

**STRATEGIC ANALYSIS OF A SMALL CUSTOM PLASTICS
MANUFACTURING COMPANY**

by

Lee-Ann McGuire
B.A., Queen's University, 1992
LIB., University of British Columbia, 1993

**PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
Master of Business Administration
EMBA Program**

in the Faculty

of

Business Administration

Lee-Ann McGuire 2003
SIMON FRASER UNIVERSITY
August 2003

All rights reserved. This work may not be
reproduced in whole or in part, by photocopy
or other means, without permission of the author.

APPROVAL

Name: Lee-Ann McGuire
Degree: Master of Business Administration
Title of Project: Strategic Analysis of a Small Custom Plastics
Manufacturing Company

Supervisory Committee:

Dr. Ed Bukszar
Senior Supervisor
Faculty of Business Administration

Dr. Richard Schwindt
Associate Professor
Faculty of Business Administration

Date Approved:

8-11-03

Partial Copyright License

I hereby grant to Simon Fraser University the right to lend my thesis, project or extended essay (the title of which is shown below) to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users. I further agree that permission for multiple copying of this work for scholarly purposes may be granted by me or the Dean of Graduate Studies. It is understood that copying or publication of this work for financial gain shall not be allowed without my written permission.

Title of Thesis/Project/Extended Essay

Strategic Analysis of a Small Custom Plastics Manufacturing Company.

Author:



Lee-Ann McGuire

11 August 2003

Date

ABSTRACT

This paper examines the strategic positioning of a small private company (“Pathway”), a provider of custom plastic manufacturing services in Vancouver. Pathway has considerable technical expertise in the plastics field, but corporate development has been constrained somewhat by inexperienced management and relatively unsophisticated business practices. Notwithstanding these handicaps, Pathway’s six year history has been characterized by under capitalization, rapid sales growth, and consistently increasing profitability.

The custom plastic manufacturing industry in North America has been in a phase of rapid decline, in terms of both sales volume and profitability. This decline is primarily attributable to increased competition from overseas entrants into the North American market. The overseas competitors have significantly lower costs and are diverting a substantial volume of work away from North American custom manufacturers.

Pathway has managed to avoid the negative consequences of the industry decline by focussing on servicing a niche market of alternative energy companies in Vancouver. As a result, Pathway enjoys better-than-average returns, and considerable growth in sales volume from year to year. However, this positioning strategy has left Pathway with an undesirable risk profile because the vast majority of Pathway’s sales are to one customer. Diversification of Pathway’s client base is desirable, but in the short term, Pathway must remain focussed on fulfilling the increasing demands of its predominant customer. Thus, increased sales concentration is likely unavoidable at present.

In preparation for eventual diversification through sales growth in the future, Pathways’ internal strategies should focus on developing more sophisticated business planning practices. Initial efforts should include developing an external sales and marketing team and formalizing the approach to human resource management.

DEDICATION

To my Mom, even though when I wanted a Pepsi, she just wouldn't give it to me.

To my Dad, for giving me an alibi when I needed it most.

To my MBA classmates, for putting the izzle in my fo' shizzle.

To all the girls I've loved before;

To the good citizens of DesMoines, Iowa, just for being there.

To Leonardo DiCaprio, for making me late for work in the morning: he knows what I'm talking about!

To Tony Robbins, for introducing me to myself.

To the heroes of 9/11: Never Forget.

To the Emergency Response Unit at Dollywood: there aren't enough "thank you"s in the world. Let the healing begin.

To the many trees that gave their lives so selflessly that this paper may live.

To David Hasslehof: the world is a better place with you in it.

To my boys at the IBEW, local 239: wiring power to the fight the power, always.

To Walter Simmons, my varsity lacrosse coach, for taking a chance on an unknown kid.

To Sir, with love (but how do you thank someone who has taken you from crayons to perfume?)

To reality television producers everywhere: I couldn't have procrastinated without you. Take me, Mark Burnett, I'm yours!

To my second-grade teacher, Mrs. Marfly, for believing in me.

To the 1976 Philadelphia Flyers, for showing me another way.

To the one I've left behind, a simple prop to occupy my tme.

To my peeps in the six-oh-four: in the timeless words of MC Fatlip, I don't got no homies who don't got my back, yo.

ACKNOWLEDGEMENTS

I would like to acknowledge the superlative instruction I have received throughout the EMBA program from the SFU Business Faculty. In particular, I would like to thank my senior supervisor, Dr. Ed Bukszar, for his support and direction on this project.

TABLE OF CONTENTS

APPROVAL	ii
ABSTRACT.....	iii
DEDICATION.....	iv
ACKNOWLEDGEMENTS.....	v
TABLE OF CONTENTS	vi
LIST OF TABLES	viii
LIST OF FIGURES	viii
1 COMPANY PROFILE	1
1.1 Introduction	1
1.2 Corporate History.....	2
1.3 Range of Products and Services	5
1.3.1 Design Services.....	6
1.3.2 Machining	8
1.3.3 Injection Moulding	10
1.3.4 Fabrication and Assembly	11
1.4 Target Market.....	12
1.5 Sales Concentration.....	14
1.6 A Plan for Growth.....	18
2 INDUSTRY ANALYSIS.....	21
2.1 Analysing Competitive Environments	21
2.2 Threat Of New Entrants: Moderate to High, Increasing.....	23
2.2.1 Overseas Competition.....	23
2.2.2 Common Technology Available to All.....	24
2.2.3 Low Capital Costs.....	24
2.2.4 Below-Average Returns May Deter Entry.....	25
2.3 Power of Suppliers: Low to Moderate, Increasing.....	26
2.3.1 High Concentration of Material Suppliers.....	26
2.3.2 Many Critical Inputs are Proprietary	26
2.3.3 Shortage of Skilled Employees.....	27
2.3.4 Equipment Suppliers are Not Concentrated	28
2.4 Power of Buyers: Low to Moderate, Increasing	28
2.4.1 Low Concentration of Buyers.....	28
2.4.2 Threat of Backward Integration.....	28
2.4.3 Lowered Switching Costs	29
2.5 Threat of Substitute Products or Services: Low, Stable	29
2.5.1 Substitute materials relatively scarce and expensive.....	29
2.5.2 Substitute manufacturing processes of limited utility	30
2.5.3 Emerging technologies are still developmental	31
2.6 Current Competitive Environment: Intense, Increasing.....	31
2.6.1 Mature industry with declining sales.....	31
2.6.2 Excess capacity rampant.....	31

2.6.3	Barriers to exit	32
2.7	PATHWAY'S NICHE	32
3	INTERNAL ANALYSIS.....	37
3.1	Generic Strategy	37
3.2	Pathway's Value Chain Configuration.....	42
3.3	Core Competencies	47
3.4	Competitive Advantages	48
3.5	Culture.....	51
3.6	Organizational structure	53
3.7	Financial Analysis.....	60
4	STRATEGIC ISSUES.....	63
5	RECOMMENDATIONS	74
	APPENDIX: PATHWAY'S FINANCIAL STATEMENTS	80
	REFERENCES.....	83

LIST OF TABLES

TABLE 1: LIST OF ALTERNATIVE ENERGY COMPANIES IN VANCOUVER	12
TABLE 2: GROWTH MATRIX (AAKER, 2001).....	19
TABLE 3: FINANCIAL RATIOS	60
TABLE 4: CLIENT AND INDUSTRY SECTORS	70

LIST OF FIGURES

FIGURE 1: HISTORICAL AND PROJECTED REVENUE GROWTH.....	5
FIGURE 2: SALES CONCENTRATION COMPARISON,	15
FIGURE 3: CUSTOM PLASTICS MANUFACTURING - PORTER'S FIVE FORCES ANALYSIS: ADAPTED FROM BUKSZAR, 2003.....	22
FIGURE 4: PORTER'S VALUE CHAIN GRAPH: PORTER, 1980. ADAPTED FROM BUKSZAR, 2003.	45
FIGURE 5: PATHWAY'S ORGANIZATIONAL CHART	54

1 COMPANY PROFILE

1.1 Introduction

Pathway Design & Manufacturing Inc. (“Pathway”) is a closely-held, owner-managed product design and engineering company specializing in plastics. Pathway is structured as a vertically integrated custom supplier of design, development, prototyping, tooling and volume manufacturing services: see www.pathwaydesign.com.

Pathway operates out of a 15,000 square foot facility located in South Burnaby and currently employs a staff of 75 full-time employees, including industrial designers, mechanical and materials engineers, toolmakers, and machinists. Pathway’s in-house manufacturing capabilities include injection moulding, machining, fabrication, and assembly.

Pathway’s business model conception was of a turnkey operation which could take a client’s product idea through the entire product development cycle without having to outsource any stage of the process right through to commercial-scale manufacturing. Pathway has worked on a diverse range of products including cosmetic containers, electronic PDA’s and web browsers, home colonic units, produce merchandisers for grocery stores, automotive wind and bug deflectors, an electronic wallet, hydrogen laboratory supplies, office furniture, lighting systems and methanol-conversion units. Pathway will undertake to design and manufacture any plastic product, whether a consumer good or a highly engineered component, sub-assembly or system.

1.2 Corporate History

Pathway was founded in 1997. The business had no tangible assets and only skeletal financing from owner-investments.¹ Modest premises were leased in New Westminster and the business of Pathway was started, relying on pre-existing contacts in the plastic fabrication industry. The work performed centered around provision of design services, with some rudimentary plastic fabrication manufacturing.

Successive increases in sales necessitated relocating to larger facilities; consequently, the company moved four times in three years, ending up at its present location in South Burnaby in the fall of 1999. As Pathway's business grew, the range of services expanded, with the addition of injection moulding, machining, and toolmaking capabilities, and all the while the core focus on plastics materials and processing was maintained.

For the most part, Pathway's expansion of services was dictated by the demands of its clients. For example, Pathway began machining at the behest of Glas Aire, an OEM of automotive accessories. Pathway had been designing wind deflectors for Glas Aire for some time, and Glas Aire was having problems getting its tools made for the products Pathway was designing. As a solution, Glas Aire installed a vertical machining center (VMC) at Pathway's premises in order that Pathway could make the moulds on its behalf.

After this introduction into machining, Pathway returned Glas Aire's VMC and acquired its own. Over the past three years, Pathway has built up a full-service machine

¹ Total shareholder investment was in the amount of \$6,000. Additional financing of \$25,000 was secured through the federal government's small business start up initiative.

shop to offer manual and computer numeric controlled (CNC) machining and toolmaking services to its clients. At present, Pathway has five CNC VMC's, a manual mill, a manual lathe, a CNC router, a tool grinder, an EDM machine, and other sundry machining equipment such as drill presses and routers. With the exception of investments in computers and software, all of Pathway's capital investments have been in its machine shop equipment. While all the equipment Pathway owns is of general application, it is the only machine shop in Vancouver that specializes in the machining of plastics.

Over the course of the past five years, Pathway has experienced revenue growth in excess of 2700%, entirely internally financed by positive cash flow. April 2003 marked the end of Pathway's 17th consecutive profitable quarter. Pathway's financial success is particularly notable in light of its neophyte management and its history of undercapitalisation.

With respect to business development, Pathway is currently undergoing a transition from a high-growth, cash starved start-up company, to a more mature stable operation. Concomitantly, the corporate culture is evolving from an *ad hoc* style of management to a more systemized set of controls. For example, the process of becoming certified under the ISO 9000 – 2000 standard necessitated a more regulatory approach to corporate governance and administration than had previously been in place.

Recently, a management buyout of one of the founders took place. Although the share purchase was nominally conducted through the remaining shareholders personally, the loans borrowed to finance the deal are guaranteed by Pathway, and as such constitute a contingent liability of the company. The understanding among Pathway's various

creditors is that a grossed-up amount is to be bonussed out to the company's shareholders annually in order to cover the principal repayments of the debt.

Thus, although the debt does not appear on Pathway's books, the repayment of the debt will have a substantial impact on Pathway's profitability during the period of the repayment of the debt. This creates an operational imperative in terms of maintaining existing levels of profitability that did not exist prior to the buyout. Profits generated in the 2003 fiscal year will suffice to payout the shareholder debt in its entirety. Once that objective has been fulfilled, Pathway will be in a much better position, as prior to the buyout, a dysfunctional stalemate among shareholder/managers had arisen. The post-buyout management structure is much leaner and more effective, and apart from the diversion of a substantial amount of cash for the buyout payments, the transaction has worked to the company's advantage.

Pathway's historical growth rate has slowed in the last two years to an average of *45% per annum*. Copies of the historical financial statements of Pathway are included for reference in section 3.7. The following graph charts the flow of revenues historically to 2003 and through to projections to 2006:

Historical and Projected Revenue Growth (** indicates projected sales volume)

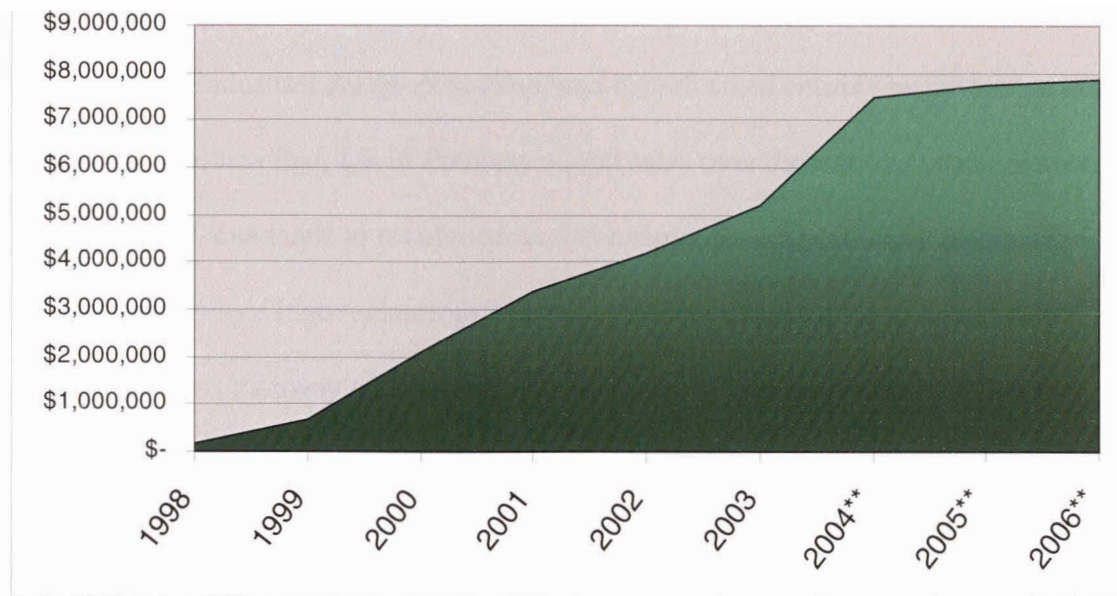


Figure 1: Historical and Projected Revenue Growth

The sales projections are made on the assumption that Pathway's core business will remain unchanged. While commercial-scale manufacturing is a possibility for Pathway, if it materializes, it will require a fundamental restructuring of the company, predicated on extensive equity financing.

