Summary

Ever since my childhood, it has been a dream to own a bike company, with the freedom to design and build frames by hand right here in British Columbia. Now with an engineering background, access to rapid prototyping methods for advanced composites, and access to relatively low cost machining, the dream could turn into a possibility. Recent advancements in suspension kinematics, and materials science have allowed for a one bike quiver, allowing for small businesses to enter the market without the need to invest in making a bike for each discipline. Because of this, we propose that two bikes be considered in this analysis for our production runs: a high-end race oriented road bike frame, and a modern 160 mm high single pivot mountain bike frame. The model for our business will be selling both in our flagship store, or online direct to consumer. Our goal is to provide manufacturing in Canada, so the cost of labour will consider this, opposed to most manufacturers working overseas in Asia. The goals of the project are to survive the first design cycle of frames. The industry is quite competitive; most are big brands such as Specialized and Giant but there is still room for boutique brands to enter the market and be (very) successful. Evil Bicycles is an excellent example of this. Think of it this way, Ford owns the market, but that doesn't mean a small brand like Koenigsegg can have a slice of the pie.

There are some ethical challenges of building composite frames, primarily environmental. Carbon fiber is non-recyclable, and there are many toxic chemicals which are used in its manufacture, especially for removing the foam cores after molding the frame. The tooling required to construct frames is well defined, with many sources listing the price of tooling, labor, and materials required for operation. Because of this, the main risk we face is overestimation of demand. To minimize this risk, we will research data on numbers of owners of boutique frame brands with frame prices in the range we determine in our analysis. From this range, we will perform a simulation based on the upper and lower bounds of this estimate to determine what the risk of pursuing this dream is, and if it shall be pursued.

Market Analysis and Competitive Landscape – Demand for 885 frames

It is estimated that there are 1 million mountain bikers in Canada alone, with an estimated 738 000 mountain bikes sold each year in Canada. Of these, we can assume that most mountain bikes sold by independent retailers are high end bikes, and that the data gathered from Pinkbike polls can be utilized to break down this data farther. The data relevant to our analysis is shown below in Figure 1 - Canadian Adult Bicycle Sales, 2008 (Competitive Research Associates 2010) and Figure 2 - Canadian Bicycle Sales by Unit (Competitive Research Associates 2010).

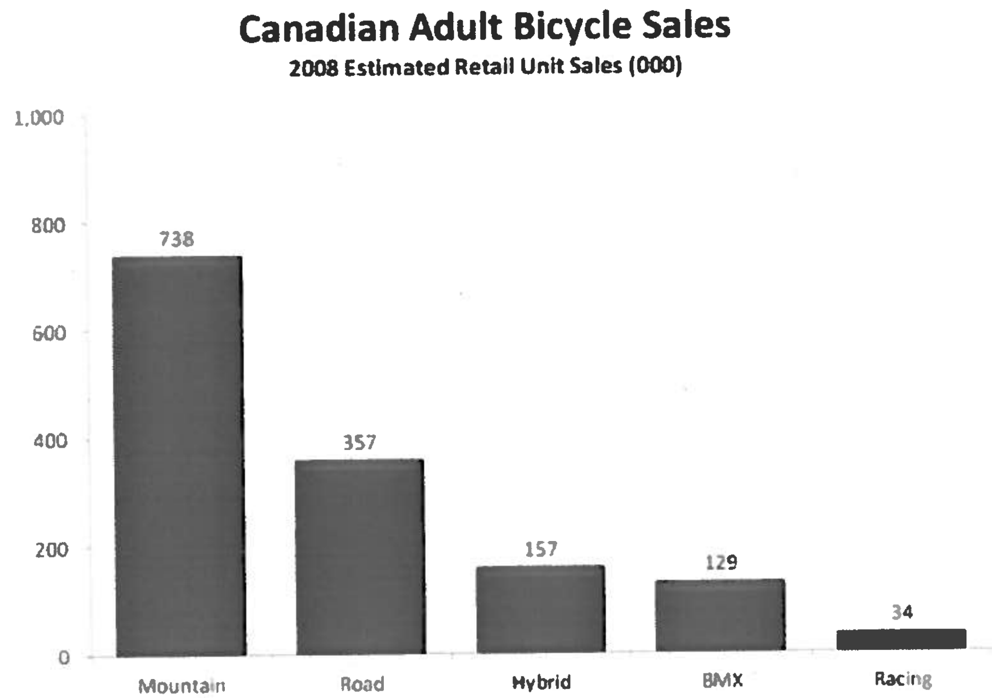

Figure 1 - Canadian Adult Bicycle Sales, 2008 (Competitive Research Associates 2010)

