning properties and a rise in cooling efficiency by utilizing the inherent high thermal conductivity of ceramic fiber and aluminium alloy.

Fiber Reinforced Plastic (FRP), has been launched into the field of car materials, increasing weight savings and allowing high flexibility in the design of various structural and non-structural components.

FRP is an attractive material for the automobile industry, since it helps in creating light, fuel efficient cars. However, FRP related costs are higher than steel due to adverse factors such as longer molding time, greater difficulty in making large-sized components and poor coating properties.

But FRP should be considered an important material in the future. FRP-made components which have already been put into practical use include rear spoilers, bumpers, side mud guards, cover tops, clutch master-cylinders, etc. and in low production volumes, entire automobile bodies.

Ceramics

Ceramics, have begun to be more widely used for the automobile industry in Japan. Key advantages are outstanding heat resistance, anti-abrasion and anti-corrosion properties.

In practice ceramics are used as oxygen sensors, and water temperature sensors and constructional ceramics for mechanical seals, catalytic carriers, diaphrams for buzzer phones, and spark plugs. Recent developments in adiabatic engine technology have included the development of ceramic valves, pistons, piston rings, and in prototype forms crankshafts. Also with the increased popularity of turbocharging all manner of engines, ceramics are often used for the turbine blades and in some cases the actual turbine housing.

Special Metallic Materials

Form-memorizing alloy is a new product that is obtained from nickel and titanium, and has been used for radiator-grill shutters. The process works by expanding when heated beyond a certain temperature. This system has been installed in the shutter system of the radiator grills in conjunction with springs. Simple in construction, it is a highly dependable system which ensures perfect performance without any sensor or motor.

Sintered Forging

Sintered components are produced by compacting powdered material in a mold and heating it in a kiln to fuse the individual powder grains together.

Since sintered forging allows for greater precision, achieving desired dimensions, consistent density and high productivity, this alloy has been widely used as a material for car components. In general, iron powder, copper powder, nickel powder and graphite powder are used as raw materials. They are blended in proportion according to the required performance levels of each product.

ANTI SKID BRAKE SYSTEMS (ABS)

In 1982 Robert Bosch & Co. of West Germany announced a new mass production anti-skid braking system. The idea was to reduce the skidding of vehicles through the modulation of braking effort on each individual wheel. This was accomplished by mounting sensors at key hydraulic points in the braking system, and by "programming" ideal points into an onboard computer. These first systems were available in North America and Europe to the consumer through Mercedes Benz and BMW at an additional $4-5,000.00 per vehicle.

Advances since then have brought new entrants to the world wide market. Bendix has developed its own system, as has Girling but the newest products come from Japan. Of the five major brake component manufacturers in Japan not one has missed an opportunity to develop anti-skid devices. What makes the Japanese products so interesting is that they have now reduced costs to such an extent that the retail markup per vehicle of these devices is under US $1,200.00. Opportunity for Canadian parts manufacturers lies in the provision to Japan of certain subcomponents. Key amongst these will be aluminium calipers or later in the production cycle, specialized ceramic calipers and brake cylinders which utilize cheap Canadian energy for production.

ELECTRONIC CONTROLS

One of the most talked about developments in the automobile of the 1980s has been the increased use of electronic controls. First initial applications were in the use of convenience options such as power assisted windows, and power assisted seats. The next step was the use of electronic as opposed to mechanical controls for heating and ventilation and entertainment systems. The latest development is the use of electronics in critical areas of automotive safety and reliability.

The best example is the increased use of electronics as sensors for brake safety, engine monitoring, and now even environmental warning devices. These are all usually linked to an onboard computer which passes the information on to the driver via a diagnostic/warning display system on the dashboard. Other areas where electronic controls have and will have considerable impact include braking, power steering, and automatic transmissions.

The implications for the Canadian parts industry are two-fold. First, parts manufacturers must be able to identify vulnerable areas where cost or weight reductions can be achieved, or where increased utility is gained by the purchaser. Such areas would include the using of electronic window lifts, the use of fewer hydraulics and the increased fuel economy derived from electronic fuel injection. Secondly, the Canadian parts supplier will have to identify replacement technologies for each of the components and subcomponents involved in the shift to electronics. For instance, while window winding and seat adjusting mechanisms are relatively similar in both their manual and electronic forms, there is a great deal of difference between conventional hydraulic and electronic braking systems.