1.3 Range of Products and Services

As a custom supplier, Pathway does not have any proprietary products. Instead it offers a range of design and manufacturing services outlined below.

1.3.1 Design Services

Design services performed for clients typically fall into 3 different categories: part design, tool design and design of jigs and fixtures. Part design involves mechanical engineering or industrial design personnel, and is performed entirely on computer. This work comprised less than 1% of Pathway's total sales over the last two years. Pathway's business in this area tends to revolve around consumer products and low technology products. Pathway's high technology clientele perform their own core design work.

However, Pathway's having design capability in-house does add value for its clients. Even if the part is designed by the client's own designers, there is still room for input in a design-for-manufacture capacity. If clients are using Pathway's prototyping or tooling services, there is a natural back-and-forth interface that transpires through various design iterations of prototyping and tooling. The greater the degree of collaboration between the part designer and the toolmaker, the better the end product. All of Pathway's project managers have some mechanical design expertise; accordingly, when formulating manufacturing processes, project managers are able to provide valuable design input to the client's engineers.

Tool design work on the other hand, is driven more by Pathway's manufacturing services. Tool design is usually a collaborative effort between Pathway's mechanical engineers and its toolmakers. Pathway has design injection moulds, vacuum forming moulds, punch dies and various other tools. This is a specialized technical area of expertise, and most of Pathway's technology clients would not have this expertise in-house. Most of the time, Pathway is commissioned to do the toolmaking on behalf of its clients, for a price typically varying between \$5,000 and \$50,000 per tool. When the tool

is completed, it belongs to the client, but usually remains on Pathway's premises in order that Pathway can provide manufacturing services.

On occasion, Pathway has absorbed the cost and risk of building tools itself. This is a technique for securing manufacturing work by locking in the customer. For example, in an effort to secure laboratory supply work, Pathway has undertaken to build an injection mould to manufacture 125 mL sample cups for a laboratory supply distributor. By absorbing the cost of building the tool itself, Pathway creates a switching cost for its customer.

Lead times on procuring injection moulds typically run about 8 weeks, and moulds are difficult to transport as they generally cannot be transported by air freight. Usually, manufacturers will try to procure a mould locally for that reason. For a company that does not manufacture itself, it will endeavour to contract with a toolmaker in close proximity to its manufacturing contractor. This too is a consequence of the logistical difficulties of transporting and setting up moulds. All of these circumstances operate to lock in customers to their custom moulders, which makes it worth the risk for Pathway in some instances to absorb the up-front cost of the mould to secure the manufacturing contract.

For Pathway, the decision to enter into tool making two years ago was a natural corollary to its "one-stop" shop strategy. In effect, customers seeking to procure manufacturing services will utilize Pathway's tool making services, and vice-versa. This nexus between design and manufacture surely generates additional work for a Pathway, because of the added value generated by having crossover expertise in all aspects of product development.

Similarly, the design of jigs and fixtures has led to manufacturing work. The term “jigs and fixtures” refers collectively to any fixed apparatus that is used in the manufacturing process to hold work during processing. Process development is the procedure by which it is determined how a part is to be made. Jigs and fixtures are the tools that the process designer invents to expedite the manufacture of a part, and to lower the per part cost. For example, if the design of a part required that a hole be drilled into a plate at a precise location, the process designer may develop a jig that automatically positions the part properly beneath a stationary drill along an assembly line. Jigs and fixtures decrease the labour costs of manufacturing, while improving the quality and precision of the manufacturing process.

Design of jigs and fixtures is thus an important component of manufacturing process development, an area that tends to be outside the expertise of the design engineering staff of Pathway’s clients. Designing and manufacturing jigs and fixtures typically requires at least a cursory understanding of ergonomics, the interface between humans and machines, which is more the province of industrial designers than mechanical engineers. Pathway has industrial design capability in-house, which is very rare. Having this capability creates another aspect of design-for-manufacture where Pathway can offer its clients value.

1.3.2 Machining

Over the last two and a half years, Pathway has slowly built up the capabilities and equipment of a full-service machine shop. In keeping with Pathway’s culture of being a young and technology-savvy company, Pathway has purchased, almost

exclusively, computer-numerically controlled (CNC) manufacturing equipment. CNC machining requires the services of a computer programmer, who programs the operations of the machinery. CNC machining has some advantages over traditional manual machining in that it allows for more efficient production manufacturing, with greater repeatability than does manual machining.

Currently, Pathway has five CNC vertical machining centres, including one fourth axis VMC, one CNC table router, one manual mill, one manual lathe, one electric discharge machine, a tool grinder, a punch press, a drill press, and various table saws, band saws, and routers. Equipment found in a standard machine shop that Pathway does not possess includes a CNC lathe, a surface grinder and a fifth axis VMC. Occasionally not having this equipment in-house prevents Pathway from undertaking certain jobs itself, and in those instances, Pathway will either refer the work, or sub-contract out the job to one of its machining suppliers.

The typical machine shop in Vancouver is a stand-alone operation. Some will offer CNC production machining and programming, and some will also offer toolmaking services. Few offer product design, and fewer offer any meaningful level of internal quality control services. Those who do are generally devoted to servicing the aerospace or medical supply industry in Vancouver.

CNC machining is suitable to both prototype and volume manufacturing. Many products are routinely manufactured in significant quantities by CNC machining, bike parts being one such example. Vancouver is a centre for mountain bike component manufacturing, and parts are machined in the tens of thousands.

1.3.3 Injection Moulding

Pathway added injection moulding to its range of proffered services more than two years ago. Performance in this area has been somewhat disappointing. There has been slow progress as Pathway builds up an inventory of moulds. Because of the high cost of injection moulds, injection moulding is exclusively a volume-manufacturing proposition. If there is a particularly simple mould, quantities of manufacture could be as low as a few hundred, but this is the exception rather than the rule. Injection moulding in Vancouver is a highly competitive, cost-based industry. For all but the most complex parts, the quality of the services is essentially the same from supplier to supplier. The biggest competition in this area comes from offshore suppliers.

As soon as any significant quantity of manufacture is involved (*i.e.*, parts in the tens of thousands), it becomes more economical to manufacture parts offshore. In such circumstances, companies will also procure toolmaking services offshore because of the difficulties associated with transporting injection moulds.

Locally, it seems that what little volume manufacturing there is, is the subject of fierce competition. The dollar value of injection moulding work performed by Pathway has been much lower than projected. Whereas the equipment in Pathway's other departments is overbooked, the injection moulder operates less than 5% of the time. What little work Pathway has secured on this front has been of the R&D manufacturing variety. Feedback from prospective clients has indicated that Pathway's pricing structure is not competitive for large volume work.

1.3.4 Fabrication and Assembly

Pathway's business originated in this area, which typically involves labour intensive, low-tech manufacturing. Pathway's background in manufacturing plastic retail displays provided it with considerable expertise regarding the manufacture of plastic products by hand. Pathway's first foray into volume manufacturing was making retail display units for the produce departments of Safeway grocery stores across the US. Manufacture of plastic retail displays is a relatively low margin endeavour, but operations require little in the way of startup capital.

The manufacturing technique used is generally referred to as "plastic fabrication", which typically involves thermoforming. In the thermoforming process, sheets of plastic are positioned over exposed heating coils until the plastic becomes malleable. The plastic is then bent by hand into a pre-determined shape created by a jig. While inherently "low tech" and labour intensive, the thermoforming manufacturing technique requires proficiency in the area of jig design.

In addition to its retail display work, Pathway's fabrication and assembly department provides R&D level manufacturing services to Pathway's high-tech clients, such as those in the alternative energy sector. This work accounts for the bulk of the dollar value in the "manufacturing" category. R&D manufacturing is undertaken when the cost of tooling mandates a labour-intensive manufacturing method until the part design is finalized.

As one might expect from Pathway's operations as a turnkey custom manufacturer, many of the regular parts that Pathway makes have work performed in more than one department. For example, many of the parts manufactured in Pathway's

· machining department are finished in the fabrication and assembly department. Having the assembly capability in-house creates some synergistic opportunities to bring work into the other departments at Pathway.

1.4 Target Market

Alternative energy companies based in the greater Vancouver area are Pathway's primary target market. The predominant manufacturing areas in Vancouver historically have been mining and forestry related manufacturing, such as the manufacture of heavy equipment by Finning International. However these sectors are in decline. Although Pathway did work on one project for mining giant Cominco, and on a few design projects for Deere-Hitachi, on the whole, work from these mature industries has been elusive.

Pathway has done minor projects from other established technology companies such as Creo and Nokia, but for the most part, they seem to have established supplier networks that are hard to break into on any significant scale.

The alternative energy sector is represented by something of an embryonic cluster of manufacturing companies in Vancouver. Included in this group are:

Azure Dynamics Corp.	Ballard Generation Systems
Ballard Power Systems	Ballard Transportation Systems
Cellex Power Products	General Hydrogen Corp.
General Hydrogen Corp.	Greenlight Power Technologies Inc.
Nxt Phase Inc.	Westport Innovation Corp.

Table 1: List of Alternative Energy Companies in Vancouver

Pathway has a relationship with all these companies, and has done work for all but Azure Dynamics and Greenlight Power. The combination of Pathway's proffered array of services and its niche specialization in advanced engineering plastics particularly qualified the company for work in Vancouver's burgeoning fuel cell industry.

Pathway's largest client is Ballard Power Systems, the widely acknowledged world leader in the development of zero-emission proton exchange membrane fuel cells. Ballard's PEM fuel cell technology is utilized in engines in vehicles, power conversion products for fuel cell generators for systems from portable power products to larger stationary power generation products. Pathway manufactures more than 70 different plastic components and sub-assemblies for Ballard, the majority of which go into Ballard's fuel cell stack for automotive applications.

Because of the alternative energy's reliance on advanced engineering plastics, Pathway is uniquely positioned to service this sector in Vancouver. While hopes are high for the development of an alternative energy manufacturing cluster in Vancouver, there is of course still a great deal of uncertainty regarding the future of this technology.

At present, the alternative energy industry is in the development phase. Very few industry participants are commercially viable, and are funded primarily by equity investment at this juncture. However, buyers are becoming markedly more sophisticated in this industry. In part, the hostile investment climate necessitates this, as firms have to be cost-conscious to some degree, even while products are still in the developmental stage; access to capital has been compromised for all companies because of the current climate.

To accomplish the cost reductions necessary to reduce their respective burn rates, OEM's in the alternative energy industry are being very proactive about procurement strategies, and focusing on supplier logistics. Measures taken to increase the efficiency of their respective supply chains indicate an increasing degree of buyer sophistication.

1.5 Sales Concentration

Despite having identified diversification of its client base as one of its primary business objectives for the past two years, Pathway's sales have become more concentrated over time, not less. In the first three-quarters of the 2003 fiscal year, sales to Ballard represent a full 90% of total revenue.

In previous years, Pathway's work was spread over a number of different customers, each of which operated in a different industry. This balance has eroded over time. As the work being done for Ballard disproportionately increased, attempts were made to bring in work from other clients to mitigate reliance on Ballard, unfortunately to no avail. The following graph, Figure 3, depicts the increase in sales concentration over the years.

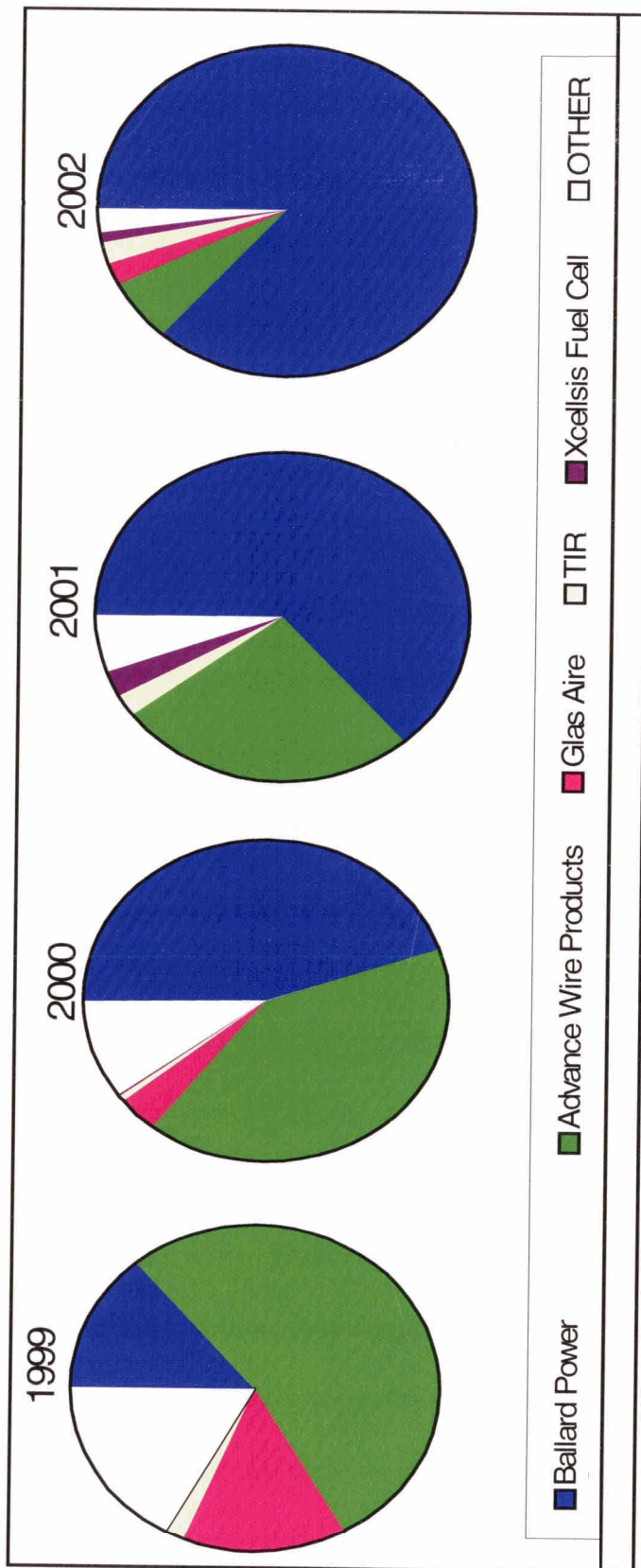


Figure 2: Sales Concentration Comparison,

For Pathway's remaining clients, the decline in proportion of total sales has been not only relative, but also absolute: less dollar value is being sold to these miscellaneous clients than before. Irrespective of total sales proportions, Pathway is doing less work for its miscellaneous clients than it was a year ago.