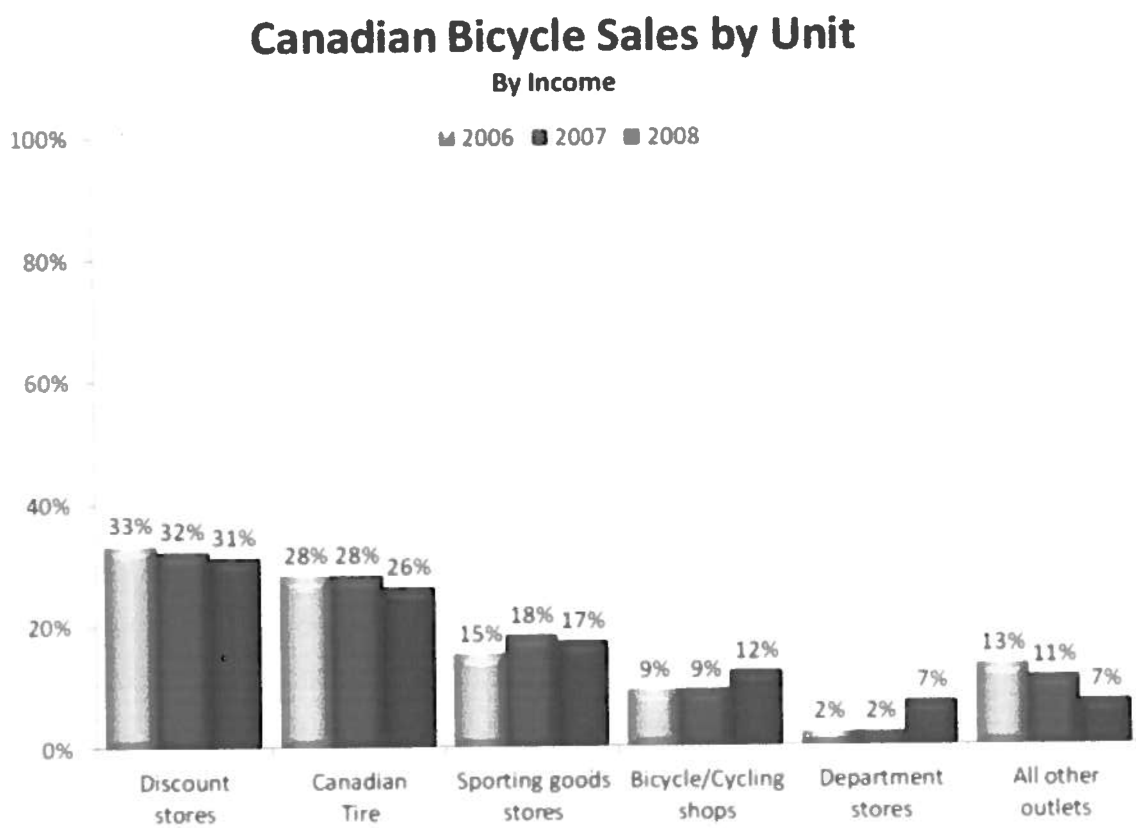

Figure 2 - Canadian Bicycle Sales by Unit (Competitive Research Associates 2010).

Of the 738 000 mountain bikes sold, 12% were sold from independent retailers (vs. Walmart, Canadian Tire, etc.), yielding 88 560 high end mountain bikes sold annually in Canada (Competetive Research Associates 2010). This is an important consideration, as the report found that independent dealers and cycling shops sold high end, expensive bicycles, which were typically not sold through other outlets. (Competitive Research Associates 2010).

The Pinkbike poll, "Which brand will you purchase next" paints a picture of consumer purchase trends, with 5411 respondents. A sample of this data comparing demand for boutique vs generic brands is shown below in Figure 3 - Which brand will you buy from next?. Assuming that we are a small brand, we expect to be a similar size to Zerode from the get go, with a 2.2% market share. This gives annual demand for 885 frames. Manufacturing in house, this far exceeds what we expect our manufacturing capabilities will be(Which Is the Brand of the Complete Bike Will You Likely Purchase next? - Polls - Pinkbike 2016).

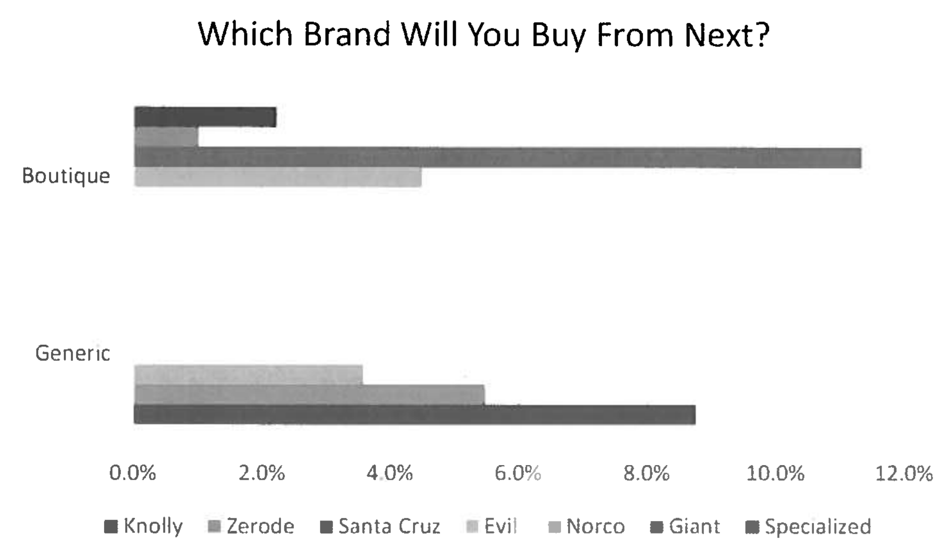

Figure 3 - Which brand will you buy from next?

Additionally, we do not expect any challenges from selling direct to consumer. The below results below in Figure 4 - Support for direct to consumer vs brick and mortar illustrate that most purchasers are supportive of a direct to consumer model. This gives justification to our proposed model (Pinkbike 2017).

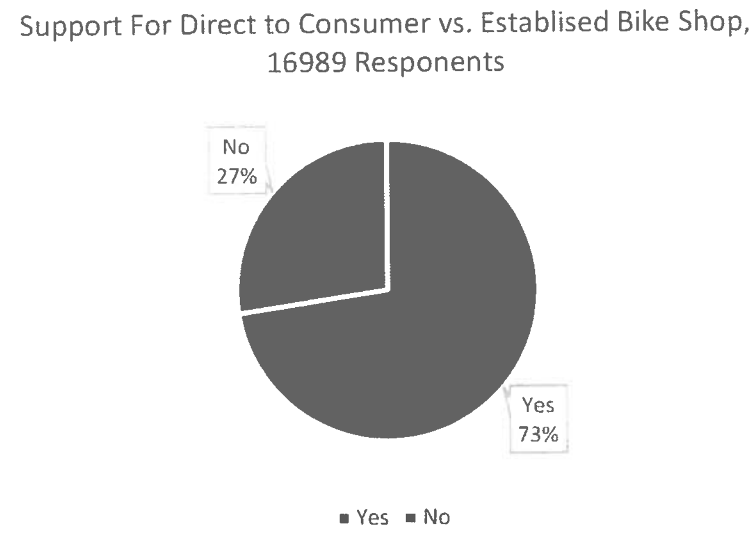

Figure 4 - Support for direct to consumer vs brick and mortar

Cost of Tooling - $39812.25 in Year 0

Though we would do our hand lay up in Canada, we will outsource our mold manufacture to Asia. It is possible to send drawings and have a complete mold set prepared overseas for $10000 USD ($13408 CAD), since we will be machining our molds in house, we will anticipate similar pricing, but much faster lead time. We will acquire used equipment to start up, primarily we will purchase HAAS CNC machines, as they are known to be extremely reliable. The pricing was estimated by searching for used equipment online. To our surprised, there was a wide range of products available on eBay, with most other sources not listing prices. This gives us a ballpark to high-end estimate of what we should expect to pay for this equipment. The following images illustrate the buy-it-now purchase price of our required machinery, that is a 5 axis CNC mill, CNC lathe, Laser Cutter, and Autoclave.