PLASTICS

The last two years have seen a considerable increase in the use of plastics inside and around the exterior of all automobiles. We are quite familiar with plastic trim, plastic fascias, and are becoming used to plastic body panels. The newest developments however include plastic engine components, and plastic structural components for bodywork. General Motors and Japanese companies are developing plastic fuel injection nozzles, and other heat affected critical components. Additionally, experimentation is now under way for all-plastic frames and floorpans.

For the Canadian parts industry the impact will not only be a loss of traditional business, but may translate into new opportunities. For instance, plastic fastening will become a problem in some cases since these products cannot be welded. Also, from a production line standpoint newly installed metal handling and welding automation systems will have to be replaced by more sensitive and non-destructive plastic handling machinery. The challenge therefore is not only to develop more uses for plastics but also to develop practical production methods to capitalize on the best features of advanced materials.

LIGHTING

The 1985 Tokyo Motor Show was an excellent showcase for emerging fiber optics useage. As had been predicted, fiber optics have found their way into the interior of automobiles, especially for instrument illumination. However, exterior useage is being encouraged by increased designer freedom in taillights, side lights, and turn signals. A number of displays were on hand showing cost effective fiber optics useage for transmitting both light and data inside a vehicle.

As the new U.S. headlamp and tail lamp regulations come into effect we are beginning to see more inventive and economical use of lighting materials and end products. From a design point of view headlamps and tail lamps are being made narrower, longer and thinner thereby achieving much more aerodynamic design of new automobiles. From a materials standpoint the use of plastic headlamps and fiber optic tail lamps will significantly reduce the weight and possibly the cost of light subassemblies. For the Canadian producer of automotive parts, the small scale cost efficiencies of both plastics and fiber optics should prove very attractive.

FOUR WHEEL DRIVE

Four wheel drive, as a "Yuppie" phenomenon has gained considerable popularity in North America of late. However, the Japanese motor industry seems once again poised to take an expensive and esoteric product into the mainstream automotive market by reducing production costs and thus retail prices. In evidence at the Tokyo Motor Show were a number of vehicles from 700 cc. microcars to 3000 cc. luxury sports cars which were equipped with four wheel drive. In the case of the microcars, the increased cost of the 4WD amounted to less than 15% of the total vehicle's cost, a feat that has not been seen even in Europe where 4WD is more common.

The Canadian parts manufacturer should be able to attract business through the supply of large volumes of key components, both to the North American based Japanese companies and the Big Four. There is little doubt that over the next five years this type of drivetrain will become more common place as have four wheel disc brakes for ABS and fully independent suspension.

INSTRUMENTATION & INTERIORS

As with other electrical componentry, instrumentation is undergoing considerable change. Liquid crystal, light emitting diode and fiber optics technologies are all in use in many Japanese instrument clusters. The changes therefore include more "active" systems as opposed to the typical "passive" systems found in North America. For instance, "talking" warning devices, numerous switches and gauges are more common in all types of vehicles.

In other areas of instrumentation, the dashboard has become a diagnostic centre. Often using touch sensitive, heat-sensitive, flush mounted controls, the driver can check brake wear, engine oil temperatrue, and other mechanical functions. The key difference of the Japanese has been to adapt once esoteric technology to the "average" car. A key example is the limited use of head-up displays in the instrumentation of some Nissan sedans. At present, head-up displays are in prototype form at General Motors, and in use only on combat aircraft in the United States.

Interiors are also undergoing considerable change. New designs are incorporating "belt-lines" around the interior of the car, enclosing the passengers in more contour forming seats. Much effort has also been spent on seat design and technology, including the reduction of weight, height and track length. One interesting development has been the use of electrical air pumps to add stiffness or lumbar support to various parts of the seat. Although not in production yet, we would expect to see the seats available within eighteen months.

For Canadian parts suppliers, the interior, seating and instrument areas may be areas of growth. With either new designs or by using other's designs, Canadian parts suppliers could begin to supply the requirements of the new Asian assemblers in North America. The key will be consistent high quality, ease of delivery, and highly competitive pricing.

SUSPENSION SYSTEMS

In recent years a considerable amount of work has been done in the area of suspensions. Mazda in 1983 introduced a variable damper setting for it's sports cars and 626 series luxury cars. These products are electronically adjustable by a switch on the dashboard, and also include automatic self-levelling.