Reliance on any one customer would be inherently risky; reliance on Ballard as that one customer is particularly so. Even if the relationship with Ballard improves, specific risk factors with respect to Ballard's work still exist. The risks inherent in Pathway's reliance on Ballard specifically are:

1. Ballard has no established product or market, nor does it have a commercially viable working model for the different fuel cell applications at this time. The price point of these products is still too high. There are significant technological advances yet to be made before this product will be ready for market, and there are certainly no guarantees that Ballard will be successful in this respect. As a result, it is virtually impossible to forecast industry growth for products that do not yet exist in a commercially viable format.
2. Ballard currently is developing fuel cells for three different categories of applications: stationary power, portable power, and automotive applications. Pathway primarily produces components for the automotive applications, and this sector is universally regarded as being a much riskier endeavour than the stationary and portable power applications.

3. Furthermore, automotive applications are particularly risky because of the developing competition from low-emission vehicles. There are currently low emission hybrid electric vehicles on the market, such as the Ford Escape and the new Honda Civic. The emergence of these environmentally friendly non-fuel cell vehicles is likely to have a depressive effect on support for fuel cell vehicles. Fuel cell vehicles will require the implementation of a completely new fuel storage and refuelling infrastructure to deliver hydrogen fuel rather than gasoline, a significant disadvantage when compared to the low emission hybrids.

4. The automotive sector for fuel cells is almost entirely driven by the zero emission vehicle requirements to be imposed by the state of California in 2003. That legislation is subject to amendment at any point in time, and is formally reviewed on an annual basis. The trend at the California Air Resources Board has been to water down the stringency of the emission restrictions every time the legislation is reviewed. Concomitantly, these legislative amendments may reduce demand for Ballard's products.

5. Even if it is assumed that Ballard succeeds in developing a commercially viable technology and further, that market demand for the automotive application for fuel cells emerges, Pathway is by no means assured of sharing in this success. Firstly, there is the very tangible possibility that

Pathway would not continue to do work for Ballard in the future. This could be due to a relocation of Ballard's operations, a consolidation of their supply chain, a souring of relations or an incorporation of the work in-house.

6. Even if none of those eventualities were to materialize, Pathway is not set up as a low-cost manufacturer. Pathway would be unable in its current configuration to compete on a cost-basis to supply components on a commercial scale. This last factor illuminates the catch-22 of Pathway's reliance on Ballard: if Ballard's commercialization plans are not realized, Pathway's business will suffer, but if the commercialization plans are realized, Pathway is still likely to lose the majority of its business.

In light of the foregoing, the most important issue confronting Pathway at present is how to improve its risk profile without detracting from its commitment to being a tier-one supplier to Ballard.

1.6 A Plan for Growth

Pathway values its relationship to Ballard highly, and has no desire to reduce the extent of that involvement. The relationship is a strong one, and Ballard has been very generous with Pathway over the years in terms of developing Pathway's capacity and sophistication as a supplier. There is a strong mutual loyalty between the two companies, notwithstanding the substantial differences between the two corporate profiles.

In light of this particular state of affairs, Pathway must look to developing a growth strategy to achieve the objective of reducing its reliance on Ballard. Variations on such strategies are presented in the following growth matrix (Aaker, 2001):

	PRESENT PRODUCTS	NEW PRODUCTS
PRESENT MARKETS	<i>Market Penetration</i>	<i>Product Expansion</i>
NEW MARKETS	<i>Market Expansion</i>	<i>Diversification</i>

Table 2: Growth Matrix (Aaker, 2001)

Anyone of these four options is viable for Pathway. There is certainly room for Pathway to penetrate further with its existing markets and products; unfortunately, the penetration strategy may lead to further sales concentration. Pathway could instead look to add further services to its current offering, which is the way that Pathway has grown in the past. Right now, Pathway is considering the option of adding a concurrent custom mechanical engineering department, which would constitute a new product that would have appeal to Pathway’s existing customers.

Pathway may also go the other route of attempting to access new markets. Medical supply is an adjacent industry that Pathway has not done much work in, but which requires very similar expertise to alternative energy clients. In the alternative, Pathway can pursue the diversification strategy and seek new products for new markets.

Since its inception, one of Pathway's long-term goals has been to develop its own proprietary products. Having a range of proprietary products is standard practice for custom manufacturers. Custom manufacturers have unused production capacity at their disposal for essentially zero marginal cost; manufacturing their own products makes productive use of that excess capacity. Often custom manufacturers will opt to manufacture industrial products that suit their manufacturing capability to counterbalance the vagaries of cyclic custom manufacturing. Pathway has intended to develop a proprietary product line for this purpose, but has yet to do so because of lack of excess production capacity to date.

In order to determine which of these four strategic avenues would be the most prudent course of action, the current market Pathway services, the alternative energy sector, must be examined in order to ascertain what opportunities and threats Pathway's core business is likely to confront in the foreseeable future. This alone will determine whether Pathway needs to look to new products or new markets to fulfill its objective of improving its risk profile.

In Chapter Two, an industry analysis will be performed to determine the competitive environment in which Pathway competes. In Chapter Three, an internal analysis will be performed on Pathway. As a product of this analysis, the most significant issues currently facing Pathway will be identified in Chapter 4. Recommendations and a strategic plan in response to those issues will be delineated in Chapter 5.

2 INDUSTRY ANALYSIS

2.1 Analysing Competitive Environments

A potent tool for analyzing competitive environments is the five-forces model created by renowned strategist Michael Porter (Porter, 1979). The model is designed to assess the degree of competitive intensity in any particular industry. The more intense the competition, the less profitable firms competing in that industry are likely to be. By assessing the particular configuration of competitive forces in the industry in question, the five-forces model is an excellent foundation for the development of a strategic plan for the individual firm.

The five forces originally identified by Porter, *i.e.*, threat of new entrants, bargaining power of customers, bargaining power of suppliers, threat of substitute products or services, and the level of current competition among incumbent firms will each be examined from the perspective of the custom plastics manufacturing industry in North America (Porter, 1979).

Each of the five forces have a number of different variables worthy of consideration, some of which increase the intensity of the competition, and others which decrease the intensity of the competition, as illustrated in the accompanying graph, Figure 3 (Bukzar, 2003). All will be delineated in turn, and those that increase intensity will be marked with a (+) sign and those that decrease intensity will be marked with a (-) sign.

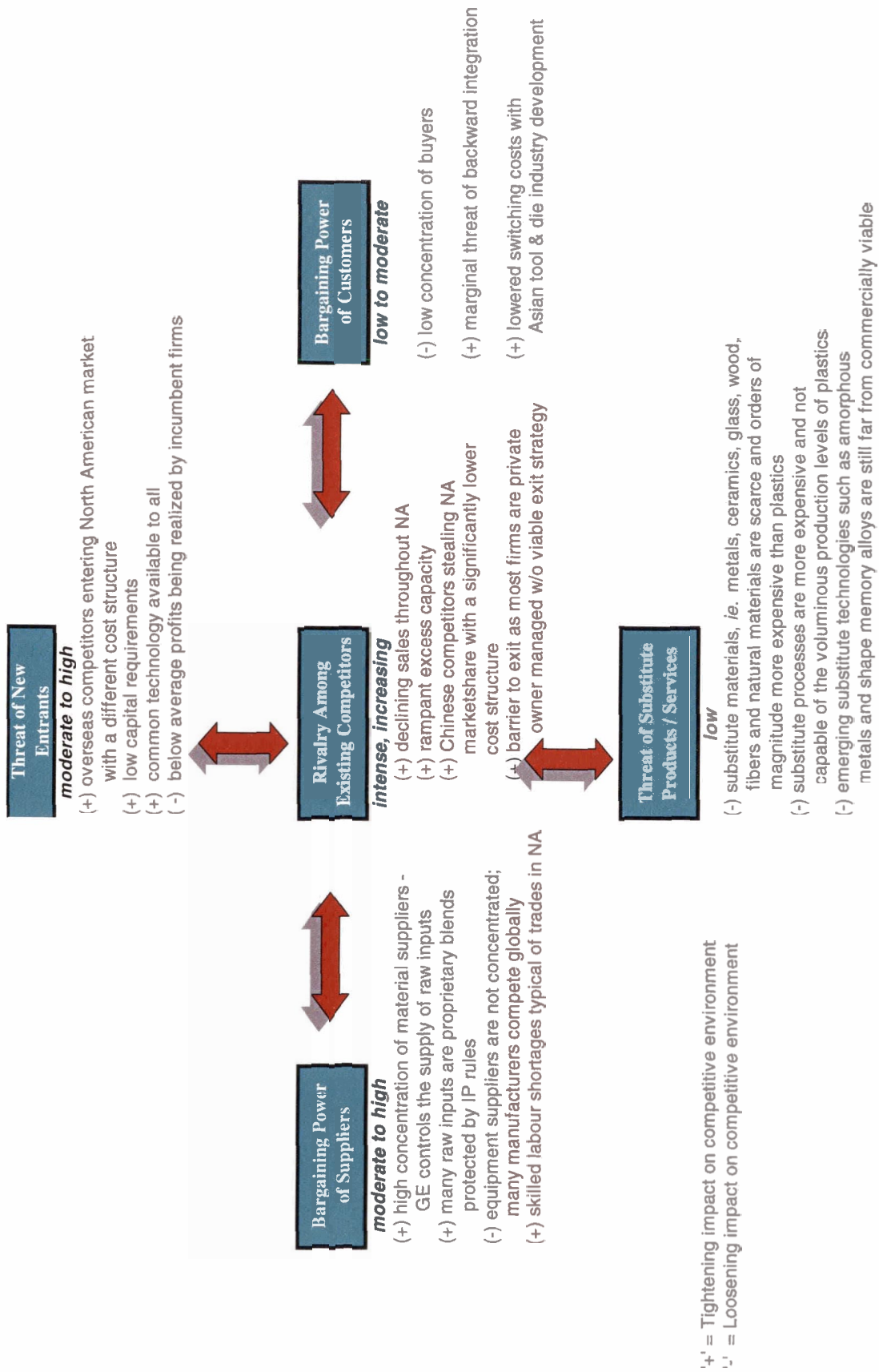


Figure 3: Custom Plastics Manufacturing - Porter's Five Forces Analysis: Adapted from Bukszar, 2003.

2.2 Threat Of New Entrants: Moderate to High, Increasing

2.2.1 Overseas Competition

In recent years, the North American custom plastics manufacturing industry has been subjected to an unprecedented level of competition from offshore competitors. Historically, North American OEM's strongly preferred to outsource manufacturing locally. In part this was due to a significant quality difference between work done in Asia and work done in North America in custom plastics manufacturing. Only low-end work was outsourced to Asian manufacturers because of differences in processing technology, skill of the labour and the quality of tools. Having to ship moulds overseas caused unacceptable delays in manufacturing, and custom tooling manufactured in Asia was perceived of being significantly inferior quality.

However, Asian countries, led by China, have been advancing at a remarkable pace. There is now a surfeit of skilled toolmakers in China that can manufacture a complex mould with only two weeks' lead time, a third of the time required by a market-leading North American toolmaker. Quality is now roughly comparable to the North American supply, but the price is 30% – 40% lower than the North American pricing scheme.²

Chinese producers are entering the North American market by opening a front-end office in North American manufacturing centres to attract local OEM's.³ By providing a viable and attractive toolmaking option in China, Chinese custom plastics manufacturers

² Based on a survey of quotations obtained by Pathway staff from Chinese and North American suppliers in June, 2003.

³ In Vancouver, the Hong Kong Mould Mfg of Canada Ltd. is a typical example. The office serves to liaise with North American clients but all the work is done offshore.

did an end run around the logistical difficulties inherent in shipping a mould overseas for use in manufacturing. Both tooling setup costs and per part costs are substantially lower in China than they are in North America, and OEM's are looking to outsource manufacturing overseas in unprecedented numbers.

Thus, while the worldwide plastics industry is enjoying steady growth in the order of 3% per year overall, the North American segment of the industry is in rapid decline. Between 2000 and 2001, sales volumes of the custom plastic manufacturing industry in Canada decreased by 17% (K&H Global, 2002). It will be difficult to recover the market share lost to offshore competitors who are operating on an entirely different cost structure.

2.2.2 Common Technology Available to All

There are only infrequent instances of proprietary technology in the custom manufacturing business. All of the intellectual property vests with the client OEMs. Plastic processing technology is readily available to all would-be entrants.