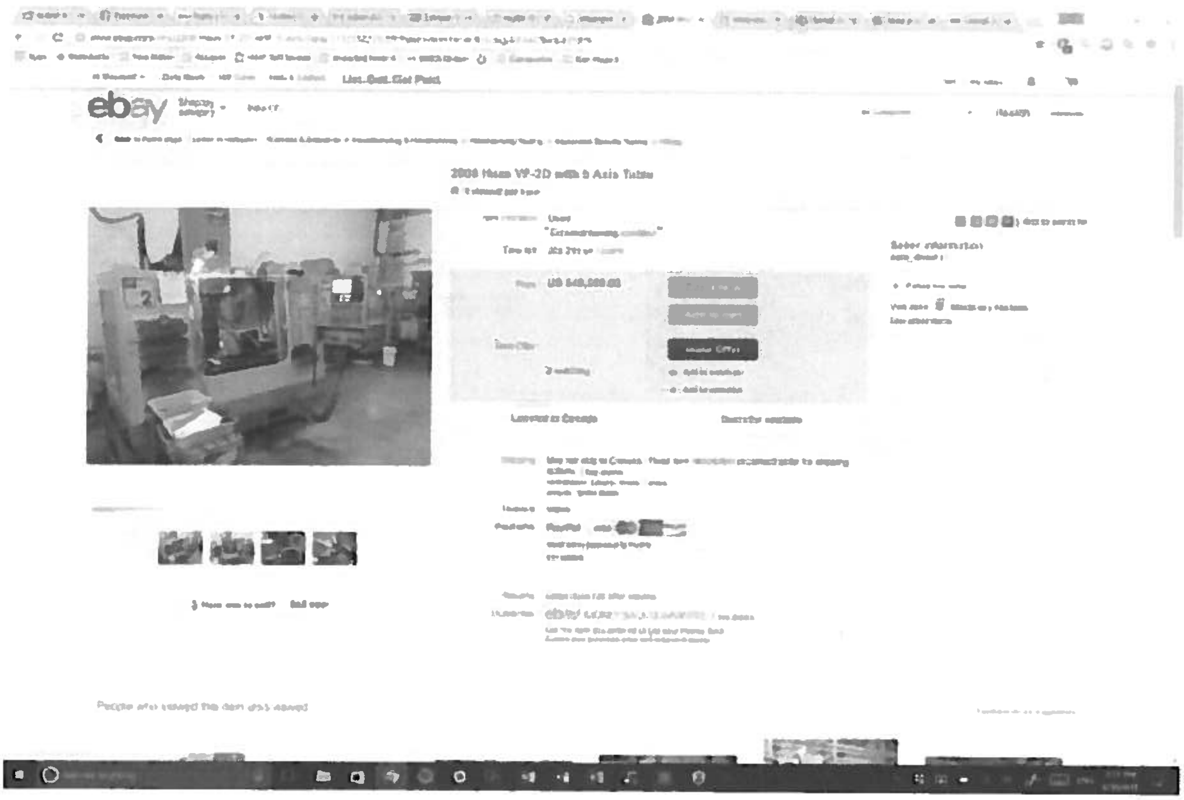

Figure 5 - HAAS VF2 5 Axis Mill Pricing

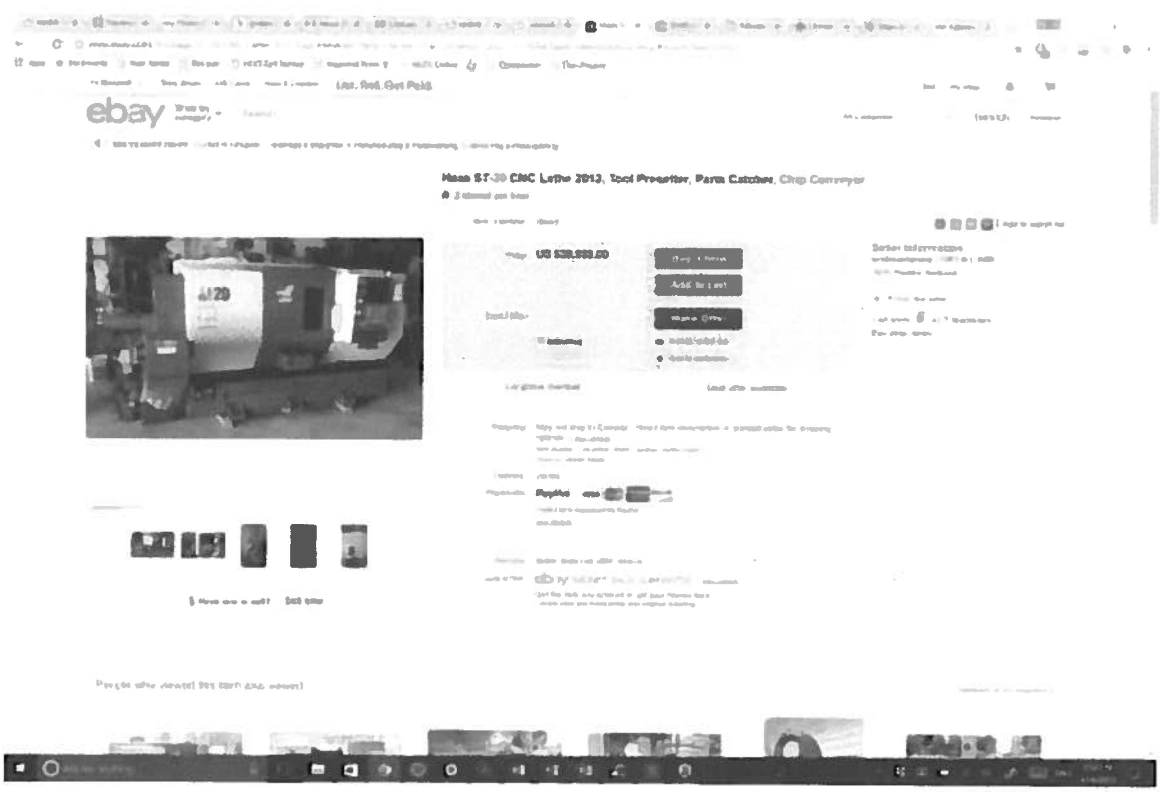

Figure 6 - HAAS ST20 CNC Lathe Pricing

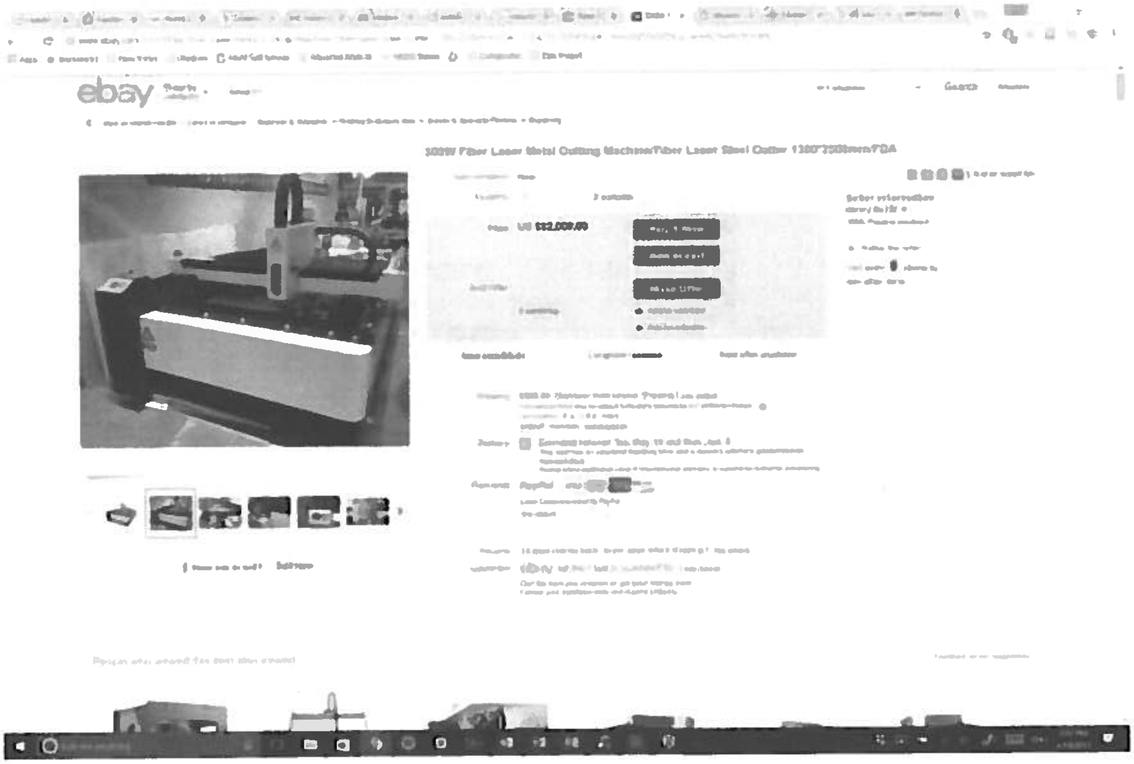

Figure 7 - 500W Fiber Laser Cutter Pricing

Cost of Consumables - $485.63 per frame

We still have a material cost associated with the fabrication of each frame. Assuming a high estimate surface area of 1.2 m^2 per frame, with a layup schedule of 8 layers: 6x UD and 2x3k weave. We will require 2.4 m^2 of 3k, and 7.2 m^2 of UD prepreg. 1 m^2 of each material will be wasted during the cutting of fibers as well, and this will be accounted for in our analysis. We will only use high quality T700 grade fiber for our frames. This typical layup schedule is representative of current manufacturing methods as shown below in Figure 8 - Typical Bicycle Frame Layup Schedule (Liu and Wu 2010) (Liu and Wu 2010).

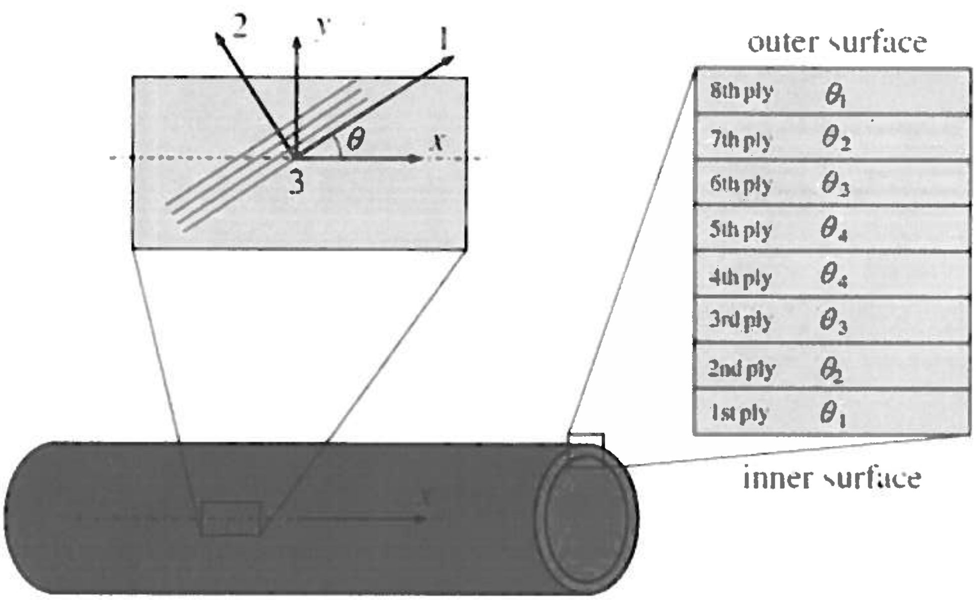

Figure 8 - Typical Bicycle Frame Layup Schedule (Liu and Wu 2010)

Rockwest composites has list prices available, and these are assumed to be high as we will be ordering in bulk. The prices are listed in cost in USD per lb of material. Each lb of material provides us with 1.96 m^2.

Weight (lbs)	Cost/lb
0-2	$ 44.99
2-4	$ 36.79
5-9	$ 30.59
10-60	$ 28.39
61+	$ 22.19

Table 1 - Rockwest Composites Prepreg T700 Pricing (Rockwest Composites n.d.)

With this, we associate a material cost estimate of $285.63 CAD per frame. Additionally, we will require foam mandrels, fittings, acetone/finishing chemicals, and finishing materials. A ballpark on this is an additional $200 CAD per frame. This puts our cost of consumables at about $485.63 CAD per frame.