In the area of springs, considerable attention has been given to synthetic materials. For both compression and leaf springs, resin on composite materials seems to work well.

Further development is ongoing, and in Japan the truck industry has become very interested. Key qualities include lower energy usage in manufacturing, less overall weight, and potential longer life of the springs. This last point may mean some return to leaf springs for cars, since lower profiles are possible with leaf springs as opposed to coil springs. This would be a major factor in decreasing aerodynamic drag.

Other spring related developments center around electronic controls. Like the Mazda variable suspension, other European and Japanese companies have developed electronic suspensions that "squat" at highway speeds, reducing drag and improving fuel economy. Citroen of France has been a leader in this area for decades, but it took Mitsubishi and Japanese parts companies to reduce costs and increase reliability. In this regard work is continuing on air suspensions, which are automatically controlled by sensors and compressors connected to on-board computers. In short, the suspension systems of cars and trucks represent considerable product improvement and new product opportunities.

PROPRIETARY VS. BOUGHT IN DESIGN

In the creation of every new automotive part, there is a conscious decision made to either create a part oneself, or to buy-in. The latter technique is steadily disappearing in North America, while in most of Europe and Asia it has already done so. We are clearly seeing the development of proprietary technology and product design in almost every facet of the automotive parts industry.

As a general rule, those parts that are proprietary to the parts producer are usually not "image" or "character" parts. By this we mean that they are not usually parts that give an identity to the finished vehicle. For instance, "image" parts include body panels, logos, interior patterns and fabrics, and for some cars (Ferrari, BMW, etc.) the entire drivetrain. However, the non-image proprietary products include Bosch's ABS anti-lock brake system, Recarro seats, various MAG wheels etc. It is these latter types of product, where the vehicle company buys a part for it's branded or technical qualities, that helps sell not only parts but entire cars.

Realistically, however, there are some parts that cannot be proprietary to one parts company. Therefore, in choosing the product mix, parts companies must not only carefully mix OEM and aftermarket parts, but must also understand the implications of their proprietary and non-proprietary OEM supply.

NEED FOR SUBASSEMBLIES

As the North American vehicle assemblers continue to increase their productivity and demand more cooperation from suppliers, there will be an increased need for subassemblies. As currently defined, subassemblies are completed groups of components that can be installed quickly and inexpensively on a vehicle during the assembly process. A subassembly is not just a more complex component or part, it is a fully functional, independent part of a vehicle.

For automotive parts manufacturers a number of strategic alternatives are emerging, all of which concern the supplier relationship. Working from the top down, vehicle assemblers will expect to be supplied by subassemblers exclusively, who are known as tier one companies. The tier one companies in turn will be supplied by component manufacturers, who often are today's parts companies. This tier two group of component companies will in turn be supplied by a third tier, that is, their own raw materials sources. Thus, a three tiered system of supply and production will exist, and it is in the tier one and two areas where competition will be fiercest. Today's automotive parts manufacturers will become either tier one or tier two suppliers, and the integrated companies will cover both levels.

NOTES ON SECTION IV

CRITICAL POINTS

* Product technology development is usually evolutionary, thus product improvement can often be more rewarding than new product research.

* Product quality is defined as predictable performance, to equal or exceed designed parameters.

* Overall cost reduction is a must, to enable a company to compete against offshore producers.

* There is a need to understand the significance of substitute and complimentary materials for all parts.

* Parts have product life-cycles all their own, the successful parts company will plan for the whole range of each product life-cycle.

* Proprietary design and production is a major competitive tool in many product areas.

* Sub-assemblies are the next stage in OEM purchasing requirements. Tier one parts companies should concentrate on full sub-assemblies, not just components.

QUESTIONS

1. What parts that you currently make are vulnerable to substitution by new technology or new materials?

2. What parts have you recently re-designed, and what new parts will you design and manufacture? How long is the product life cycle for each part?

3. How good are your parts (price, quality, & delivery) versus the competition? What is are the strengths and weaknesses of each part that you produce? Are you quoting on parts for 1989 and subsequent year vehicles?