2.2.3 Low Capital Costs

The low capital costs of starting up an operation in this sector increase greatly the possibility of new competitors entering the fray. The equipment used by companies like Pathway is relatively inexpensive, and has a wide range of uses across many market sectors. Furthermore, a strong second-hand market exists for capital assets such as injection moulders and CNC VMC's. As a result, a would-be competitor need not assume any sunk costs to undertake a venture of this nature.

In this respect, custom manufacturing is not unlike the restaurant industry. Interestingly, the sector does not experience nearly the turnover that restaurants do. In a survey of local machine shops, the average length of time in business is in excess of 20 years. From year to year, turnover is very low.

2.2.4 Below-Average Returns May Deter Entry

Activity in the custom manufacturing industry currently generates lower-than-average returns. Theoretically this should be expected to deter additional entrants from entering into the fray, but because the offshore competitors are working with a substantially different cost structure than are North American companies, this does not hold true for all potential new entrants.

2.3 Power of Suppliers: Low to Moderate, Increasing

2.3.1 High Concentration of Material Suppliers

A handful of material and resin suppliers dominate the plastics manufacturing industry in North America: General Electric, BASF, Dow Chemical and DuPont. These few companies possess virtually all of the market share. There is a wide variety of different distribution companies involved, but these few producers manufacturer virtually all of the resins sold in North America. Sometimes the resins are extruded into sheet or rod stock before being sold to the end user, which also is typically done through a separate supply chain. The network of distribution and primary forming companies intermediating between resin supplier and end user tends to obscure the position of dominance occupied by the producers.

Nevertheless, for utility grade plastics such as ABS, polypropylene, polystyrene and polyethylene, the resin price varies consistently and predictably with the price of raw crude oil. The economies of scale achieved by having this oligopoly of a few huge multinational corporations as producers of resin, together with their extensive, complex distribution network create a formidable barrier to entry to any would-be competitor in the raw material input arena. For similar reasons, backwards integration is not a credible threat.

2.3.2 Many Critical Inputs are Proprietary

Many important types of plastic are proprietary, protected by intellectual property laws. For example, Lexan is the General Electric brand of polycarbonate that is used in a variety of applications, most notably for bulletproof barriers because of its strength and

optical clarity. Kydex is another GE brand, used for airplane interiors because of its heat resistivity, UV resistance and other properties. Teflon is another GE brand of plastic used for the manufacture of non-stick cookware surfaces. All of these plastic blends have particular properties that make them uniquely suited to the applications for which they were developed, and are not readily substitutable.

The uniqueness and proprietary nature of most engineering plastics greatly increases the power of suppliers to the plastics manufacturing industry for obvious reasons.

2.3.3 Shortage of Skilled Employees

There is a shortage of skilled technical workers in the local market. Machinists, CAM programmers, plastics technologists and mechanical engineers particularly are in demand. All of these tradespeople have skills that are in demand by industries other than custom manufacturing. Consequently, skilled technical workers have considerable negotiating power, and command quite high wages. A typical toolmaker in Vancouver will earn \$32/hour plus benefits and scaled overtime.⁴ The labour shortage leads to an inflationary impact on wages, but over time, this shortage will dissipate. Immigration policies, and a concerted effort on the policy front are increasing the number of skilled professionals and tradespeople available to the high tech sector every year. This coupled with the general downturn in plastics manufacturing will mitigate the influence of the current skilled labour shortage.

⁴ Unpublished private compensation survey of 15 Vancouver toolmaking shops commissioned by Creo Products Inc.

2.3.4 Equipment Suppliers are Not Concentrated

Manufacturers of processing equipment are relatively numerous and diffuse. Almost all of the manufacturers of plastic processing machinery compete globally. No clear market leader has emerged, as each brand is perceived to have advantages and disadvantages. For this capital input, the buyers retain most of the negotiating power.

2.4 Power of Buyers: Low to Moderate, Increasing

2.4.1 Low Concentration of Buyers

Buyers of custom plastic manufacturing services are a diverse and diffuse group. Typically they are Original Equipment Manufacturers (OEMs) looking to outsource manufacture of a component or product, either because of complexity of the manufacturing process or for perceived efficiency. Custom plastics manufacturers often serve a broad range of customers across industries. In some areas, buyers will be more concentrated, such as the Big 3 Automakers who commission almost all of the custom plastic manufacturing work in Windsor, Ontario.

Across the plastics manufacturing industry as a whole, however, buyers are not at all concentrated and do not typically wield much negotiating power.

2.4.2 Threat of Backward Integration

The nature of custom plastics manufacturing work is such that it is best performed by relatively small companies. In America, 90% of companies in this sector have less than 50 employees, and ship less than \$2 million USD per year in product (USITC, 2002).

The work outsourced by OEM's tends to be low volume production. As production requirements increase, it becomes more economical to set up a specialized line to make the part in question. Accordingly, a threat of backward integration exists with all high-volume custom plastic manufacturing.

2.4.3 Lowered Switching Costs

The reduction in switching barriers that has occurred as a result of the maturation of the Asian toolmaking industry has increased the negotiating power of OEM buyers of custom manufacturing services. In the past, a custom supplier could hold the buyer hostage to a significant degree merely by physical possession of the moulds, which are difficult to move and were expensive and time-consuming to replace. The switching costs of OEMs are reduced now because Chinese suppliers are able to provide substantially cheaper moulds with a greatly shortened turnaround time, as discussed in section 2.2.1. In the face of sharply decreasing sales, North American custom manufacturers must of necessity cede some bargaining power back to the OEMs.

2.5 Threat of Substitute Products or Services: Low, Stable

2.5.1 Substitute materials relatively scarce and expensive.

Plastic itself has evolved as a substitute material for the various natural products it replaced in different applications, such as metals, ceramics, glass, wood and fibers.

A change in the price of plastic would have to be of a significant magnitude before it became price competitive to substitute back again to the raw material inputs that plastic displaced in the first instance.

Some of plastic's natural substitutes are relatively scarce commodities, and therefore not a feasible substitute regardless of price. In a few applications, such as food container packaging, glass is a ready substitute for plastic. For most applications, however, the price differential is so significant that coupled with the disparate levels of availability, the relevance of natural materials as substitutes for plastics is limited.

2.5.2 Substitute manufacturing processes of limited utility

Many of the manufacturing processes used by the custom plastic manufacturing industry are exclusively for manufacturing with plastic resin, such as injection moulding, blow moulding, and rotational moulding. Other material inputs cannot be processed with these machines. Other types of plastic processing methods can be used on other material inputs, such as machining, fabrication and casting. Even in those instances where plastic processing equipment can be used on other materials, plastic is substantially cheaper and less labour-intensive to process.

Plastics processing techniques are capable of voluminous production output of complex shapes in a way that is for all practical purposes non-substitutable. For example, the universal manufacturing process of casting could yield the same complex part as the plastic process of injection moulding but the per part cycle time of injection moulding might be as little as 20 seconds, while the same part cast could have a cycle time as long as 12 hours.

2.5.3 Emerging technologies are still developmental

There are some new technological developments underway with composites, amorphous metals and shape memory alloys that at some point in the future may make these materials viable substitutes for plastics in certain applications. However, these materials are a long way from commercial viability on a mass scale. Once developed they will offer superior specifications at presumably comparable prices, but that degree of technological advance is still many years in the future.

2.6 Current Competitive Environment: Intense, Increasing

2.6.1 Mature industry with declining sales

Custom plastic manufacturing is a mature industry, technologically developed with mature markets. On a global scale, the plastics industry is still growing at a moderate, but healthy pace. This moderate growth rate obscures the massive displacement of plastic manufacturing work from North American custom manufacturers to Asian firms, as discussed at section 2.2.1.

2.6.2 Excess capacity rampant

Most North American firms have been saddled with excess capacity since 2000, when the proverbial bottom fell out of the custom plastics manufacturing market. Competition for jobs domestically has become more rivalrous, and a downward pressure exists on prices. Modest margins are being eroded. Although a number of firms in this industry have gone bankrupt in the past year in the Vancouver market, those companies that remain still report excess capacity.

2.6.3 *Barriers to exit*

Some moderate barriers to exit exist. There is a notable degree of asset specificity, and the market for second-hand plastics processing equipment has declined along with the state of the industry in general. This creates an exit cost, as the value of the equipment may be trapped in the operation.

Also significant with regard to the existence of barriers to exit is the typical profile of a company in this industry. Most are small, privately-held owner-managed operations. Given the unsophisticated nature of most of these companies, it may be presumed that most owners do not themselves have exit strategies, and cannot readily go to work in another industry, were they able to find a purchaser for the custom manufacturing operations.

2.7 PATHWAY'S NICHE

The foregoing five forces analysis paints a pretty dire picture for the present and future health of the custom plastics manufacturing industry in Canada. The downturn in the industry has been particularly marked in the past three years, which were all strong years for Pathway financially in terms of revenue growth and increasing profitability. Indeed, as the financial analysis contained in section 3.7 demonstrates, Pathway has managed to significantly outperform the industry averages in the last few years.

Pathway has thrived in the midst of an industry in decline because of the particular niche it has grown into by catering to the needs of local alternative energy companies in

the R&D phase of development. This market niche has been more or less immune to the problems plaguing the rest of the custom manufacturing industry for a number of reasons.

Firstly, the industry is not as rivalrous as it might otherwise be because of its relatively low profile. Aside from Ballard, companies in the local alternative energy sector are not well known. Overall, there is a general misperception as to the state of the industry as a whole. Most laypersons think that the technology is farther removed from commercial viability than it is. It would seem that many potential suppliers dismiss the opportunities available in this sector because of their misperception that the technology is not commercially viable.

Secondly, it seems that most established companies in the plastics industry consider doing work for R&D companies to be an unacceptably high-risk proposition. Because of the hot-and-cold treatment alternative energy companies get in the local press, popular opinions as to the stability of operations of these companies, or as to the adequacy of their financial resources, seem to be somewhat arbitrary and ill-founded. The perception that these companies could either relocate or go bankrupt on any given day deters suppliers from doing business with R&D stage companies.

Thirdly, even with considerable growth in volumes from Pathway's perspective, the pre-commercial production volumes are too small to warrant the attention of larger firms. Even though Pathway does a few million dollars per year in sales to Ballard, that volume is divided up over more than 50 different components. Most are too small to be of interest to the larger players in the custom manufacturing industry, such as Teleflex Canada.

Fourthly, the market is growing rapidly enough to dilute the intensity of any rivalry amongst incumbents at present. Indeed, there is not a marked degree of awareness of each other among competitors in this field. The field of competition is still controlled by Ballard for all intents and purposes. Over the past four years, there have been periods when Ballard has endeavoured to consolidate its supply chain, interspersed with periods where Ballard has sought to diversify its supplier network. Throughout this period, Pathway's work for Ballard has increased both relatively and absolutely to the point where Pathway is now Ballard's largest supplier in terms of dollar value.

Finally, the alternative energy niche is protected from the increasing competition in the rest of the custom manufacturing industry because at present there is no mechanism in place for a would-be competitor to gain entry to this niche market. There is no public tender process, and no open market exists for bidding on work. There is a supplier forum that is by invitation only, and to which Pathway is the only company to date to receive such an invitation.

Common practice in the industry is to not put work out for quotation by more than one supplier unless it is a new part. Existing parts are rarely put out for quotation by competitors. Because companies are in pre-production product phases, cost is not the determinant factor in sourcing suppliers. Speed of turnaround and manufacturing flexibility take priority. Because all of Pathway's corporate growth has been precipitated by work of this nature, all of its systems and operations are designed to provide the requisite flexibility in manufacturing.

Other firms wanting to gain access to this industry would have to curry favour with the purchasers of alternative energy OEM's, and there does not seem to be any

established route for doing so. Indeed, purchasers are often solicited for requests for quotation from would-be suppliers, but such efforts are usually to no avail unless there is a pre-existing gap in the supply chain.

All of these factors combine to create a niche for Pathway to provide custom plastic manufacturing services without being exposed to the full rigours of competition that characterize the industry at-large. Pathway has enjoyed some halcyon days of above-market financial returns and revenue growth rates, but these are not enduring conditions. As the target market of alternative energy companies matures and approaches commercialization, competition in Pathway's space will become more rivalrous.

Indeed, the corner appears to already have been turned with regard to the attractiveness of the industry with the concerted effort of Teleflex Canada to break into the alternative energy supply chain in the same position Pathway currently occupies. The aggression of Teleflex in its attempt to position itself as a player in the industry signals a likely end to Pathway's unchallenged market position.

Teleflex Canada is a subsidiary of Teleflex Inc. of the US, a large multinational conglomerate. Teleflex's local operation is a contract manufacturer servicing the marine and automotive sectors. With its considerable access to capital via its parent company and its extensive production capacity extant, Teleflex Canada could process a significant volume of custom manufacturing work for the sector. Because of the ability of Teleflex to handle huge volumes of work and to ramp up to even larger volume production if required, Teleflex represents a real threat to Pathway's incumbent position as the premier supplier of manufacturing services to local alternative energy companies.

Prior to last year, Pathway was the only company overtly targeting supply of this sector. Pathway has been the only manufacturing services supplier that has joined alternative energy industry associations and attended functions such as the annual Hydrogen Conference. Last year, Teleflex Canada joined Pathway as a member of Fuel Cells Canada, and this year, had an executive elected to the Board of Directors for Fuel Cells Canada, as did Pathway. This would indicate an increasing rivalry in Pathway's market niche.

To summarize, the competitive environment in the market of supplying manufacturing services to alternative energy companies in Vancouver is not particularly rivalrous. Given the early stage of the development of the industry, this is not particularly surprising. Market mechanisms do not yet exist for fulfilling demand for manufacturing services. The status quo of no ready means of entry into the alternative energy supply chain has a major dilutive effect on the intensity of the competitive environment.

