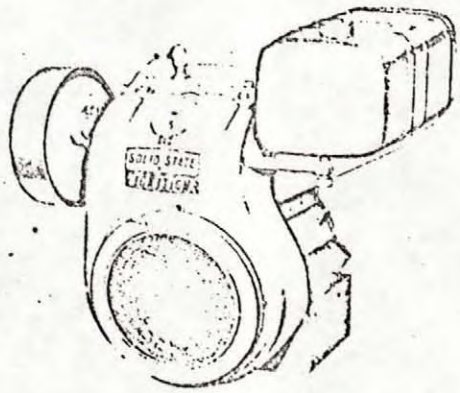
DEPARTMENT OF REGIONAL ECONOMIC EXPANSION

STUDY OF OPPORTUNITIES IN AIR COOLED GAS ENGINES

NOVEMBER 1972



Regional Economic Expansion
Expansion Économique Régionale

PLEASE NOTE

This report has been edited, where necessary, to remove comments and data that are classed as confidential. In the interest of efficiency, this has been done by simply removing small sections of the report. As a consequence, there are some blank spots which, we hope, will not interfere with the readability of the report.

Department of Regional Economic Expansion

AIR COOLED GASOLINE ENGINES

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AIR COOLED GASOLINE ENGINES

SUMMARY

The opportunities for manufacturing in this field appear extremely limited. Licensed assembly of imported components appears to be the only viable possibility at all; this might be in:

a) assembly of 2-cycle engines in the 15 H.P. to 35 H.P. range as used by the snowmobile industry.

b) assembly of 4-cycle engines in the 2 H.P. to 15 H.P. range as used by the lawn and garden equipment industry.

The viability of the opportunity for assembly of 2-cycle snowmobile engines may be considered somewhat questionable since the only Canadian independent engine assembler has not been notably successful in this market. Further, one of the largest importers and distributors has thoroughly studied and rejected the possibility.

The 2-Cycle Snowmobile Engine Market

Canadian production of snowmobile is expected to be in the area of 320,000 units this year. This represents roughly half of the total North American sales.

The remaining snowmobile makers in Canada are unattached. It is anticipated that Canadian manufacturers will be reasonably likely to retain most of their 50% share of the North American market in future years and it is estimated that industry growth will be roughly as follows:

Year	Unit Sales	Rotax Engines (assuming Bombardier retains 55% of Canadian Production)	All Other Engines
	Quantity		
1972	625,000	172,000	141,000
1975	780,000	209,000	171,000
1980	810,000 (1)	223,000 (2)	182,000 (2)

(1) Executive, March 1972 as confirmed by industry conversations
(2) Assumes Canadian snowmobile manufacturers retain 50% of the North American market

If an assembly plant of 2-cycle engines was attempted it would best be located in the province of Quebec since nearly all Canadian snowmobiles (approximately 98%) are manufactured in that province. Currently nearly all snowmobile engines are imported.

In this regard, now assemble roughly 50,000 2-cycle snowmobile engines per year from Swiss components. The bulk of this production goes to U.S.

There does not appear to be a Canadian market for independent suppliers of the smaller (2 to 7 h.p.) motors. Power saws are the largest users of such motors and the manufacturers of these make their own motors. D.E.S.A. Industries of Canada, a Toronto company manufacture saws and the motors for them.

The 4-Cycle Engine Market

Gasoline powered lawn mowers, garden tractors and snow blowers account for approximately 35% of 4-cycle engine purchases in Canada.

This market breaks down as follows:

Product	Canadian Production in Units	Expected Growth Per Year
Gasoline lawn mowers	200,000	+ 7%
Garden tractors	10,000	+ 7%
Snow blowers	25,000	+25-30%

The snow blower industry is growing very rapidly at the moment and this rate of growth is expected to continue for the next year or so.

A multitude of miscellaneous industrial and farm equipment applications are consuming several million dollars of four-cycle engines in the 2 H.P. to 15 H.P. range.

Four-cycle engines currently used in Canada are mainly imported from Briggs & Stratton of the U.S.

Most manufacturers of lawn, garden and industrial equipment are concentrated in Ontario and if an assembly plant of 4-cycle engines was established in Canada it would best be located in that province.