4. Will you be a Tier One or Tier Two supplier?

SECTION V: MANAGERIAL TECHNOLOGY

Of the three types of technology that have been identified for purchase from Japan, this is the most difficult to define. This "soft" technology is dependent not so much on technical competence but on listening, tolerance and innovation. While much of what follows involves a very large dose of commonsense, the rather difficult to understand theoretical processes are equally difficult to implement. It is not easy to "create" quality circles, even though the theory is relatively straight forward and simple.

As has been mentioned before in this research manual, the most effective production asset that Japan has developed is personal communication. The strength of most Japanese companies lies in the skills of the employees and the company's ability to make use of them. Communication, and skills usage, therefore, are the main focuses of this section.

SKILLS TRAINING

As most automotive parts manufacturers know, if there is not enough knowhow in a company there will be short lived success. This is becoming increasingly apparent as new processes and technologies emerge in which new products are produced for a lower cost and at higher quality than their predecessors. Therefore, the need for skills training is not only apparent at entry level positions but at all levels of the company for both long and short term employees.

Without going into great detail about the Japanese education system, suffice it to say that Japanese companies are obliged to become involved directly in their school training systems, for skilled trades, technicians and management. In addition, regular upgrading of skills is considered an important part of the manufacturing process and thus considerable resources are devoted to in-plant training, seminars and special courses. No dollar value can be placed on these activities, yet the resounding success of the Japanese automobile industry must be at least be due in some small part to skills development.

For many companies there is a three tiered skills development training program. The first tier involves hiring qualified high school, technical school and university graduates into the company. The second tier concentrates on imparting the accumulated knowledge of a particular job that the company currently has. In many cases this involves considerably more than on the job training, since employees are often placed in specialized company run training courses. The third tier is continuous updating through company and outside seminars, technical exchanges and research at all levels of the company. Although in many instances this type of program does not differ from that of a North American company, there are two factors that provide better results overall. The first is a well developed system of peer and management-worker communications, through the use of quality circles, suggestion boxes and genuine personal interest being displayed at all levels of the company. For some companies there is a second success factor, long term employment. Although this has become a major issue with some companies, the commitment that is expressed by a company to its employees often has very tangible results.

COMMITMENT TO COMPANY AND WORKERS

Morale is unusually high in most Japanese companies. Although some privileged employees benefit from guaranteed life-time employment, two-thirds of the workforce do not. Therefore motivation encompasses company health and recreation plans, profit sharing etc. Beyond that however, there is extensive use of consultation and discussion between workers, technicians and management.

In the area of life-time employment, there have been suggestions that there is considerable potential for abuse of the system. It should be noted that employers can still dismiss employees for laziness, dishonesty, etc. and even if an employee is not performing to expectations they can be isolated from the company team. In companies where team effort is essential non-participators are side-lined in very public manner. This kind of punitive psychology works best when the whole society has a very structured set of expectations, as in Japan. However, to apply this system to North America would appear to be fraught with difficulty.

First, our societal values include high regard for individual rather than group effort, and second, mobility within companies and from company to company is extremely high, and a given right of the employee. Also, we must consider the cost to the company in not having the flexibility to rapidly change course due to a fixed skills structure. Thus, while certain Japanese managerial techniques appear to be worth copying, in most cases life-time employment is not.

In North American terms, commitment to the company is and will probably continue to be described as hard work, and constant effort. For the employees, company commitment to them will be defined as fair remuneration, a safe and healthy work environment, and consideration of their ideas and thoughts about their own and the company's work. It is this latter area were North American companies have traditionally failed, and where considerable time and effort will be spent in the years to come to equal if not exceed the two-way communication found in Japanese companies. The tangible results of this effort will be increased productivity, higher quality products, less wastage, and often a less hostile union/mangement relationship. Benefits therefore are to be found not only in performance improvement but in cost reduction.

RESEARCH AND DEVELOPMENT

The Japanese auto parts manufacturers generally invest 5% of sales in R&D. Most of this effort is channelled into improving existing products and developing new processes, although sucessful companies are reluctant to discuss details. In order to achieve this success R & D expenditures are aimed at improving the salability of existing or bought-in products through quality improvements and through unit cost reduction.

In a recent tour of Japan it became evident to the seminar leaders that Japanese R & D is successful because it **develops** products into saleable goods, and buys research as needed. As mentioned in Section II of this manual, a technology bridge is being developed between Europe and Japan in automotive parts, while North America's role is relegated to that of purchaser. If this situation is allowed to develop further North American parts companies, especially Canadian ones, will increasingly be limited to producing low margin products under license, or not being in the parts business at all.