However, the foregoing analysis of the direction and intensity of the five-forces of the custom plastic manufacturing industry as a whole would indicate that the less rivalrous atmosphere is merely a temporary abatement of competitive pressures. As the alternative energy industry matures and garners more credibility, other companies will seek to enter Pathway's niche.⁵

⁵ There are signs this is already happening on a perceptible scale. The June 2003 editorial column of the trade publication *Canadian Plastics* noted the composition of PEM fuel cells as being predominantly plates, seals, gaskets and pumps made of composite or plastic materials, which could be manufactured and assembled here, and terms it "a great opportunity" for BC plastic companies hard hit by the "ever-diminishing return" in mainstream plastics processing. This is exactly the work Pathway is doing currently (LeGault, 2003).

3 INTERNAL ANALYSIS

3.1 Generic Strategy

Since its inception, Pathway has generally pursued a differentiation strategy. Rather than competing on price, Pathway designed its operations to proffer value-added services over and above what the competition was offering. Initially, Pathway offered plastic fabrication services coupled with industrial design. When prospective customers were looking to have parts fabricated, design services were provided for free, in order to attract the manufacturing work. In this way, Pathway was able to attract work away from the mom-and-pop type operations that typically performed low-tech plastic fabrication services.

When Pathway added machining to its offering of manufacturing services, the operation was structured in order that a mechanical engineer oversaw every machining job in the role of project manager. This enabled the engineers employed by our clients to deal on a peer-to-peer basis. Most machine shops in Vancouver do not offer engineering support. Indeed, many of the established machine shops do not have the capability of accepting clients' electronic drawings in the IGES file format that enables transferability of drawings between different software programs. Pathway on the other hand, has invested in seats of various popular CAD software packages to ensure that our engineering staff is able to exchange drawings effortlessly with our clients' via email.

Clients perceive an added value in the services provided by Pathway, and accordingly are willing to pay a premium for those services. Particularly valued is Pathway's flexible manufacturing capacity, coupled with its emphasis on customer

service, engineering support, and our provision of ISO certified quality control services. Pathway's pricing structure is consistently higher than that of its competitors. To clients in Pathway's target market, reliability of supply is worth paying substantially higher per part costs.⁶

Because Pathway is a custom supplier, working on a Purchase Order to Purchase Order basis, quotations can be made to new customers on a "loss-leader" type basis. For example, when first quoting work from a prospective customer Pathway will occasionally underquote to outbid all competitors for strategic reasons. The strategy is of course to secure the work, introduce the customer to Pathway's commitment to quality and customer service and to the range of services offered. After a time, a new client will stop sending requests for quotation out to Pathway's competitors, and instead, will take the price that Pathway offers on new work. Apparently, reliable suppliers are few and far between in the local Vancouver market: once Pathway proves itself to the new client as a reliable supplier, a premium can be charged for those services.

Clients in the research and development sector are more concerned with the quality, reliability and flexibility of their supply chain partners than they are with costs. Pathway needs to maintain a more expensive organizational structure in order to be able to provide flexible contract manufacturing services. A cushion of available labour and capital must be maintained in order to accommodate the necessity for rework or

⁶ Pathway Customer Satisfaction survey conducted in October 2002 illustrated that Pathway gets awarded work notwithstanding its higher prices because Pathway "delivers", ie. manufactures parts to specification on time.

alterations on any particular project, as that can be required with less than a day's notice. This business necessity also translates into a requirement for a more skilled workforce. Pathway's cost of doing business is likely higher than its competitors, but this allows Pathway to provide significantly superior levels of customer service.

For example, most suppliers treat purchase orders as binding, but Pathway allows for changes to ordered parts up until the point of delivery. For companies in the research and development phase of development, having a flexible supplier who will accommodate changes of this nature is worth paying an extra premium. If on the other hand, the supplier treats the purchase order as binding in accordance with the industry standard, the client will often have to pay for parts that it cannot use. As a result, custom manufacturers who are accustomed to doing work for companies with commercial product lines do not routinely provide the level of service that Pathway does as a matter of routine.

Having been in business for more than 5 years now, Pathway has found it less necessary to initially compete on the basis of price, as its reputation is more generally known in the community. Last year, significant downsizings at Ballard Power and at Ballard Generation have actually translated into new clients for Pathway, as former Ballard employees moved to different companies in the alternative energy sector, and began to send work to Pathway from their new employers.

At present, Pathway has no designated sales staff. All project managers are expected to perform an inside sales function, and this has sufficed to fuel growth beyond the sustainable growth rate. New customers come through word-of-mouth referrals and from our modest Yellow Pages listings. Networking and industry association activities

have been minimal at best. Pathway has been a member of Fuel Cells Canada (FCC) since its inception in 2000, and elected a representative to the Board of Directors of that national organization in 2003.

Culturally, Pathway is characterized by an aversion to networking, sales and marketing functions. This is an admitted shortcoming of the company. As an alternative, Pathway endeavours to hire engineers who are somewhat different than the typical engineering stereotype in favour of engineers who are more personable and outgoing. This enables the bulk of the sales work to be performed by technical staff. Again this is a substantively different operational model than typifies the competition.

Because of its differentiated strategy, Pathway has been able to offer a significant degree of responsiveness to customer demands, a critical advantage in dealing with the unique needs of R&D level manufacturers. It is not unusual for Pathway's clients to change the specifications on a part long after its ordered. For example, if a machined part is ordered, the toolpath for machining the part must be programmed first. For a company in the R&D phase, it is not unusual to change the part's dimensions while the production run is underway, after the toolpath has been programmed. Most machine shops would not revise a part after it has been ordered. For Pathway, it is not unusual to have a part design undergo half-a-dozen revisions after ordering and before delivery.

Supplier development staff have advised Pathway that it is precisely Pathway's responsiveness and flexibility which makes it a valued supplier to Ballard. Because of the intensity of the sales concentration that evolved over time, discussed at 1.5, Pathway has little choice but to retain its flexibility. Whether this has been a conscious achievement on the part of Ballard Power is unclear; however, whenever orders for the

core parts that Pathway manufactures for Ballard slow down, Ballard diverts works from other departments to fill Pathway's capacity. Ballard likely perceives advantages to keeping Pathway dependent on its business to a significant degree.

From the point of view of the OEM, there are many advantages to having a supplier wholly dependent on it, provided that the OEM has taken due care not to become similarly dependent. There is the advantage of having a marked power differential when the time comes for supply negotiations. The OEM can exert an enormous amount of pressure for price reductions in these circumstances. Similar pressure can be exerted regarding delivery schedules.

If the supplier does not have any other large customers, the OEM can exert a level of control over the supplier's operations to the extent of reordering production schedules. In Pathway's case, Ballard's buyers will sometimes delay the production of one part, in order to accelerate the production of another, altering Pathway's delivery schedule according to its own internal priorities. If Pathway's sales were less concentrated, Ballard would not have this freedom.

Even though it is in Ballard's interest to keep Pathway for all intents and purposes as an exclusive supplier, the arrangement is somewhat problematic for Pathway. Reliance on one customer has a direct negative impact on Pathway's risk profile, and as a result, restrains its ability to raise capital. Pathway's current constitution has evolved because Pathway lacks a proactive sales and marketing force. Over the past four years, Pathway has become overly dependent on work from Ballard as a result.

3.2 Pathway's Value Chain Configuration

Pathway's value chain configuration is not particularly complex, although it has integrated to some degree on both the horizontal and vertical axes. Pathway has undertaken horizontal integration over the years by adding new processes to its repertoire, and thus diversifying its operations. The most notable examples of this diversification have been Pathway's forays into machining and injection moulding. Different plastic manufacturing processes bring Pathway into competition in different market segments, each with its own cyclicity; in theory, this horizontal integration should stabilize Pathway's overall revenue base.

Pathway has also vertically integrated some functions along the product development cycle. Pathway has developed the capacity to design and make tools in-house, a function that many product design companies choose to outsource to specialized toolmakers. In fact the original conception behind Pathway's business model was to offer a completely vertically-integrated product design and manufacturing facility, a turnkey operation where clients could bring a product from ideation to commercial scale production. Although this model has been loosely adhered to, practical experience has shown that very few clients demand or utilize the breadth of Pathway's services as they are currently figured. It is the rare exception that we will be commissioned to design, prototype and manufacture the same product. It is much more common for clients to utilize only one or two facets of Pathway's proffered services along the value chain, and provide the rest of the services themselves.

With respect to its various capacities, as Pathway's value chain is currently configured, Pathway has chosen to continue to outsource plastic extrusion, rapid prototyping, and vacuum forming. At various junctures, each of these functions were assessed as to whether it made sense to integrate them in-house. For example, in one instance, Pathway did consider vertically integrating into the plastic sheet extrusion process.

For all manufacturing processes apart from injection moulding, Pathway buys its plastic material pre-processed, extruded in rod and stock form. For most parts, using pre-fabricated plastic stock is perfectly sufficient, as well as standard for the industry. It is very unusual for a company to extrude plastic granules in their raw form, as well as process them into finished products. The extrusion process is quite capital-intensive; accordingly, extrusion tends to be centralized in very large corporations, such as General Electric.

However, Pathway was consistently having difficulty procuring sheets of a particular grade of epoxy resin in a specified thickness within extremely tight tolerances. The only supplier of this variety of sheet is a small company located in up-state New York, and the material rejection rate for sheets bought by Pathway ranged consistently between 20% and 80%. Uncertainty of supply, long lead times and a high material reject rate were causing considerable operational problems. This translated to a direct loss in the tens of thousands of dollars annually. Building an extrusion line in-house was considered as a means of gaining more control over the material supply.

Ultimately, this make-or-buy decision was decided in favour of continuing to "buy", because it could not conclusively be determined that even with the advantage of

setting up its own extrusion line, Pathway would be able to extrude the sheet within the required tolerance. This example illustrates that Pathway is open to reconfiguring its value chain, but does so with careful consideration of the pros and cons of each make-or-buy decision.

In terms of how Pathway creates value for its customers, the attached graph, Figure 4 illustrates the focus of Pathway's primary activities in the areas of operations and the provision of services (Porter, 1980). The most notable aspect of Pathway's operations is the degree of integration among the operational activities. This impacts inbound and outbound logistics, but is most significant in terms of how it impacts operations. The use of a custom programmed operations database to control the custom manufacturing process is a way in which Pathway differentiates itself from its more traditional competitors and creates value for its customers.

Marketing and sales on the other hand has virtually no impact on Pathway's value chain, as the only activity performed in this area is cursory inside sales by Pathway's project managers to existing clients. Service, on the other hand, is a significant part of Pathway's primary value-creating activities. Being ISO certified and having a sophisticated internal quality control department in-house is an important dimension to Pathway's offering. Quality control systems are of particular value to research and development companies, and it is an aspect of service that many of Pathway's stand-alone competitors do not offer.

Figure 4: Porter's Value Chain Graph (Porter, 1980): Adapted from Bukszar, 2003.

Also significant from a service perspective is Pathway's flexible approach to manufacturing. Having a supplier that, without penalty, allows last-minute design changes in the manufacturing process is a convenience for R&D level companies. Pathway's project managers are themselves engineers with considerable expertise, which allows for the provision of valuable technical expertise, rather than just performing an administrative function.

In this last respect, Pathway's primary service activities are inextricably linked with the value created in the secondary support category of the firm's infrastructure. Pathway's decentralized structure also links back to the value created by its flexible manufacturing operations. Ironically, it is the absence of a sophisticated or rigid infrastructure that contributes to the margin of value created by Pathway's activities.

Another notable support activity in Pathway's value chain is human resource management. Again, it is the absence of codified policies and formal structure that makes this activity a creator of value. Every attempt is made to accommodate the needs of each employee on an individual basis. Many employees work flexible hours, and all are given time off to attend any school or training programs they perceive to be relevant to their own career development. Job descriptions are modified or cobbled together in some instances to meet the career expectations of the particular employee. Recruitment and hiring is conducted at the senior executive level to ensure cultural fit among new hires.

In almost every respect, the delivery of human resources management functions is highly personalized and individuated, all under the supervision of an immensely personable and engaging HR Director. The net effect of this is to attract and retrain top-level talent notwithstanding below-market compensation rates. This HR strategy is only

practical for a small company of less than 100 employees, and thus must be altered to align with Pathway's growth plans in the future. At present though, HR is a source of considerable value creation at Pathway.

The other support activities identified by Michael Porter in the value chain model, technology development and procurement, are not particularly salient at Pathway. Procurement is usually a relatively unimportant practice for custom manufacturers, as the customers usually specify and source materials, and inventory levels of stock material are minimal. In Pathway's case, the value of carried inventory is typically in the region of 1% of sales. With longer term and high volume orders being the exception rather than the rule, sophisticated procurement policies are not often helpful to custom manufacturers.

Technology development holds more potential as a source of value creation for Pathway in the future. It is a natural avenue to exploit for Pathway, with its technologically oriented culture.

3.3 Core Competencies

Pathway's core competency is plastics expertise. Of all raw materials inputs, plastic is the most complex. It can be processed in a myriad of ways, and depending upon the variety used, can replicate the properties of virtually any other raw material. There are thousands of varieties, each with its own nuances when it comes to processing. For example, thermoset plastics are notoriously difficult to mould within close tolerances. Almost all fuel cell components are made from thermoset plastics. Working with

thermoset plastics can be something of a 'dark art' and Pathway has a lot of experience in manufacturing with thermosets.

Of all the machine shops and product design boutiques in Vancouver, Pathway is the only one that self-identifies as having expertise in plastics (Dominion, 2002). The manufacturing base in Vancouver is fairly limited, and historically has revolved around heavy equipment used in the oil and gas, mining and forestry industries (VEDC, 2002). As a result, there is a notable dearth of plastics expertise in the local market.

Having closely located suppliers is an important consideration for research and development clients as there is a greater need for close collaboration. There are frequently meetings held between Pathway's own engineering staff and the engineering staff of its partners. Having a local supply network facilitates quick turnarounds, as time in transit is accordingly reduced. By way of illustration, the first couple of years that Pathway did work for Ballard, shipments were regularly made by taxi instead of by courier at Ballard's behest, in order to ship parts the instant they were manufactured. Being located mere blocks away from alternative energy companies such as Ballard and QuestAir, gives Pathway a noteworthy competitive edge because of factors such as these.