Labor Estimate - $240 CAD per frame, 130 frames/per employee/per year

For each frame, we will hand lay up all of the components. In an interview that occurred between Bike Radar and Giant, Giant stated that it takes 8 person-hours to build a frame (BikeRadar 2014). Though, Giant has their process refined like clockwork. Because we are not Giant, we will initially triple our hours of labor required per frame because let's be real we suck and are clueless right now. We will (sadly) try to pay our workers a low wage of $15/hour. But hey, we're a start-up and can offer equity as well, a $5000 bike, and a pretty casual workplace! This places a frame at $360 CAD per frame.

Beyond cost of labour, we must think of how many frames we can actually make per person. Assuming a 40 hour work week, this gives 2000 hours per employee of time working per year with 2 weeks of vacation. This means each employee can make 130 frames each year, provided everything goes smoothly.

Shop Space Estimate – Free!

Since we are a start-up, we are trying to do things as cost effectively as possible. My girlfriends father has a very large (8 car garage) on the island, and he does not have enough toys to fill it, so we will start here rent free through at least the first design cycle. He has agreed to split the cost of the lathe, and mill, as well as cover the cost of tooling for each. This is if I stay with his daughter, is there a way to quantify risk with this? Let's assign a 95% probability, which I hope is a large overestimate to us staying together. Otherwise, there is a 5% chance that we have to spend an additional $5000 a month in overhead. We will not include overhead in our main analysis, but will incorporate it into our risk analysis.