A commercially viable assembly plant for engines (two or four-cycle) would have to produce approximately 50,000 units annually to be competitive. A plant of that size would require an investment in the order of $800,000 to $1 million.

An assembly plant operating under licence would require a relatively low level of technical know-how since it would be supplied by the licencor. Labour on the assembly line is of an unskilled nature and is usually performed in great part by women.

GENERAL BACKGROUND

Air-cooled gasoline engines come in two basic designs: 2-cycle and 4-cycle.

Two-cycle engines vary in size from 35 c.c. (H.P. to 550 c.c. (45H.P.) displacement. They can have from one to four cylinders depending on size.

Two-cycle engines are mostly used in the snowmobile industry. Most of these engines vary between 223 c.c. and 440 c.c. Racing machines have larger engines but they make up a very small segment of the market.

Power chain saws are driven by 2-cycle engines of the one-cylinder design. Most of these engines have displacements between 35 c.c, (2H.P.) and 110 c.c. (7H.P.)

A small percentage of lawn mowers are equipped with 2-cycle engines. They all have one cylinder and most are in the 3H.P. (approx. 45 c.c.) range.

Two-cycle engines are also used in industrial applications but the products mentioned above account for roughly 90% of the estimated market.

Four-cycle engines vary in size from 2 H.P. to 80 H.P. They come in 1, 2 or 4 cylinder configurations depending on size.

These engines are used in a great variety of applications. The largest users are lawn and garden equipment, farm equipment and a variety of industrial applications such as pumps, conveyors, generator sets, compressors, power sweepers, asphalt tampers etc.

The lawn and garden equipment industry is the main user of 4-cycle engines. Most common sizes are from 2 to 10 H.P.

Two-cycle engines are cheaper than 4-cycle engines for a given size and deliver more torque at a given R.P.M. The 4-cycle engine however is smoother running and quieter. Generally, the 2-cycle design has to be used where the engine operates at varying angles such as snow and all-terrian vehicles, chain saws etc... Four-cycle engines cannot be used for these applications because of lubrication problems encountered at steep angles. In 2-cycle engines, the lubricating oil is mixed with the gasoline which eliminates the problem.

Following is a list of typical applications for each engine design.

AIR-COOLED GASOLINE ENGINES APPLICATIONS

TWO-CYCLE ENGINES

APPLICATION	ENGINE SIZE
Snowmobiles	15 to 35 H.P. (223 to 440 c.c.)
Power chain saws	2 to 7 H.P. (35 to 110 c.c.)
Lawn mowers	Approx. 3 H.P. (45 c.c.)
Various industrial products	full range

FOUR-CYCLE ENGINES

Lawn mowers	2 to 4 H.P.
Garden tractors	4 to 12 H.P.
Snow blowers (domestic)	4 to 8 H.P.
Farm equipment	full range
Various industrial products compressors generator sets pumps conveyors refrigeration etc....	full range

MARKET POTENTIAL

The following market potentials were derived from discussions with industry sources. (Statistics were not readily available).

Market by Product Type

The total Canadian market for 2-cycle engines is estimated at approximately $45 million for 1972.

The market for 4-cycle engines is estimated at approximately $20 million for the same period.

Market by Consumer and Industry Type

a) Two-Cycle Engines

Following are estimates of market potential for 2-cycle engines according to end use for certain key products.

Snowmobiles

Based on forecasted purchases of 300,000 snowmobiles engines this year and assuming an average price of $110 per engine, this market is evaluated at roughly $33 million.

Power Chain Saws

Based on an estimate of 155,000 units built in Canada in 1972 and using an average price of $30 to $35 per engine, this market is evaluated at $4.6 million to $5.4 million.

Lawn Mowers

Based on an estimate of 40,000 lawn mowers using 2-cycle engines at an average price of $30 to $35 per engine, this market is estimated at $1.2 million to $1.4 million.

The remainder of the 2-cycle engine market estimated at approximately $5 million is divided primarily between all terrain vehicles and various industrial applications.

b) Four-Cycle Engines

Following are estimates of market potentials for 4-cycle engines according to end use for certain key products.