3.4 Competitive Advantages

Pathway's most noteworthy competitive advantage is its flexible approach to manufacturing. Every facet of Pathway's operations is oriented towards allowing for the constant alterations and revisions that are attendant upon R&D level manufacturing. This advantage is borne of the unique nature of Pathway's business systems, and of the attitude of its staff and management.

Being a new company⁷ managed and staffed by young people, Pathway has the advantage of having been very digitally-oriented in the development of its business systems. One of Pathway's organizational goals from the outset was to run a paperless office in so far as possible. For operations management functions, Pathway opted to design and program its own database in order to tailor its functionality to the typical demands of Pathway's clients. The database has been designed to actually facilitate flexibility in manufacturing of the sort typically required by Pathway's clients. A database programmer is kept on staff to continually adjust and expand the functionality of the operations database to keep processes as streamlined and organized as possible in the context of manufacturing with near-constant design revisions. All of Pathway's activities are integrated by the operations database.

For example, when parts are passed through inspection by the quality control department, the inspector uses the database to generate inspection certificates, and, using the same information, the database automatically produces the documentation necessary for shipping the parts to the client, as well as the invoice to charge the client.

In recruiting staff members, Pathway specifically seeks out employees who thrive on chaos, and prefer an unpredictable workday. A common interview question asked of prospective employees is "how would you feel if you spent 6 long hours setting up a job to run on a machine, and before you can make a single part, an engineer tells you to tear down the setup and cut one more of the part you were working on yesterday?" There's a

⁷ Most of Pathway's competitors are long-established businesses with non-computerized systems and equipment. A 2003 market survey of Vancouver area machine shops established the average age of machine companies to be in excess of 20 years in business. This survey was conducted by Pathway staff, and the results were not published.

particular personality type who finds this sort of scenario invigorating rather than frustrating, and Pathway tries to recruit employees like this as much as possible.

Constant reinforcement is given to staff regarding the importance of making all aspects of our operations flexible in order to accommodate our clients' particular demands. Management maintains an ongoing rhetoric about flexibility and accommodation being the real products Pathway sells, and encourages staff to be creative when additional demands are placed upon our production capabilities.

Our competitors are not comparably oriented in their manner of doing business. Traditionally, custom manufacturers respond to last-minute changes in part specifications in revised dock dates and increased prices. Pathway views such changes as being inherent in the R&D process, and consistently obliges its customers' changes as a matter of course. The economic efficiencies that are generated by Pathway's digitally streamlined operations management system allow for Pathway to be accommodating to client demands while protecting its margins.

As discussed at section 3.1, the convenience and flexibility proffered to clients by allowing for last minute changes allows Pathway to charge a premium for its services. The premium is moderate, usually less than 5%.⁸ Clients are willing to pay the modest premium, because of factors such as Pathway's reputation for reliable delivery and its adherence to ISO quality standards. By aligning its operations from the outset with regard to the objective of achieving flexibility in manufacturing, Pathway is able to

⁸ Based on informal feedback from clients' purchasing departments obtained by Pathway staff.

extrapolate those modest premiums to significantly higher returns than the industry average.⁹

3.5 Culture

Pathway's culture is characterized primarily by its youth. A conscious recruitment policy of preferring enthusiasm to experience has been adhered to, resulting in a younger-than-average workforce. The average age of Pathway's management staff is a relatively spry 28 years.

The youth of its employees is accompanied with a general air of insouciant irreverence that informs Pathway's corporate culture. Perhaps the best identifier of the corporate culture at Pathway is its anti-corporate orientation. There is no dress code, and office staff members do not have set hours of work. There are no apparent status identifiers, and there is considerable socializing among different classes of employees. Professionals, trades, production and clerical staff eat lunch together at the same table every day.

There is also corporate support for employees' outside interests, including the devotion of financial and other resources to support them in their hobbies. Pathway has sponsored mountain biking, providing employees with thousands of dollars in mountain bike components and paying for guided helicopter mountain biking expeditions. Pathway has provided thousands of dollars in support of an employee team of competitive robot builders. Pathway accommodates the training schedule of an Olympic hurdler and two

⁹ Cf. financial ratio comparison contained in section 3.7.

world-class mountain bikers, the touring schedule of a few different up-and-coming indy rock musicians and the demands of a fine artist.

Groups of employees organize themselves for rock climbing and scuba diving almost every weekend. Biannual staff parties routinely are attended by 100% of Pathway's employees. Every Friday afternoon, work stops at 3 pm for "Beer-o-clock" which involves beer and bocce on summer days, and beer and remote control Mini-Z car racing in the winter months. Pathway's indoor modular remote control car racing track covers approximately 800 square feet, and league rankings are hotly contested.

There is a low turnover among office staff and management employees, as well as skilled labour. There are periodic layoffs of production employees, in accordance with the somewhat cyclic demands of R&D manufacturing. It is unusual for production employees to leave their positions at Pathway voluntarily, and the core group of production employees has been employed steadily for more than three years. Many employees develop social relationships with their co-workers. When growth or an employee departure necessitates a new hire, recruitment focuses around finding someone with similar interests to incumbent employees in the relevant department. Interviewing is done collectively, and hiring consensually. Everyone in the relevant department is accorded veto power over any hiring decision.

According to internal surveys, employee satisfaction at Pathway is for the most part, very high. Most employees feel a considerable degree of loyalty to, and pride in, the

company.¹⁰ There is a strong work ethic among employees, and most regularly go “beyond the call of duty” for the greater corporate interest. This is particularly notable because most of Pathway’s management level employees are remunerated substantially below market-level rates for their respective skill sets, and Pathway does not offer employment benefits. There is no employee share ownership program.

3.6 Organizational structure

In keeping with its culture, Pathway’s organizational structure is in practice relatively flat. Responsibility is divided up into function areas.

There are four executive level positions identified on the official organization chart, as shown below, but two people fill these four positions. This is the result of a restructuring that took place after the shareholder buy-out conducted in 2002. Because the 2003 fiscal year was consciously earmarked as being a period of “milking” as much profit as possible from Pathway’s operation in order to pay down as much of the subordinated debt pertaining to the shareholder buy-out as possible, the two remaining executives decided to take on additional responsibilities rather than hiring additional staff.

¹⁰ Recently, 80% of Pathway’s staff volunteered to spend 30 hours of unpaid personal time to field a team for Pathway in a “Junkyard Wars” competition against a team of Ballard’s engineers for nothing more than bragging rights.

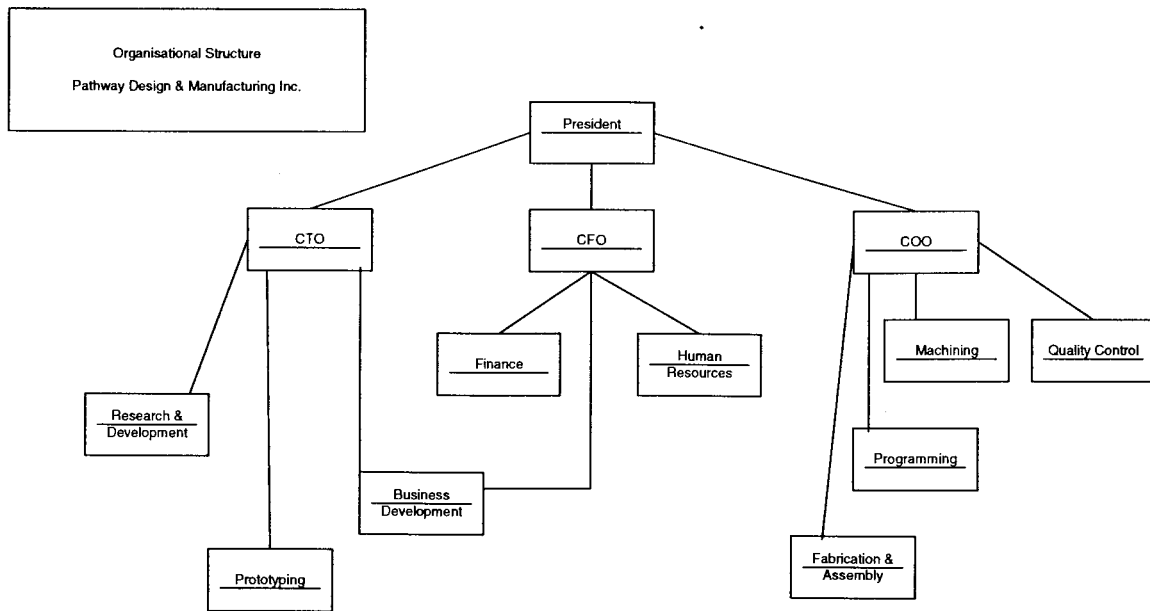


Figure 5: Pathway's Organizational Chart

The Chief Financial Officer and the Chief Operations Officer roles are now filled by one person, as are the President and Chief Technology Officer roles. The two executives share responsibility for business development, which includes the formulation and implementation of business plans and strategic directions. In addition, each executive level manager has direct responsibility over two additional functional areas: Pathway's CTO also looks after prototyping and research and development, and the CFO looks after finance and human resources. Thus, all administrative and support functions are conducted under the guidance of only one layer of management.

Operations, on the other hand, has two layers of management. All functions within operations are under the direct supervision of a separate line manager. Line managers have technical backgrounds relevant to the area over which they have responsibility, and have typically been promoted from within the ranks of the departments they now manage. Pathway's Chief Operations Officer has authority over these

departments, but as is the case with all of the lines of authority at Pathway, control is very loosely maintained. Line managers have control over particular functions, but the actual work is performed under the supervision of project managers, who are engineers.

For example, the manager of the machine shop has the varied responsibilities of allocating the department budget, reviewing the performance of the employees in the department, and monitoring quality processes within the department. However, the execution of a machining job would be under the supervision of a project manager. Project managers at Pathway all hold a professional designation, either a degree or diploma in mechanical, electrical or materials engineering, a degree in industrial design or a diploma in plastics technology.

Project managers are responsible for the order from the time it is placed by the client. Project managers oversee all of the following functions:

- ❖ Preparation of Bill of Materials
- ❖ Inventory management for repeat orders
- ❖ Materials procurement
- ❖ Scheduling of machine time
- ❖ Scheduling of human resources
- ❖ Delineation of process instructions
- ❖ Design of requisite jigs and fixtures
- ❖ Quality inspection
- ❖ Shipping and documentation
- ❖ Communicating with clients

The most important of these functions is of course the last. As discussed at section 3.1, Pathway's differentiating strategy is predicated on providing superior customer service. Project managers are Pathway's frontline of customer service, as they are responsible for day-to-day communications with our clients. Indeed, it is expected that they communicate with their respective client contacts every day, if there is anything to report.

Significantly, there is no "direct report" for project managers within Pathway's organizational structure. There has been an attempt to inculcate an illusion of reporting to the client, instead of to an internal manager. Project managers are not held accountable for the profitability of the jobs they oversee, only for client satisfaction.

Pathway is a truly decentralized operation, where real authority is delegated to every employee in the company. Line managers are given only general macro-level objectives, and no restrictions on how to fulfill those objectives. Last year, the company wide objective of perfect delivery date compliance was established. At company wide meetings, the objective was introduced, and an attempt was made to instill a sense of responsibility among all employees for improving Pathway's delivery performance. The annual performance bonus of all employees was made contingent upon fulfillment of the objective. No other goals were given to any manager or employee, nor were any restrictions placed on what measures could be undertaken in furtherance of the objective.

The underlying rationale behind this "unbalanced scorecard" approach of presenting only one official performance metric for the entire company is the hope that providing a sole point of focus for employee and management efforts might serve to counteract some of the problems that occur with a high degree of decentralization.

Project managers remain essentially unfettered in the conduct of their job duties. They are not provided with much in the way of guidance beyond “make the customer happy”. Project managers need a certain degree of freedom in the conduct of their duties as the measures needed to satisfy the customer will change from project to project.

The unintended consequence of this method of directing project managers is that their efforts are almost exclusively externally oriented, and little regard is had for Pathway’s own internal objectives. This is not problematic in and of itself; indeed, the paramountcy accorded to client satisfaction is probably a key element of Pathway’s success. However, from time to time, some of Pathway’s own operational objectives need attention. Giving project managers only one more objective reduces the likelihood of distracting from the general customer service imperative. The implication is that Pathway’s structure is restricted to somewhat rudimentary improvements, and although it is improving over time, it is currently characterized by some operational inefficiencies.

As a result, there are some structural problems evident at Pathway. Lines of responsibility are frequently blurred to an extent that issues are not addressed as efficiently as would be possible under a more hierarchical or regimented organizational structure. An illustration is provided by the common occurrence of a machine operator error resulting in parts being made out of specifications. Jurisdiction for resolution of the problem could be claimed by any one of the project manager, the machining department manager, the quality control manager or the human resources manager.

Equally well, blame for the error in the first instance could be assigned to any of the identified parties. The project manager may not have written clear process instructions. The machining department manager may have assigned the task to an

inappropriate operator. The quality control manager may not have devised adequate in-process checks, or the human resources manager may not have provided adequate training. The intention behind leaving the organizational structure more fluid was to empower employees, and ultimately encourage them to work hard. Unfortunately, it seems that in some instances, a decentralized organizational structure has the opposite effect, by mitigating a sense of individual accountability.

The manner in which work flows through Pathway's operations illustrates the decentralized nature of Pathway's work structure. All new requests for quotations that come in from current or prospective clients are managed by the Chief Technical Officer, who either quotes the work himself, or delegates it to a project manager for quoting under his supervision. If the client finds the quoted price and delivery satisfactory, a purchase order is issued. Pathway's CTO then assigns supervision of that project to a project manager on the basis of areas of the subject matter expertise of the particular project managers, and their respective workloads at the time.