Marketing - $18500 per year

One of the most critical components for success in the mountain bike industry is solid marketing. Because of this, we will need to have athletes on board to promote the brand. The image that we will try to portray, is "Fuck the industry", we want to be different. Because of this, we will not support a race team, and will solely support media athletes. We anticipate releasing 1 full length movie of a 5 day road trip, as well as 6 short edits to do just this. Because of our edgy attitude (as well as mountain bike athletes not living the most glamourous of lifestyles), we can assign a low budget to all of this. Athletes will require a frame each, and we will initially support 2 athletes. Beyond this, we will pay a filmer $1000 per edit, as well as assigning a cost of $5000 to the road trip including all expenses and paying our filmer. These edits and movies will not feature any of our branding, and will appear to be just-for-fun side projects of the filmers and athletes. Additionally, we will have one bike to send between Vital and Pinkbike for reviews, we will sell this frame used at half price after the fact, forgoing $1500 in revenue. This gives a yearly marketing cost of 2.5 bikes at $7500, and $11000 in media expenses. We will not release any press releases, nor any official advertisements. As well, we will use our industry connections to father fan the flames of the buzz around our edgy brand.

All of these numbers are from firsthand experience from working in the mountain bike industry, and typical fees we have charged as a media group.

Funding Sources

Our initial cashflow diagram has indicated that we will not have positive cashflows until year 3. With this in mind, we will require investment to get us to the point where we are turning a profit. With 3 years of O&M expenses, production expenses, and capital expenditure, this puts us at an investment of $809 800 CAD. Of this amount, we will crowdsource funding before our first year of production, at $3000 per frame sale up front. Using Kickstarter, we will assume we lose 10% of the sale price to their fee and payment processing. Our team combined has $150 000 saved up to contribute directly to the project, which we could otherwise invest at a rate of 7%. This leaves us with an additional $527 050 CAD required in an investment to get us off the ground. The current high rate is about 8.75%, we will assume that this is the interest rate on our loan.

Source	Amount	Rate
Business Loan	$527 050	8.75%
Personal Savings	$150 000	7%
Kickstarter	$132 750	7%

Table 2 - Capital Costing

This gives us a WACC of 8.14%, we would select this as our MARR, but being a start-up this would be unwise. For this project, we select an MARR of 20%, a good ballpark figure for high-risk ventures. We consider this a high-risk venture, so any analysis should be very conclusive that we will turn a profit.

Ethical and Sustainability Considerations

Our organization is very small, and because of this will face very few ethical considerations in pursuing this venture. It is not like we are trying to build a site C dam here, displacing thousands of residents and destroying ecosystems. However, we do have two major ethical consideration in fabrication of composite components.

First, is that the chemicals utilized to fabricate carbon fiber are very harmful. Acetone is used after curing to melt and remove the foam cores from the frame. This is a waste product which must properly be disposed of, and is strictly regulated in first world nations. We must note that there is a benefit of fabricating more frames in Canada if we look at the big picture, as it means fewer frames are produced overseas where lax regulation allows for dumping these harmful chemicals into the environment.

Secondly, composites unlike metal frames are currently non-recyclable. This means, that every product that we produce, it's life cycle with current technology will end up in landfills. With given the circumstances however, we will allow for customers to return damaged or old frames to us for disposal. There are many start-ups which are attempting to invent large scale recycling techniques, and we project that there will be demand for our frames at the end of the product life cycle to increase with time as a result of these methods (Composites World 2016; La Rosa et al. 2016).

Projected Cashflow and Net Present Value

The following section summarizes our projected costs, revenues, and summarizes this information in a cashflow complete with NPV at our MARR of 20%.

Manufacturing costs per frame		Cost per unit	Units required		Cost Per Unit	
			Composite Road	Composite MTB	Composite Road	Composite MTB
Raw Material	Toray T700 UD Prepreg Carbon (per m^2)	$ 22.19	8.2	8.2	$ 181.96	$ 181.96
	Core removal chemicals (per Litre)	$ 10.50	2	2	$ 21.00	$ 21.00
	Foam Cores	$ 40.00	1	1	$ 40.00	$ 40.00
	Bladder Latex (per Litre)	$ 10.00	5	5	$ 50.00	$ 50.00
	Bladder Fittings	$10.00	1	1	$ 10.00	$ 10.00
Labour	Mold prep (hours)	$ 15.00	0.5	0.5	$ 7.50	$ 7.50
	Bladder and core mfg (hours)	$ 15.00	0.5	0.5	$ 7.50	$ 7.50
	Cutting and Layup (hours)	$ 15.00	16	16	$ 240.00	$ 240.00
	Post cure/joining finishing (hours)	$ 15.00	2	2	$ 30.00	$ 30.00
	Painting (hours)	$ 15.00	2	2	$ 30.00	$ 30.00
	Assembly/finishing (hours)	$ 15.00	2	2	$ 30.00	$ 30.00
	QC and testing (hours)	$ 15.00	2	2	$ 30.00	$ 30.00
		TOTAL			**$ 677.96**	**$ 677.96**

Table 3 - Production Costs per Frame

Capital Expenditure

Tooling	Development and fab cost (2 molds)	$	26,816.00
	Used HAAS VF-2D w/ 5 axis	$	67,042.00
	CNC HAAS ST-20 Lathe	$	46,929.75
	CNC Laser Table	$	67,042.00
	Hand tools	$	2,000.00
	Autoclave	$	6,704.25
	TOTAL	**$**	**216,534.00**

Table 4 - Cost of Initial Capital Expenditure

Operational & Maintenance Expenses

Engineering and Management Staff	$	100,000.00
Sales Guy	$	50,000.00
Equipment Maintenance	$	83,200.00
Marketing	$	18,500.00
Net Yearly Operational Expenses	**$**	**251,700.00**

Table 5 - Yearly O&M Expenses

ear	Cap Ex	Loan Interest	O&M Expenses	Frame Production Expenses	Projected Frame Sales	Net Sales Revenue	Net Costs	Net Cashflow	Present Value
0	$ (216,534.00)						$ (216,534.00)	$ (216,534.00)	($216,534.00)
1		$ (46,116.89)	$ (251,700.00)	$ (29,999.64)	44	$ 132,750.00	$ (327,816.53)	$ (195,066.53)	($162,555.44)
2		$ (46,116.89)	$ (251,700.00)	$ (59,999.28)	89	$ 265,500.00	$ (357,816.17)	$ (92,316.17)	($64,108.45)
3		$ (46,116.89)	$ (251,700.00)	$ (119,998.57)	177	$ 531,000.00	$ (417,815.46)	$ 113,184.54	$65,500.31
4		$ (46,116.89)	$ (251,700.00)	$ (239,997.13)	354	$ 1,062,000.00	$ (537,814.02)	$ 524,185.98	$252,790.31
5		$ (46,116.89)	$ (251,700.00)	$ (299,996.42)	443	$ 1,327,500.00	$ (597,813.30)	$ 729,686.70	$293,244.72
								NPV	**$168,337.44**
								IRR	**31%**