Lawn Mowers

Based on an estimate of 210,000 lawn mowers using 4-cycle engines at an average price of $25 each a market of $5.25 million is derived.

Snow Throwers

This product is experiencing a fast growth and assuming that 25,000 gasoline powered units will be produced this year and using an average price of $40 per engine, a market of $1 million is derived.

Lawn Tractors

Based on estimates of 10,000 lawn tractors and assuming $75 per engine, a market of $.75 million is derived.

As previously mentioned, the end uses for 4-cycle engines are many and a detailed analysis of market potential by product would warrant a separate study.

Market by Geographic Location

Most of the 2-cycle engines are sold to the snowmobile manufacturing industry which is almost exclusively centered in the Province of Quebec and that province is the prime market for this type of engine.

Most of the equipment using 4-cycle engines is manufactured in the Province of Ontario and that province is the prime market for this type of engine.

INDUSTRY STRUCTURE

In the snowmobile industry, Bombardier, maker of Ski-Doo and Moto-Ski, has purchased Rotax of Austria who make all of their engines. Some American snowmobile manufacturers such as Arctic Enterprises and Polaris Industries have exclusive agreements with Japanese manufacturers of engines. These exclusive agreements are for stated periods of time and could be terminated by either of the parties at some agreed upon time.

The rest of the snowmobile manufacturers buy their engines from one or several of the unattached suppliers.

Vertical integration also exists for other types of products. For example, all power chain saw manufacturers in Canada make or assemble their own engines. Outboard Marine Corp. also makes its own 2-cycle engines for its Lawn Boy power lawn mowers.

The 4-cycle segment of the engine industry is not well integrated vertically because these engines are used on a wider variety of applications.

MARKETING CHARACTERISTICS

Buying Practices

Manufacturers of snowmobiles, lawn mower etc. who buy large quantities of engines will buy directly from the engine manufacturer and

will negociate prices for several thousand units at a time. A snowmobile manufacturer for instance, may purchase the engines he needs for a full year's production from a single supplier. He may on the other hand split his purchases between two or more suppliers.

The same applies to other products. As an example, a lawn mower manufacturer will offer different models with different makes of engines.

Key Industry Participants

Major suppliers of 2-cycle engines:

Fuji Heavy Industries - Japan

Fuji Motors - Japan

Yamaha - Japan

Kawasaki - Japan

Rotax - Austria

Hirth - West Germany

JLO - West Germany

- distributed through Rockwell Manufacturing Co. of Pittsburgh, Penn.

Kohler Co. - Malton, Ontario

Outboard Marine Corp. - Peterborough, Ontario

- a subsidiary of Outboard Marine Corp. of Galesbury, Ill.

Canadian Curtiss Wright - Malton, Ontario

- a division of Curtiss Wright, U.S.A. - imports from Kioritz Corp., Japan

Sachs - West Germany

D.E.S.A. Industries of Canada - Toronto, Ontario

It is believed that Japanese manufacturers currently supply approximately 325,000 2-cycle engines to the North American snowmobile industry.

Major suppliers of 4-cycle engines:

Briggs & Stratton Corp. - Milwaukee, Wisc.

Tecumseh Products Co. - Grafton, Wisc.

Kohler Co. - Malton, Ontario

- imports 4-cycle engines from the U.S.A.

Onan - Minneapolis, Minn.

Teledyne Wisconsin Motor - Milwaukee, Wisc.

Teledyne Wisconsin Motor has obtained a licence from Hirth to manufacture 2-cycle engines. It appears that other U.S. manufacturers of 4-cycle engines are in the process of obtaining licences from European and Japanese manufacturers of 2-cycle engines.

Selling Practices and Distribution

As previously mentioned, some direct selling is made to large O.E.M. accounts but the industry also uses distributors for smaller industrial accounts. Distributors' sales account for a small percentage of total sales.

For instance, a central distributor will be appointed in a given market area. This distributor will sell to small O.E.M. accounts which do not have sufficient volume to deal directly with the manufacturers.

The central distributor will in turn appoint service distributors who will sell to very small O.E.M. accounts, the replacement market and the general public.

There will also be service dealers who are usually shop owners who sell lawn mowers, snow throwers etc. The service dealers will do mostly repair work on the engines installed on the type of equipment they sell.