The project manager then has the responsibility of getting the project through the required phases of production by working with the various line managers to fit the work into the production schedule. This process is inherently collaborative and scheduling conflicts are worked out consensually for the most part with no one project or line manager having authority over the others.

If there are two jobs due on the same day, and only enough machine time to complete one of them, the involved project managers would attempt to reach an agreement as to the relative priority of the jobs. Officially, there is no central authority to allocate machine time in the event of a conflict of this nature, although the CTO *de facto*

could be called upon to resolve a dispute the project managers could not settle consensually.

Similarly, if there is disagreement between the project manager and the line manager regarding how a part should be manufactured, neither has explicit authority over the other. When these conflicts arise, other staff members are usually brought in for an impromptu committee approach to problem solving. This is done on a quick, informal and *ad hoc* basis: a committee could be formed and dissolved in 20 minutes. There is no formal procedure outlined for this process – it is the practice that has organically evolved at Pathway to work around the decentralized structure.

Once the work has been completed and delivered to the client, the project manager is expected to follow up with the client to ensure the client's satisfaction. Beyond that, there is no review conducted. Clients are formally surveyed annually to measure their satisfaction with the level of service provided, and that is the only time in which the project managers' performance is monitored. There is no cost accounting performed to check up on the profitability of each job, which is ostensibly the responsibility of the project manager.

Profitability is monitored monthly on a department-by-department basis. If a department exhibits a drop in returns, the staff in the impugned department identifies and implements corrective action under the supervision of the Chief Financial Officer. Thus, although work is performed under the supervision of project and line managers, no accountability rests for financial performance on any individual.

3.7 Financial Analysis

Pathway's financial performance has been consistently solid. April 2003 marked the end of Pathway's 21st consecutive profitable quarter. Attached are the current and historical financial statements to outline Pathway's financial evolution. In less than 6 years, the founders' initial \$6,000 investment has been parlayed into a company with retained earnings over \$1,000,000.¹¹ Considering that no one involved in Pathway's management or administration had any previous experience in business, the financial track record to date has been commendable.

The following table compares Pathway's performance with the prevailing industry standard for plastics processing, and on every major metric Pathway compares favourably, sometimes by a considerable margin (Industry Canada, 2001):

Pathway Design & Manufacturing Inc. Key Financial Ratios

RATIO	Industry	PDM	PDM
	Avg. 2001	2002	2003
Current	1.4	1.3	2.2
Sales/Receivable	8.5	7.5	5.8
Cost of Sales/Inventory	8.0	12.7	30.2
EBIT/Interest *	2.6	23.4	64.2
% Profit Before Taxes/Total Assets *	8.0	39.1	49.4
Sales/Total Assets	2.3	2.6	2.4
Debt/Equity	1.7	1.7	0.7
% Profit After Taxes	2.4	10.0	7.4
* Added back Bonus			

Table 3: Financial Ratios

¹¹ In 2002, an independent valuation performed by the accounting firm of Campbell, Saunders assessed Pathway's worth at \$3 million.

Most notable of these ratios is Pathway's markedly superior performance with respect to after-tax profits, generating four times as much as the industry average in its 2002 fiscal year. In the 2003 fiscal year, Pathway continued to improve in this respect, and will post approximately 14% in after-tax profits for 2003, almost six times the industry average.

At present, Pathway has adequate financing, and is generating relatively significant amounts of cash. However, Pathway's first four years in business were plagued by extreme cash flow problems and the constraints of woefully inadequate capitalization. This corporate history has precipitated an inherently reactive corporate growth pattern that Pathway seems to have difficulty breaking away from. For example, in 1999, Pathway was doing roughly \$200,000 worth of sales a month financed with a \$25,000 line of credit, and growing far faster than its sustainable growth rate.

As a result, the expansion of staff, equipment and materials necessary to service the ever-increasing sales always lagged behind the need. An attitude of "making-do" with inadequate resources emerged among Pathway's staff and management as a result of the exigencies of these early experiences, and that attitude lingers still, notwithstanding Pathway's changed financial circumstances.

Although Pathway now has excess resources to invest proactively to develop its business, management has not yet developed the good practice of staffing and structuring for the next stage of growth. While the aim of the 2003 fiscal year was to milk Pathway's operations for as much cash as possible to repay the shareholder debt, that objective is nearly fulfilled. In looking to the future, it is unclear if and where cash generated by Pathway's operations should be invested, or whether it should be divested.

The appendix shows Pathway's *pro forma* cash position. The 2003 fiscal year, which ends July 31, 2003 is expected to generate approximately \$735,000 in cash, leaving Pathway with a generous cash allotment of \$831,000 going into 2004. The 2004 figures are calculated on the basis of retaining that cash, but this is somewhat illusory. As discussed above, all excess cash will be diverted to owner-managers to repay the shareholder debt outstanding from the buyout conducted in July of 2002. The cash amounts are not deducted in the *pro formas* in order to illustrate Pathway's true cash position without the exigencies of the debt repayment, a one-time anomaly not pertinent to ongoing financial analysis.

As the *pro forma* demonstrates, the 2004 year will not generate as much cash, because of short term increases to trade capital necessary to cover the increased sales volume. Pathway's operations will still be cash-positive, and by 2004 the outstanding shareholder debt will be repaid in full.

4 STRATEGIC ISSUES

The most pressing issue facing Pathway at this juncture is its heavy reliance on Ballard for work. With Ballard's automotive division alone constituting more than 90% of Pathway's sales volume, Pathway is in a very vulnerable position. At best, Pathway could expect to maintain its current sales volume for another year or two with regard to sales to Ballard's automotive division. The vagaries of this situation are elucidated at section 1.5.

It is significant to note that this sales concentration is only likely to intensify. In June of 2003, Ballard notified Pathway that it expects a 75% increase in purchase order volume over last year, commencing in September of this year. Holding non-Ballard sales constant from the 2003 fiscal year to the 2004 fiscal year, and increasing Ballard sales volume in the order of 75% would put Pathway's 2004 sales into the region of \$10 million dollars.¹²

An expansion of production capacity in this order of magnitude will necessitate a relatively significant capital expansion. Additional equipment would run approximately \$750,000, and there would be costs attendant upon hiring additional employees to meet this increased workload. This increased sales volume level would strain Pathway's current leased facility to such an extent that it is likely that some efficiency would be lost. It may be prudent to consider leasing additional facilities if Ballard's demands do indeed increase by 75%. Each of these incremental investments increases Pathway's risk profile considerably.

¹² If non-Ballard customers were to remain constant, the level of sales concentration next year will approach 98%.

As it stands, the sales concentration imports an unacceptable level of risk for Pathway's managers. That factor is the primary cause for Pathway being assessed at a higher than industry average Beta by its commercial lender. Concerns among Pathway's lenders and professional advisors regarding Pathway's sales concentration risk are significant, as those concerns may ultimately inhibit Pathway's future access to capital. While Pathway's financial performance is above average on all metrics, indications from its lenders are that with its current risk profile, Pathway may not be eligible for further financing.

In essence, there are two distinct alternatives to dilute the sales concentration factor. The first avenue would be predicated on capping the amount of work done for Ballard's automotive division. At present, Pathway manufactures more than 70 different fuel cell stack components. It would be relatively straightforward to ask Ballard's purchasers to reroute a number of those components to one of its other suppliers. This would decrease the sales volume to Ballard, thereby reducing the proportion of sales relative to Pathway's other customers. At the same time, rejecting a portion of Ballard work would also free up excess capacity that could then be marketed to new customers, further reducing the proportional sales concentration with Ballard. While Pathway's management has identified diversification of client base as a corporate goal for some time now, achievement of that goal has remained elusive. Each time production capacity is expanded, the volume of Ballard's orders increases in tandem.

Ballard's demands over the past three years have been such that Pathway's sales department has essentially dissolved. There is no longer a person dedicated to the sales function; what minimal sales and marketing duties are undertaken, are shared among

managers who have other primary duties. The sales function at Pathway has been reduced to the bare minimum of inside sales, *i.e.*, responding only to received requests for quotations, and not proactively soliciting any work from existing or prospective clients. Because of this historical passivity, Pathway's growth has entirely been shaped by the demands of Ballard.

While limiting the work currently done by Ballard would facilitate creating the excess capacity Pathway needs before it can begin prospecting for new customers, there are significant risks attendant upon this strategy as well. Most importantly, if forced to source out another supplier to handle the work rejected by Pathway, Ballard may choose to divert all the work to the new supplier. Ballard's supply chain department has gone through various cycles of consolidating and diversifying its supplier base, according to the prevailing philosophy of the time.

Pathway has survived these cycles of consolidations and diversifications by being accommodating and flexible. The administrative ease of dealing with only one supplier for a wide range of components has to date outweighed any risks perceived with relying too much on one supplier. By forcing Ballard to source another supplier, Pathway reduces the value that comes from the administrative convenience to Ballard's purchasers of being able to deal with one supplier. Ballard's purchasers may choose to recoup that convenience by diverting all of Pathway's work to a competitor. Also, as the alternative energy industry matures in Vancouver, companies with greater production capacity are becoming interested in supplying the OEM's. The most pressing example of this is the entry of Teleflex into the competitive fray. Teleflex joined Fuel Cells Canada last year,

and has been campaigning heavily to enter into the industry supply chain with custom machining work.

Teleflex's manufacturing operations are predicated on large volume manufacturing, as opposed to Pathway's orientation toward prototyping and small volume manufacturing. When Teleflex receives an order for a part, an entire manufacturing cell is created to run that part. A new machine is purchased and dedicated to the manufacture of that part. Capital outlays for setup charges at Teleflex would run between \$300,000 and \$400,000. Accordingly, Teleflex needs to be assured of a significant volume of production for a part before it will undertake its manufacture.

It is expected that with the 75% increase in Ballard's machining requirements next fall, this would get the production into the realm of interest to Teleflex. Being a cost-based competitor, Teleflex could represent a real challenge to Pathway's business with Ballard. In the event that Pathway decided to turn down the increased production, or even further, reduce the amount of work currently being done by Ballard, it could lose all the work to a volume-based competitor.

The obvious alternative solution to the over-reliance on Ballard is to dilute the sales concentration via growth. This alternative presents many more options for implementation, as growth could come from expanding the markets to which the current array of services is offered, expanding the line of services offered or from launching into the proprietary product arena. Each of these alternatives has its own advantages and pitfalls, and each will be examined in turn.

Growth into other markets is probably the least risky strategy for diluting Pathway's sales concentration. Even increasing its sales volume to other fuel cell

companies helps to minimize the risk of relying on one customer. Pathway already does a significant amount of work for other companies in the fuel cell industry, most notably, QuestAir and General Hydrogen.

Pathway has been doing a small amount of work for Quest Air for three years, and is conveniently located within a couple of blocks. Quest Air develops and commercializes gas separation and purification products, and is developing compact fast-cycle pressure swing absorption units for automotive and stationary fuel cells as well as industrial hydrogen production. Customers are in the industrial gas, oil refining, and chemical processing industries. QuestAir is a private company, but it has substantial financial support from its strategic partners: Ballard, Shell Hydrogen, and the BOC Group. QuestAir is at a fairly early stage of development, and presumably would have a substantial amount of prototype and R&D level manufacturing to do before commercialization. The amount of work Pathway has been getting from QuestAir has been increasing steadily, notwithstanding no efforts have been made to capture that business.

General Hydrogen is in a similar developmental position as is QuestAir. General Hydrogen is also striving to commercialize some ancillary balance of plant components to support fuel cell stacks. General Hydrogen develops and installs hydrogen based energy delivery systems, hydrogen dispensers, and designs stainless steel hydrogen storage systems individually tailored to meet customer specifications. A major initiative right now is the “hydricity pack” that replaces lead-acid batteries in electric forklift vehicles, and General Hydrogen’s custom manufacturing needs are driven by this project.

Like QuestAir, General Hydrogen is a private company funded through investment from strategic partners and financial investors, most notably General Electric. With its solid financial backing, growing custom manufacturing requirements and tangential involvement in the fuel cell industry, these two companies represent a logical avenue of diversification for Pathway. With some sales efforts on the part of Pathway, both companies may blossom into significant dollar value clients in the near-term. That alone does not necessarily mean that QuestAir and General Hydrogen should be the primary targets of Pathway's diversification efforts.

It is important to consider that part of the reason that over-reliance on Ballard's business is not prudent is because the fuel cell technology is not yet commercially viable. The most formidable challenges the fuel cell industry has to face are reducing the price per watt of power generation, enabling the safe and effective storage of hydrogen, and establishing a hydrogen-fuelling infrastructure. Any one of these obstacles could stymie commercialization plans for years.

Diversifying to a wider portfolio of fuel cell companies does not mitigate the risk that stems from the possibility of the technology never reaching its commercial potential. Similarly, courting business from QuestAir and General Hydrogen does not entirely mitigate the risk attendant upon the locus for fuel cell manufacturing moving away from Vancouver. Lukewarm government support in the face of competition from other jurisdictions increases the likelihood of this eventuality.¹³ That said, QuestAir does have

¹³ Discussion in the Premier's Technology Council regarding implementation of the Fuel Cell commercialization roadmap (PriceWaterhouseCoopers, 2002).

a product line with sales into established industries, so there is a degree of benefit to be garnered by diversifying with the addition of this type of clients.

Risk mitigation may be better served by attempting to increase the amount of business done with local companies in the alternative energy sector who do not deal with fuel cells, such as Westport Innovations and NxtPhase. Westport Innovations specializes in the technology of allowing diesel engines to operate on an alternative fuel source such as natural gas. Westport has developed a carburetor-like device that allows for retrofitting heavy-duty diesel engines to run on natural gas. Westport has the financial support of Cummins, a leading diesel engine manufacturer. The technology is nearing maturity, and Westport has a commercially available product. However, intensive R&D is still taking place.

Nxtphase Corporation is involved in the area of power management. Nxtphase is developing a proprietary system of fibre optics to measure and regulate high voltage power currents. As a privately-held subsidiary of Honeywell, Nxtphase also has substantial financial backing in addition to a product that is quite close to market.