Table 6 - Summary of Yearly Expenses and Revenues, Cashflow, and NPV/IRR

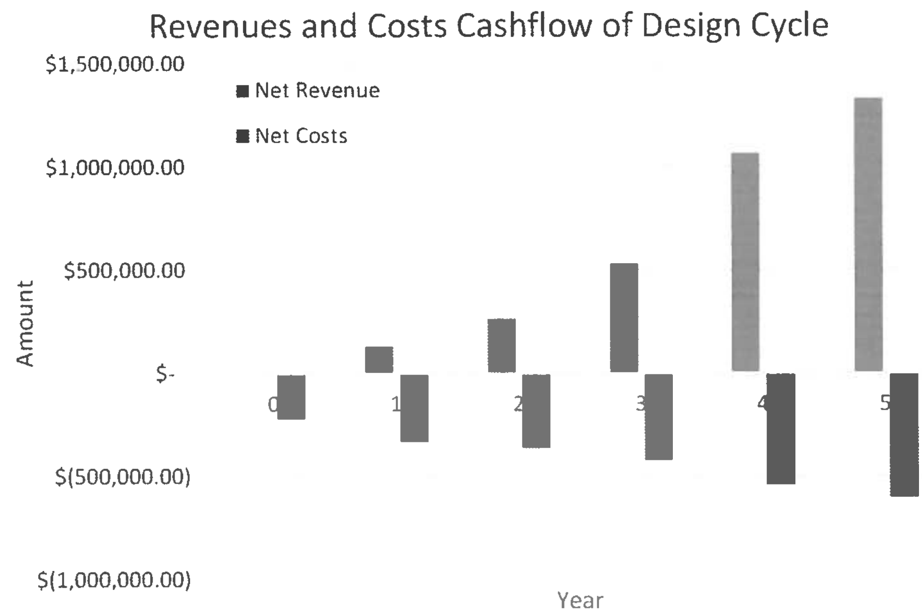

Figure 9 - Cashflow, Net Annual Costs and Revenues.

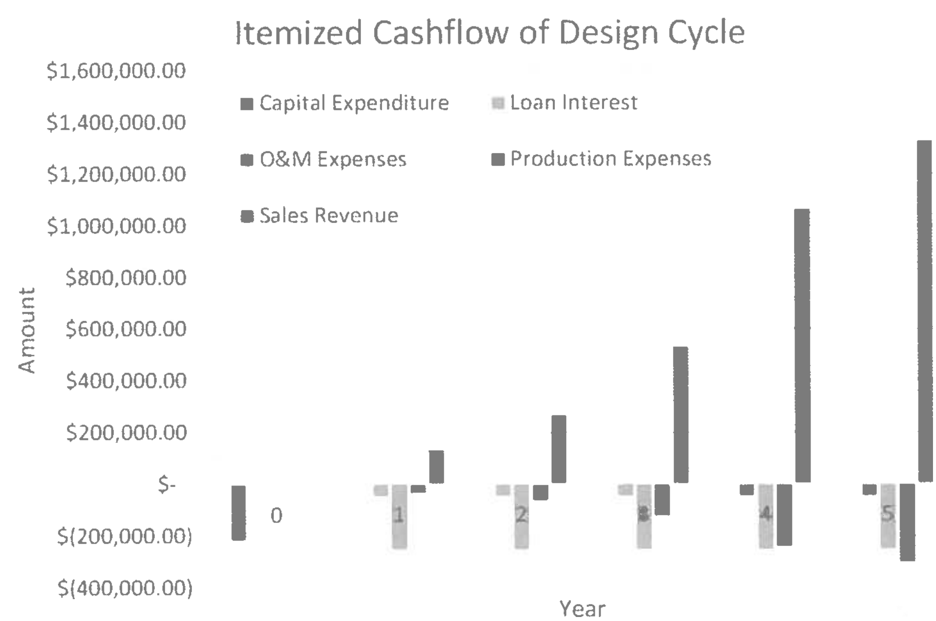

Figure 10 - Cashflow, Annual Contributions per Category

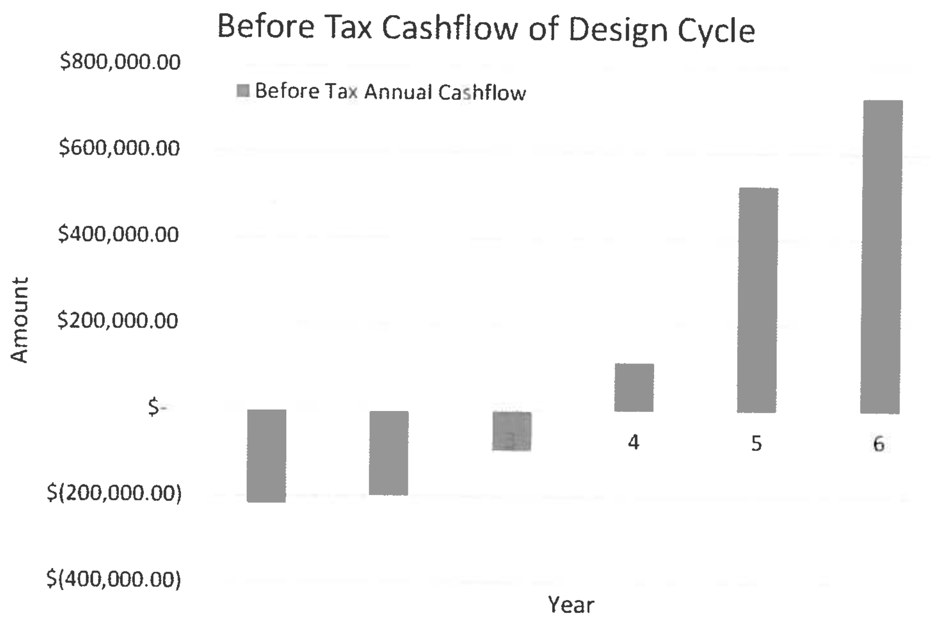

Figure 11 - Net Annual Cashflow

Refer to Figure 14 - Net After Tax Annual Cashflow on page 22 for cashflow diagram of after tax analysis.