The following discount structure seems to be standard practice for the various levels of distribution in the industry.

Type of Distributor	Discount	
	Engines	Parts
Central distributor	list less 50%	list less 65%
Service distributor	list less 40%	list less 55%
Service dealer	list less 25%	list less 45%

Imports/Exports

The vast majority of 2 and 4-cycle engines sold in Canada are imported from the U.S., Europe and Japan. Only a few Canadian manufacturers do assembly work under licence from foreign manufacturers.

Kohler Co. of Malton, Ontario assembles 2-cycle engines per year for distribution in Canada and the U.S. All of their 4-cycle engines are imported. They are licenced by Moto-Sacoche of Switzerland.

PRODUCTION

Limitations of Manufacturing

Several components of air-cooled gasoline engines are made by a few large manufacturers who supply a world-wide market. These components have to be purchased. For instance, ignition systems are made only by Waco and Fecton both of the U.S. Carburetors are made mostly by Tillotson also of the U.S.

have tried to raise the Canadian content of their engines from 50%-55% to 75% but found it impossible. Too many components were not available in Canada. All their engines are in the 2 H.P. to 7 H.P. range and are used exclusively in power chain saws.

Plant Size

All engine manufacturers operate on an international basis because large markets are necessary to operate a plant competitively. Industry sources estimate 150,000 engines per year and preferably 250,000 engines per year as the smallest production capacity for a manufacturer who would make his own components. Such a plant would require investments of a magnitude of $5 million. For assembly work only, 50,000 units per year is estimated as an economically viable production volume and an investment of $800,000 to $1 million is necessary for this type of plant.

A Canadian manufacturer could enter the industry by assembling engines under licence from a foreign manufacturer who already has established markets.

Another alternative would be to induce a very large user such as Bombardier to assemble its engines in Canada.

Methods of Production

Manufacturing of engines to be economical must be done on a large scale as mentioned and requires the use of highly automated equipment for machining the components. In addition, several types of manufacturing processes and materials are used in the fabrication of the components. Following are a few examples of materials and processes used:

Cylinder blocks	- cast iron - cast aluminum
Cylinder heads	- cast aluminum
Crankshafts	- alloy steel forgings - ductile iron castings
Pistons	- die - cast aluminum alloy
Crank case	- magnesium (chain saw)
Cylinder bores	- chrome plating
Connecting rods	- aluminum forgings

The components listed above are not necessarily made according to this description, but it does illustrate the variety of materials and processes generally used in the industry. An assembly plant would not need these production facilities.

RESEARCH AND DEVELOPMENT

Product

Air-colled gasoline engines incorporate a high degree of technical know-how. Continuous development is going on to improve performance and lately, because of government regulation, to reduce noise level and emission of pollutants. For these reasons, a newcomer to the industry without the technical expertise required would be in the difficult position of trying to catch up with the technology for several years.

The Wankel rotary engine is a major development which will have an impact on the industry. It is estimated that by the end of the decade this engine design will capture the largest share of the market.

Following is a list of manufacturers who hold licences for the rotary engine:

Sachs
Yamaha
Kawasaki
Suzuki
Yanmar
Mercury
Ingersoll-Rand

These licences are issued by Curtiss-Wright Corp. of the U.S.A., the parent of Canadian Curtiss-Wright Ltd. of Malton, Ontario.

In addition, most of the major automobile manufacturers around the world have acquired licences to manufacture the rotary engines and a concentrated development effort is now being made. Toyo Kogyo of Japan, makers of Mazda cars plan to equip half of their cars in 1973 with this type of engine.

Equipment

Important equipment changes are necessary for the production of rotary engines. Since secrecy still shrouds this development, information as to the nature of these changes was not available.

COSTS

Materials, Labour, Equipment

Detailed breakdowns of material and labour costs were not available. As previously mentioned, manufacturing of components is a capital intensive type of operation.

The manufacturing equipment is highly automated which suggests high added value per employee and consequently a relatively low labour content per unit of production. It also suggests a skilled labour force capable of operating complex machinery.

Assembly work is of a different nature. The level of skill required is rather low and assembly line is usually staffed by women.