Pathway already has solid inroads with both Westport and Nxtphase. Development of these prospects would require little in the way of risk or expenditure. At this juncture it is difficult to tell how much of either product development or manufacturing these companies would be willing to outsource.

Over the past two years, Pathway has done work for the following companies in the following industry sectors:

CLIENT NAME	INDUSTRY SECTOR
AAA Woodwork Canada	wood products
<i>Alpha Technologies</i>	<i>backup power devices</i>
Automated Coding Systems	medical devices
<i>Advance Wire Products</i>	<i>custom retail display products</i>
Canadian Forestry Equipment	forestry equipment
<i>Concurrent Mechanical Integration</i>	<i>high-tech tooling</i>
Coanda Research and Development	industrial fluid dynamic applications
<i>Cominco</i>	<i>mining and metals</i>
Creo-Scitex	printing equipment
<i>Deere Hitachi</i>	<i>construction and forestry equipment</i>
3M Touch Systems	computer touch screen technology
<i>Glas Aire</i>	<i>automotive accessories</i>
Industrial Compressor Services	air compression equipment
<i>Kelsan Technologies</i>	<i>friction control equipment</i>
Mandel Scientific	laboratory test equipment
<i>Microspere</i>	<i>ergonomic office furniture</i>
Murray-Latta Machine	custom machinery
<i>Nokia</i>	<i>mobile phones</i>
Norwood Packaging	toiletry products
<i>Norsat International</i>	<i>satellite telecommunications</i>
Pattison Sign Group	electrical signage
<i>Pearlite Display Products</i>	<i>custom store fixture products</i>
Prime Pacific Health Innovation	colon hydrotherapy equipment
<i>PSC Analytical Services</i>	<i>laboratory test equipment</i>
RaceFace Components	mountain bike components
Radioweb Communications	<i>personal electronics</i>
Saminco	electric traction components
<i>SMC Pneumatics (Canada) Ltd.</i>	<i>industrial equipment products</i>
TIR Systems	specialty lighting
<i>Trus Joist</i>	<i>lumber products</i>

Table 4: Client and Industry Sectors

The foregoing list demonstrates that Pathway's non-alternative energy roster of clients is balanced across varied industry sectors, from consumer goods to heavy industrial equipment and high tech products. Without prospecting for any new clients, Pathway could grow a balanced low-risk customer base by plumbing these existing customers for inside sales opportunities. This foregoes the cost of assessing and establishing new markets. However, the dollar value of work ordered by these clients currently is very small, accounting for less than 5% of Pathway's total current sales. Considerable development work would be required to bring these prospects to fruition.

Of particular interest for Pathway is the medical devices market. The materials expertise that Pathway has developed as a result of working with advanced engineering plastics for fuel cell applications is directly transferable to the medical devices industry, as it is one of the only other areas that uses these somewhat exotic materials. Furthermore, there is a locus of activity in the medical devices sector in the local Vancouver market that could generate sufficient custom manufacturing demands to foster significant sales growth for Pathway.

Medical devices is also an attractive industry sector because it tends to be low-volume, precision manufacturing that is suited to companies pursuing a differentiated strategy. This is of critical importance for Pathway, as it tries to gain entrance into new niches of plastic manufacturing that are immune from the threat posed to North American custom manufacturers from Chinese competitors.

The imperative of avoiding cost-based competition effectively rules out a lot of the other potential markets represented by the foregoing client list. While there is certainly potential for some relative sales increases among these clients, it is likely that significant dollar value construction will be conducted offshore for all of these companies because they are in mature industries. Pathway will of necessity be relegated to the relatively small prototyping function.

Another potential source for diversification lies in the addition of new services to Pathway's current portfolio. Pathway's management has at different times in the company's history considered adding the processes of vacuum forming and compression moulding to its offering of services. Vacuum forming was rejected on the grounds that competition for the work tends to be too cost-based. It is difficult to bundle vacuum forming with more value-added services, and the margins on vacuum forming itself tend to be unexceptional. Compression moulding as a process lined up more neatly with Pathway's differentiated strategy, but it too was ultimately rejected on the grounds of the market size not sufficing the considerable capital outlay.

Currently, Pathway's management is considering adding custom engineering to its range of services. In many respects this would be a natural extension of its current operations, as Pathway already employs 8 engineers from varying disciplines to manage projects. Offering custom engineering work would merely take one additional facet on in product development. There have been numerous indications that Pathway's existing client base would make use of custom engineering services in conjunction with the other work performed were Pathway to offer those services.

Facilitating growth by offering custom engineering services is another relatively low risk strategy for Pathway. No capital outlay is required; only additional personnel. However, this alternative highlights a subsidiary issue for Pathway. Attracting and retaining skilled personnel is a necessary prerequisite for the execution of a successful differentiated strategy. As Pathway grows, the human resource component of strategic growth becomes more problematic. To date, Pathway has been able to attract skilled personnel by offering a superior work environment, which is characterised by the footloose atmosphere of a small and young company.

With each stage of growth, some of the freedoms associated with working in a small company disappear in favour of policies, procedures, benchmarks and targets. As Pathway evolves from a small to a medium sized company, it will become increasingly more difficult to attract people solely on the basis of having a favourable work environment. At present, Pathway's remuneration standards range from 15 – 30% below market standards for professional and skilled labour positions. As the intangible incentive of a positive work environment erodes, wage expense will rise.

To combat this, and continue to retain top talent without raising compensation levels more than necessary, a cogent human resources strategy needs to be developed to preserve the above-average financial returns generated thus far. Human resource management at Pathway can best be described as neophyte.

5 RECOMMENDATIONS

Possibly the most difficult strategic decision facing Pathway in the short term is how to respond to the potential 75% increase in demand from Ballard in the fall of 2003. Considering Pathway's primary objective of improving its risk profile, undertaking to fulfill that demand would seem counterintuitive. The added pressures on Pathway's productive capacity would be such that targeting any new markets would be completely out of the question. As Pathway's sales volumes approached the \$10 million barrier, the percentage of sales represented by Ballard would approach 100%.

However, as noted at section 3.1, to refuse the work carries with it the risk of a different sort: if Ballard were forced to source out a new supplier to meet the additional demands, it may opt to divert all of the work currently being done by Pathway to the new supplier. This may be the most prudent alternative for Ballard, from both a supplier management and a cost-effectiveness perspective. The irony of course is that if Pathway attempted to mitigate the potential harm that could result if Ballard's orders were to suddenly dry up by capping sales to Ballard to at or below current levels, this might actually precipitate the very circumstance it is designed to avoid.

This is of course to a large degree purely speculative. It may be that Ballard will once again embark on a strategy of supplier diversification, and divert the additional work to a new supplier of its own accord. The weight of evidence does not support this interpretation. In the past, Ballard has placed a great deal of emphasis on supplier commitment and loyalty, and has invested a lot of resources and attention into the cultivation of Pathway's capabilities as an important part of its supply chain. A perception that Pathway is not capable or willing of continuing to move in tandem with

Ballard toward the goal of commercialization through the next phases of growth may incite Ballard to look for a replacement supplier.

A seemingly tempting strategy may be to attempt to sound out Ballard's supply chain managers as to how such an overture would be received. Unfortunately, this is not an option, as the mere presentation of a possibility that a supplier may not meet required production targets is enough to incite purchasers to source out an alternative source of supply. Pathway's strategic decisions must be made "blind" as it were, with only best guesses as to what Ballard's reactions may be.

In light of these considerations, it would be imprudent for Pathway to turn down work from Ballard. The potential consequences of an alternative supplier supplanting Pathway's position in this market are too deleterious to be risked. The best-case outcome in this scenario, wherein Ballard continued to do business with Pathway at current levels and sourced an additional supplier to meet the increase in demand in the fall, may still not be in Pathway's interest. Sharing the lucrative niche market with a competitor may precipitate a price-based competition, with two or more companies quoting on similar work.

Pathway should therefore endeavour to continue to meet Ballard's growing demands. This strategic alternative will raise some practical obstacles. Most notable will be possible difficulties in securing adequate financing to undertake a 75% increase in productive capabilities with a higher degree of reliance on Ballard's work. Pathway's commercial lenders have expressed concern in the past regarding Pathway's reliance on Ballard's business. However, some credibility should be accorded to Pathway's five years of profitable operations, and perhaps that credence would serve to outweigh the

additional risks. Furthermore, additional financing can be secured against new equipment purchases, which affords commercial lenders a high degree of comfort.

Even with a fairly aggressive capital expansion, it is likely that Pathway would only need to obtain bridge financing. As seen in the *pro forma* statements of changes in cash position contained in the financial statements in the appendix, Pathway's operations should continue to generate significant amounts of cash. With bridge financing in the temporary additional operational loans, Pathway would be able to fund increased investments in trade capital and necessary capital outlays out of cash from operations within the span of the 2004 fiscal year. This quick repayment cycle should also offer additional reassurance to concerned lenders.

Resolving to expand production capacity by such a significant degree to meet the demands of Ballard precludes pursuing other growth-predicated strategies in the near term. Expanding Pathway's range of services or expanding into new markets is tempting, but it is not practical because capacity and resources will already be strained with the effort to handle the increased sales volume to Ballard. While diversification of its sales base would bring a certain degree of comfort to Pathway's lenders and its management, that comfort should not be sought if to do so would in any way jeopardize Pathway's core business.

Industry analysis of the custom plastics manufacturing industry has demonstrated that Pathway has essentially stumbled into one of the last lucrative bastions in this declining industry. While there are other profitable niches which may be natural ventures in light of Pathway's core competencies, such as the medical device sector, it would be

reasonable to expect that other custom plastic manufacturers would also be seeking entry into these niches as well.

In the last two to three years, plastic manufacturers in North America have faced an unprecedented level of competition from offshore suppliers. Many companies have experienced substantial decreases in sales volume, as Chinese manufacturers have overtaken high volume manufacturing jobs. Cost competition domestically has eroded the margins on jobs that have not gone offshore as competition becomes more rivalrous among companies fighting over share of the shrinking market.

Relatively low-volume manufacturing sectors such as medical devices did not use to be hotly contested; however, the downturn in the North American custom manufacturing industry as a whole has rendered the low volume products much more appealing to established companies. Even if Pathway were able to earn business from the medical device industry sector as hoped, it would be unreasonable to expect to earn generous margins in light of the intensified competition. Pathway is in an enviable position, at least in the short term, in that it is able to earn above-average returns in a specialized niche of a declining industry. Diversification in the near term may improve Pathway's risk profile at the expense of its profitability to an undesirable degree.

That is not to say that the objective of client base diversification should be abandoned, merely that the time horizon for implementation should be extended to accommodate the imminent increase in Ballard production. Instead of immediately attempting to pursue a growth-oriented diversification strategy, Pathway should look at implementing some of the precursors to proactive sales growth. Marketing activities should be commenced to research possible avenues for potential proprietary products.

Pathway's management has been somewhat remiss in letting the external sales and marketing function erode in the face of healthy sales to date. A sales manager should be hired to proactively coordinate business development efforts, in order to ensure that the most strategically advantageous avenues are being pursued. This would allow for more meaningful forward planning efforts, as Pathway would not be entirely shaped by the extant demands of its current customers. Conducting marketing and business development functions prior to production capacity becoming available will provide management with alternatives to afford proactive corporate development.

It will be necessary to recruit and hire an additional executive level person to conduct these activities as current management will undoubtedly be fully absorbed with the operational expansion plans. The expansion must be effected with due credit being given to the importance of human resources for the successful execution of Pathway's overall strategic plan. There are several aspects to this factor worthy of consideration. Firstly, Pathway's strategy is one of differentiation, which requires the provision of a superior quality of service. Of course, providing superior quality custom manufacturing services requires highly skilled employees.

Pathway has used the cachet of working in a small company as its primary recruitment tool, and it is about to double in size. This necessitates some real efforts and resources being directed at retention and at development of a new recruitment strategy. Formal human resources functions have not been accorded much priority within Pathway's organizational structure to date. With a significant increase in the number of employees on the horizon, systems and policies for managing human resources must be

formulated and implemented. This responsibility will require the undivided attention of another line manager.

In light of the changing work environments, compensation policies will have to be reviewed, and brought into line with market standards. The question of group benefits should be analyzed in light of the changing employee demographics attendant upon the expansion.

Pathway has the luxury of adequate cash and an established business to finance adoption of better business practices. Running a cash-starved undercapitalized startup, Pathway's management necessarily adopted a shoot-from-hip approach to corporate planning, and a make-do approach to corporate organization. Pathway is moving out of the startup phase and it is time to leave these management practices behind in favour of a more studied and purposeful approach to corporate governance. That said, care must be taken to ensure that formalizing business practices and HR management strategies does not subvert the improvisational culture that is at the heart of Pathway's success to date.

APPENDIX: PATHWAY'S FINANCIAL STATEMENTS

REFERENCES

- Aaker, D. A. (2001). Developing Business Strategies. (6th ed.). New York: John Wiley & Sons.
- Bukszar, E. (2003) EMBA class notes.
- Dominion Directory. (2002). The Telus Pages: Vancouver. (2002-2003 ed.)
- K&H Global Business Planning Consultants. (2002). Canadian Department of Foreign Affairs and International Trade: Global Market Intelligence Report, Plastics Manufacturing. December, 2002.
- LeGault, M. (2003). "Can the Fuel Cell Save the West?" *Canadian Plastics*, June 2003 ed.
- Porter, M. E. (1979). "How Competitive Forces Shape Strategy." Harvard Business Review. July -August 1979.
- Porter, M. (1980). Competitive Advantage: Creating and sustaining superior performance. New York: The Free Press.
- PriceWaterhouseCoopers LLP. (2002). Canada Fuel Cell Commercialization Roadmap.
- Industry Canada. (2001). Plastics Manufacturing – Other. Retrieved May 27, 2003.
- U.S. International Trade Commission. (2002). Plastic Industry Data. USITC Publication #3556, 2002.
- Vancouver Economic Development Commission. (2002). Vancouver's Key Private Sector Industries for Clustering. July 2002.