For Canadian companies the emphasis on research and development must be increased if they are to stay in the automotive business. One possibility is to develop new products and processes with existing resources, a situation that most parts companies will find very difficult to achieve. The second alternative is to joint venture in North America with European or Japanese companies to produce here for the domestic and Asian assemblers. The third, and we believe the best alternative is to first find a European partner with whom communication and technology purchase will be considerably easier, and then involve a Japanese company. The usefulness of the Japanese is in bringing a product to commercial readiness, and in developing production know how and technology. Thus there is a staged series of actions that are necessary prior to becoming involved with these Japanese company research developments.

Also, the Japanese must be made more aware of the research resources available in Canada and the technology developments in Canadian industry. There are a number of Canadian companies that have considerable product and process technology of their own with which they can leverage a Japanese technology exchange or a contract with a North American located Asian vehcile assembler. To aid in this process, Japanese trading companies have recognized that there is a potential "market" for their involvement as brokers between Canadian and Japanese companies. Although this is a slow process, a number of Canadian companies have already improved their competitive position by using their technology with and without the help of Japanese trading companies.

HOUSEKEEPING

The companies that the authors visited during their recent tour of Japan had a number of common housekeeping elements that contributed to efficient working habits and high quality products. They include:

- no smoking or drinking in the work area, which contributes to reduced product damage, and increases output per employee.
- essentially no cardboard containers, which reduces non-essential clean up time and forces the companies involved (suppliers, parts companies and vehicle assemblers) to develop reusable packaging.
- narrow aisles reduce initial construction costs, reduce movement within the plant and encourage proper inventory and work-in-process control and shipment.
- all electrical wiring, air ducts, and gas lines etc. are mounted in the beams overhead thus facilitating the rearrangement of equipment for more efficient production and plant expansion.
- exclusive use of work cells as opposed to production lines, which helps promote employee morale and responsibility, and increases product quality through closer supervisory control.
- good lighting in work areas, increases safety and employee morale.
- extensive use of bulletins and posters throughout plants, keeps all informed of company and plant progress and

fosters pride in products and workplace, increasing worker/company commitment.

- many women working part-time as temporary employees, helps in the Japanese case to reduce per unit production costs.
- work uniforms common since they encourage identification with the company and a team spirit within work cells.

Although many of the above factors appear to be minor details in the daily operation of a parts company, certain tangible results have occurred. The first result has been little or no receiving inspection at vehicle assembly plants and at parts plants. This has been achieved because over a period of time each part of the supply chain has proven its ability to consistently deliver the required quality. The second tangible benefit has been steady cost reduction and complete cost control, including minimal "rework". Thus we can conclude that cost reduction and quality improvement is not only a result of stringent work rules and inspection eliminating procedures, it is a complete company commitment to working "smarter", and creating a better company environment for all company employees.

NOTES ON SECTION V

CRITICAL POINTS

* The key to Japanese research and development is constant product improvement which leads to constant cost reduction.
* The Japanese education system educates personnel and the Japanese industrial system trains personnel, therefore an integrated approach to skills training is achieved.
* Japanese managers and CEOs normally have a technical or generalist background not a financial or legal background.
* Job security means a stable workforce. The company cost for skills training and development of individual expertise is therfore not lost to competitors.
* Design, development and manufacturing planning is constantly directed to product quality, productivity and cost reduction.
* Japanese companies pay attention to housekeeping details that affect productivity and quality.

QUESTIONS

1. What efforts have you undertaken in your company to improve employee/management communication? Do you still see your workers as cost inflators or as cost reducers?

2. How much do you commit annually to R & D? Is this new research or product and process development? Do you intend to increasingly develop your own or to buy-in technology?

3. What housekeeping have you undertaken to reduce costs and improve quality? When was the last time you reorganized your plant and procedures? What will you be doing in the future?

SECTION VI: HOW TO ACQUIRE TECHNOLOGY

In the previous sections of this manual, we have concentrated on providing you the reader with a number of ideas about the technology available for acquisition. In some cases we have illustrated the usefulness of particular types of technology and commented on their applicability to the North American automotive parts industry. It now remains for us to cover the "how-to" of technology acquisition.