Analysis Methods

There are multiple points to consider in selecting the analysis method for this project. To begin, we are looking for an objective, the decision basis to allow us to carry forward with this project. The alternative to this project is to invest at our high MARR of 20%, so in each case beating this goal tells us whether our venture is worth pursuing. The goal is to know how much money we could potentially make, as well as a go or no-go decision basis. Our analysis techniques selected are:

Benefit-Cost Ratio Analysis:

Taking our projected cashflow for our first design cycle, we can obtain present value costs and revenues based on our estimates. The ratio of the benefits to costs gives us insight into not only whether the project should be pursued, but also an idea of how much additional benefit we can achieve. The rule of thumb is that a project should be approved if the ratio is greater than one, that is, the benefits outweigh the cost.

In our case, we have a PV discounted benefit of $1,647,936.92 with costs at ($1,232,999.57). The ratio of these two items, the benefit-cost ratio is:

$$PW\ B{:}C = \frac{NPV(MARR, Benefits)}{NPV(MARR, Costs)} = \frac{\$1647936.92}{\$1232999.57} = 1.34$$

Thus, based on a benefit-cost analysis, the venture shall be approved at the ratio of 1.34.

Rate of Return Analysis:

A rate of return analysis determines the IRR, that is, the interest value for discounting the cashflow such that the NPV of the cashflow is equal to zero. This value is compared against our MARR to determine the feasibility of pursuing our venture. Typically, the rate of return is utilized as an easy to digest number, as the NPV in some cases can be difficult to interpret, or may be misleading.

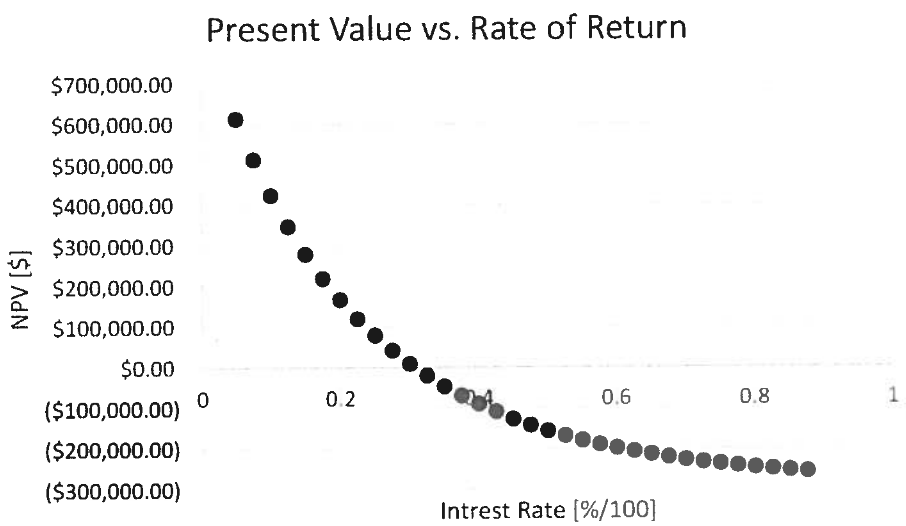

Figure 12 - Present value vs rate of return

The rate which gives a discounted present value of $0 was found to be 30.82%, as shown above in Figure 12 - Present value vs rate of return. Given our MARR of 20%, we see that the IRR is greater than the MARR. In this scenario, our basic decision rule is that if the IRR is greater than the MARR, we accept the venture. **Thus, we propose that this is a feasible venture with a rate of return of 31%.**

Payback Period Analysis:

We are concerned with the timeframe to recover initial investment, as our design cycle is only projected to last 5 years, we hope that the investment is recovered well before then. It is important to note that in this analysis, the listed values are not discounted at our MARR, and are in face value dollars. The analysis is depicted below in Figure 13 - Payback Period Analysis.

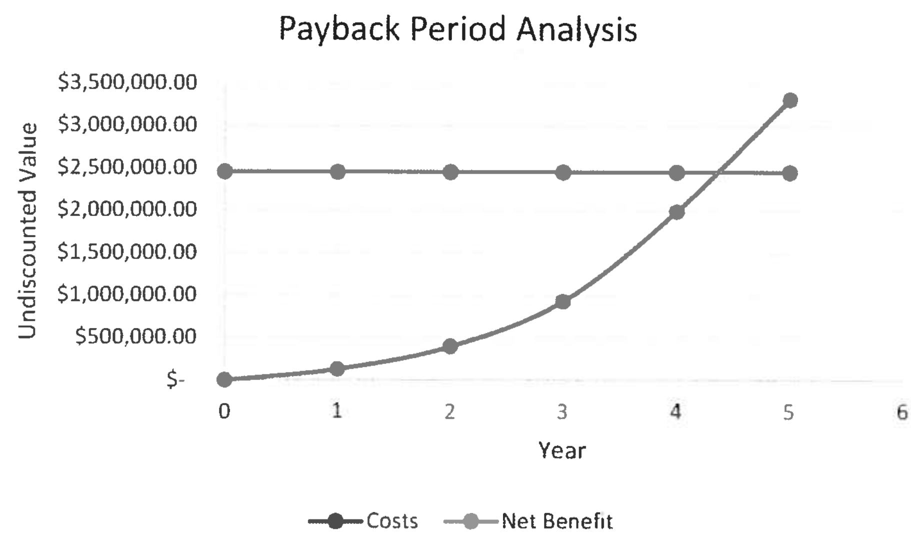

Figure 13 - Payback Period Analysis

Interpolating between the benefit values at years 4 and 5, we can find approximately where the net benefit exceeds the net costs at $2,455,609.49. The payback period is found as 4.35 years, which is less than our 5-year design cycle. It is important to consider however that the payback period is only slightly shorter than the design cycle, which may suggest that there is some risk involved in this venture. It should be noted however that given the considerable capital investment made in year 0, we do not expect the next design revision to incur the same level of costs as our initial design. **However, based on this analysis, it can be concluded that since the criteria is met with a payback period of 4.35 years, the venture should be approved.**

Sensitivity and Risk Analysis:

As previously stated, we have two major risk factors to consider. First, is that there is between a 0% and 5% chance of break up between myself and girlfriend, since we have been together for a long time and are on good terms. If we do break up, we have to pay $3000 per month in additional overhead, we analyze this over years 0-6, and in the year break up occurs, we get the present value of the $3000 per month annuity for the remaining years in the design cycle in the base year of break up, then convert into year 0 dollars and add onto our current NPV of costs.

Second item is sales revenue. Though the market analysis paints a good picture of what the projected revenue is, it isn't perfect and is a big factor in our overall analysis. The risk associated with our revenue projections is easy to produce as it comes from one sale product. Values for each year are taken, as the revenues grow with time, and are used to find the NPV of revenue for each iteration. 1000 iterations were performed and from this, the mean and standard deviations for sales revenue were determined.