Tariffs

Import tariffs vary from duty-free to a tariff of 15% depending on the end use of the engine.

For instance, engines for agricultural equipment come in Canada duty-free. The general tariff rate for several industrial applications is 15%.

The U.S. has a general tariff rate of 4% for all end-uses.

PLANT LOCATION CRITERIA

An engine plant must preferably be close to its markets and in an area where skilled labour is available. Based on these criteria, Quebec is the most likely location for the manufacturing of 2-cycle engines while Ontario would be favoured for the 4-cycle design.

CANADIAN FACTORY SHIPMENTS OF SNOWMOBILES 1966-72

Year	Number of Snowmobiles (1)
1966	78,659
1967	116,665
1968	186,845
1969	324,508
1970	363,119
1971	322,050 p
1972	320,000 e

Source: (1) Statistics Canada

p - preliminary figures from Statistics Canada
e - estimated figures

Following is a list of Canadian snowmobile manufacturers.

Name	Plant Location
Auto-Ski Inc.	Pte-Claire, Quebec
Boa-Ski Inc.	La Guadeloupe, Quebec
Bombardier Limitee	Valcourt, Quebec
Conroy of Canada Ltd.	Thetford Mines, Quebec
Featherweight Aluminum Products Co.	Montreal, Quebec
Metal Rousseau Inc.	St-Jean-Port-Joli, Quebec
Moto-Ski Ltee.	La Pocatiere, Quebec
Northway Snowmobile Limited	Pte-Claire, Quebec
Outboard Marine Corp. of Canada Ltd.	Peterborough, Ontario
Roll-O-Flex	Regina, Saskatchewan
Skiroule Ltee.	Wickham, Quebec
Wee-Ski Corporation Internationale Ltee.	Princeville, Quebec

CANADIAN FACTORY SHIPMENTS OF
GASOLINE LAWN MOWERS 1966-70

Year	Quantity
1966	208,190
1967	212,457
1968	205,376
1969	253,298
1970	242,425

Source: Statistics Canada

Following is a list of Canadian manufacturers of gasoline lawn mowers reporting to Statistics Canada in 1970.

Name	Plant Location
Davis Outdoor Equipment Ltd.	Toronto, Ontario
Moto-Mower of Canada (Division of Dura Corp.)	Ingersoll, Ontario
Outboard Marine Corp. of Canada Ltd.	Peterborough, Ontario
Polee Power Products	Windsor, Ontario
Sehl Engineering Ltd.	Kitchener, Ontario

CANADIAN FACTORY SHIPMENTS OF SNOW BLOWERS
(OTHER THAN HIGHWAY TYPE) 1966-70

Year	Quantity	Value ($'000)
1966	N/A	1,524
1967	N/A	2,010
1968	N/A	3,090
1969	N/A	5,839
1970	21,205	5,230

Source: Report on Canada's Outdoor Power Equipment Market: Maclean-Hunter Research Bureau. September 1972.

N/A - not available

CANADIAN SALES AT WHOLESALE PRICES OF
GARDEN TRACTORS - 1966-70

	Less Than 10 H.P.		10 H.P. and Over	
Year	Quantity	Value ($'000)	Quantity	Value ($'000)
1966	1,556	941	2,175	1,638
1967	1,618	888	3,984	3,251
1968	1,881	926	5,034	3,939
1969	3,478	1,805	5,209	4,734
1970	4,618	2,483	4,510	4,526

Source: Report on Canada's Outdoor Power Equipment Market: Maclean-Hunter Research Bureau. September 1972.

PUBLICATION CONSULTED

- Statistics Canada
- Report on Canada's Outdoor Power Equipment Market. Maclean-Hunter Research Bureau
- Fortune. July '72. "A Car That Will Reshape the Industry's Future".
- Executive. March '72. "Charting the Future".

MANUFACTURER'S CATALOGS

Kohler Co.	(4 catalogs)
Pioneer Chain Saws	(4 catalogs)
Briggs & Stratton	
JLO Engines	
Teledyne Wisconsin Motor	
Lawn Boy (snow throwers)	
Honda	(2 catalogs)
Moto Mower (snow throwers and garden tractors)	(2 catalogs)
Tecumseh Products Co.	