IDENTIFY YOUR NEEDS

As we have explained continually, during the seminar and in this manual, there are three types of technology that you can acquire. They are process, product and managerial technology. However, it is up to you to decide the type of technology required to increase your competitiveness, to open new markets, or to assure your long term survivability in any field.

The first item of business should be to evaluate your product lines and to ask the following questions:

- Are my products needed today and will they be needed in the next five years?
- What products are substitutes for what I now make or intend to make?
- Would a change of production materials used reduce costs, improve quality, or enhance my product's overall appeal?

If any of these questions indicate that you have some deficiencies you must then consider whether or not you have the resources to correct any shortcomings or to take advantage of the opportunities that you have discovered. The largest problem will be with time since with the shorter product life cylces in the automotive industry and rapidly changing consumer tastes your product or material change may have only a short lived effect. Thus, the key question is "Do I have the time, the money and the people to develop new product technology or should I buy it?"

In the area of process technology you must consider your company's ability to achieve constant cost reductions while improving quality to the point were there are zero defects. Ask the following questions of your company:

- Do we have the know how internally to reduce costs at least 25% below their current levels by 1990?
- Do we have the ability to produce the highest quality product in our industry, at the lowest possible price?
- Do we have the flexibility to rapidly change our production levels, and the types and numbers of products produced within that range?

If you identify deficiencies within these areas, you must once again evaluate your own internal resources to see if you have the capabilities to correct the problems, or take advantage of the opportunities. Again, how much of a factor is time?

Management technologies overlap the previous two types of technology in that they represent the "soft" aspects of technology acquisition. Invariably companies and organizations are leery of parting with information that makes them competitive. Hence, as the Japanese have done in the past, one often ends up buying process or product technology simply to acquire the managerial technology that is included in the package. Also, one must consider that hiring outside experts may be a more cost effective and productive substitute to buying managerial technology. It should be recognized however that some facets of management technology cannot be bought at all, you have to work through the problem as it applies to your situation. At a minimum the following questions should be asked:

- What special qualities do my competitors have that I need?
- Is that something that they are likely to part with, or can I get that knowledge from other sources without divulging to my competition that I have a weakness?
- Again, what is the time value of this technology and how long will it take me to get it up and running?

In this whole section we have assumed that your company has the internal capabilities to a. know the types of technology that it should have, and b. that your company knows itself well enough to identify the needed technology available in the environment. However, for a number of reasons this may not be true. Many companies are unaware of the complete range of technology available and how best to identify internal company requirements. If this is the case, information and assistance are frequently available from a number of consulting firms, and your provincial or federal government representatives.

SOURCING TECHNOLOGY FOR ACQUISITION

To this point we have assumed that you have carefully analyzed your corporate strategy, the changing international market, the changing North American automotive situation, and are aware of your own internal capabilities and deficiencies. Therefore, you are now ready to look for a number of technological purchases from around the world to help your company to achieve its goals.

Technology is available from three main sources. The largest and most common source is from manufacturers or researchers in any number of fields. The second source is governmental or quasi-governmental organizations, such as technology centers, research foundations and the like. The third source is universities whose laboratories, management schools and technical training centers often have a wealth of knowledge.

The largest problem that will be encountered is how to identify what is available. The following is a list of information sources:

- trade journals, a number of which you probably already subscribe to.
- trade shows, not only the ones that you attend as exhibitors but special technology fairs such as the

Hannover Fair in West Germany. There are a large number of technology fairs in Europe, North America and Asia, all of which are excellent sources of information.

- trade missions, both from federal and provincial governments which are both industry specific and/or country specific.
- your industry association is often an excellent resource centre for either the technology itself or those who own certain types of technology.
- technology brokers or consultants. If you are just browsing for ideas this is an extremely expensive route to take, but if you know what you need it may give you the quickest results.

It is extremely important to remember that all of the above costs time and money. One must be perfectly aware that to acquire knowledge of any kind takes a considerable amount of time. You should also be aware that the three sources will not provide all the answers unless you know exactly what key ingredients you need to help your company. Often these will not be obvious.

COSTS AND MANAGEMENT OF TECHNOLOGY ACQUISITION

The costing of new technology should be divided into three phases, the search, the negotiation, and the implementation. In all cases money, personnel and time must be taken into account. It is essential to remember that everything has a value and at each phase of the acquisition you should have clearly defined bailout points.