Using both the NPV of costs and revenues for each iteration, total NPV was found for each iteration. From this, the mean, standard deviation, maximum, and minimum net present values were found, as well as the probability of negative NPV. The results of the simulation are shown below in Table 7 - Simulation Results.

Simulation Analysis Results

	Years Rent Free	Sales Revenue	NPV	P(neg NPV)
Mean	**5.508**	**$ 1,267,886.52**	**$ 154,482.43**	**0.1168**
SD	**1.376929918**	**$ 127,590.80**	**$ 128,577.86**	
Max	**6**	**$ 1,667,082.41**	**$ 559,893.60**	
Min	**0**	**$ 896,800.55**	**$ (224,719.52)**	

Table 7 - Simulation Results

The mean NPV is less than our calculated in the risk-free case, this is as expected as the overhead cost was not previously accounted for. It's seen that more than one standard deviation of the NPV is required to generate a negative NPV, with a risk of 11.7% associated to negative NPV. We can conclude from this analysis that the venture is low risk and should be pursued.

Summary of Analysis:

To summarize the analysis, the results from each method are collected and shown below in Table 8 - Economic Analysis Summary.

Analytical Technique	Criterea	Results	Conclusion
PW Analysis	NPV > 0 at MARR	$168,337.44	Approve
Benefit-Cost Ratio	Ratio > 1	1.34	Approve
Rate of Return	IRR > MARR	31%	Approve
Payback Period Analysis	Payback period < design cycle	4.35 years	Approve
Monte-Carlo Simulation	Mean(NPV) – SD(NPV) > 0	$25,689.78 > $0	Approve

Table 8 - Economic Analysis Summary

Each economic analysis method concluded that the venture should be pursued. Assuming that this is the case, the following section will analyze what our anticipated after tax profits will be.

Net Profits and After Tax Cash Flow

Multiple considerations were taken for the after tax cashflow analysis. The venture includes both capital assets to be depreciated, as well as loan interest to be paid from our initial investment requirements.

Our capital investments fall under the CCA Class 43.1: Include in Class 43 with a CCA rate of 30% eligible machinery and equipment, used in Canada primarily for the manufacture and process of goods for sale or lease, that are not included in Class 29 or 53. The capital investments made will be depreciated at a rate of 30%, with a rate of 15% in the first year. Additionally, we will have to pay loan interest, at $46,116 per year. In years where losses are projected, the tax shield/credit of the CCA and interest payments are applied in later years, in this case year 3:

The yearly CCA is then:

CCA(year) = (Capital Investment)*(CCA Rate)*(1-CCA Rate)^(year-1), and halved in year 1.

With these items in mind, we find our ATCF for each year, using the equation:

ATCF = Net Profit + CCA + I = OR(1-t) – OC(1-t) + (CCA)(t) + (I)(t) = BTCF – Income Tax

Application of this is shown in the following **Error! Reference source not found.** and Figure 14 - Net A fter Tax Annual Cashflow:

Year	Before Tax Cashflow	CCA	Loan Interest	Taxable Income	Tax (Negative is credited)	After Tax Cashflow	Notes
0	$ (216,534.00)			$ (216,534.00)	$ -		
1	$ (195,066.53)	$ 32,480.10	$ (46,116.89)	$ (181,429.74)	$ (3,545.57)	**$ (195,066.53)**	
2	$ (92,316.17)	$ 45,472.14	$ (46,116.89)	$ (91,671.42)	$ (167.63)	**$ (92,316.17)**	
3	$ 113,184.54	$ 15,915.25	$ (46,116.89)	$ 143,386.19	$37,280.41	**$ 75,904.14**	Credits from year 1 and 2 applied
4	$ 524,185.98	$ 22,281.35	$ (46,116.89)	$ 548,021.52	$ 142,485.60	**$ 381,700.38**	
5	$ 729,686.70	$ 7,798.47	$ (46,116.89)	$ 768,005.11	$ 199,681.33	**$ 530,005.37**	

Table 9 - After Tax Analysis

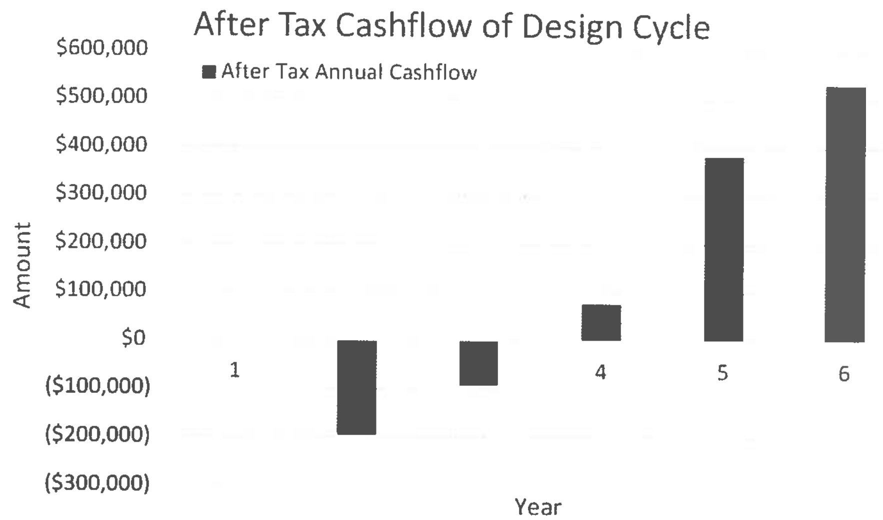

Figure 14 - Net After Tax Annual Cashflow

Conclusion

This final project performed a complete engineering project economic analysis on the venture of starting up a super rad bike company. This analysis went "full send" to analyze the current market size and competitors to determine what the projected revenues could be, looked at real world sale prices of equipment and materials required for the fabrication of high performance bikes. From this, cashflows were generated which allowed for multiple economic analyses to be performed to evaluate the feasibility of pursuing this venture. Additionally, we looked at after tax profits, as well as performed a simulation to quantify the risk associated with pursuing the venture.

The completed analysis identified that the venture has a present worth of $168,337.44 CAD with a cost-benefit ratio of 1.34. This provides a rate of return of 33%, greater than the MARR used for this venture which was set high at 20%. Given the 5 year design cycle, it was found there was a 4.35 year payback period, with the greatest revenues in year 5 we are confident that a second design revision will be possible. Risk was evaluated using a simulation, and it was shown that more than one standard deviation of risk was required to have a negative NPV for the venture.

From these analyses, we conclude that this venture should be pursued and has the potential to grow into a bicycle corporation. Time to quit my guaranteed paycheck, awesome engineering job(in the fuel cell industry, hi Mark!) and make some cool ass bikes!