The costing has to take into account direct costs such as employee time and expenses, outside advisors, and of course, the value placed on the technology itself. The value of that technology must reflect a time saving, a research and development cost saving, and an experience-gathering saving. You must be fully aware of the hidden costs that are attached to any technology acquisition. These include training costs, servicing of the new technology, and legal liabilities. This last point is extremely important in the automotive industry given the recent class actions and individual settlements that have occurred due to faulty design, improper assembly and toxic or unsafe raw materials, and patent violations.

As mentioned previously, the first management procedure to be established for each acquisition project is a series of clearly defined go/no go decisions. These may be made on the basis of rapidly escalating cost, date sensitive technology, and substitute technology that reduces the value of your target technology. Continuity of the personnel in the project is extremely important, since as people are changed on a project so too are the priorities, and there will be an increase in total costs.

NEGOTIATION AND IMPLEMENTATION

The negotiation phase of any technology acquisition project will take a number of unexpected turns. Therefore, one must have previously examined as many variables as possible prior to commencing negotiations. This translates into extensive preparation efforts to establish the true value of the target technology, the possible costs to your company (monetary and otherwise), and your alternate strategies should negotiations stall or breakdown.

Preparaton and information management throughout this whole process cannot be overemphasized. You must know not only what you want, but also what the other side is likely to want, and all of it in minute detail. In negotiating with the target company you will find an extremely large number of people who concentrate hundreds of hours on small technical details, in order to wrest the best deal for their side, and put you on the defensive. To counteract this you must a. prepare a large team for technical backup, b. do your research on alternate technologies thoroughly, and c. control the location for negotiations. For example, it is unwise to undertake all negotiations in their country, since the selling company will know exactly how long your team has to spend there, and will delay serious negotiation to the last possible moment. Also, full advantage will be taken of your psychological problems in an unfamiliar environment, and the long lines of communication to your home office. When negotiating for any technology one cannot be over prepared.

It should be remembered that the structure of the final deal is in itself a cost. For instance, in many cases in the automobile industry it is both undesirable and almost impossible to simply buy technology for cash. Invariably a performance based licensing agreement or a joint venture will occur, in which both the purchaser and the seller have continuing mutual longterm interests. Thus, like marriage you are not acquiring just the bride but the whole family, or in this case not just the technology but a new partner.

Alternate strategies are another piece of the negotiating puzzle in which you will have to invest considerable amounts of time and money. Be prepared for time to run out, for someone else to bring out a much more worthwhile technology, and for a change in market conditions and your own corporate goals. In the case of offshore technology purchases, the technology seller is often more interested in its own entrance to a new market than in allowing you continued access to that market. Therefore one of the conditions of sale may be your teaching them in a number of different ways how to access that market, which may increase your costs. Specifically, you may have to put up a new plant, automatically making your existing facilities redundant and often a third party will enter the picture and the negotiations as a supplier or client. In many cases the technology that you buy is tied to a specific raw material source thus limiting your flexibility in both price and quality variations. Your alternate strategies must take into account not only the above but be able to determine if the additional cost and attached constraints allow the acquisition to remain viable.

After considering the following, and having reached an agreement the whole acquisition must be implemented. To properly integrate the technology with your company you will have to sell the benefits of the new purchase not only to the management and technicians, but also to the production workers involved. This will mean considerable personnel training, skills upgrading and the establishing of new routines. Physical changes to plant and machinery may be needed in addition to those directly associated with the new purchase, since any new element in a production system will impact directly on the existing procedures and facilities.

NOTES ON SECTION IV

CRITICAL POINTS

* Clearly identify your product, process and managerial technology needs.
* Be aware of the time value of money, technology and rising costs.
* Source technology from companies, government institutions and academia.
* Three phases of managing technology acquisitions: search, negotiation, implementation.
* Preparation in all phases is essential, it <u>cannot</u> be overdone.
* Establish clear bail-out points.
* Try to control location and tone of negotiations.
* Implementation can make all the effort worthwhile, or it will ruin your new investment.

QUESTIONS

1. What are your technology needs? How do they fit into your corporate plan?

2. Can you develop the technology yourself? What is the cost of self-development versus buy-in?

3. What do you intend to do with the new technology you want to acquire?

4. Is this a once only task, or will it be ongoing?