

# Envirofit International: A Venture Adventure

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This case focuses on Envirofit International, a student start-up venture that began in an undergraduate entrepreneurship course. Two engineering students and two faculty members at a land grant university in the United States designed a retrofit kit to vastly reduce emissions from dirty two-stroke motorcycles, which are used throughout Asian cities as taxis. This case presents the beginnings of the Envirofit story, and the issues involved in creating an entrepreneurial venture focused on triple bottom line objectives in “base of pyramid” markets. Specifically, the case examines the ambiguity facing a start-up as it begins to develop a technology, a business model, and a management team. The case demonstrates the tension between planning and doing in managing the uncertainty facing a new venture.

## Introduction

It was a late Friday afternoon in September 2003 when Nathan Lorenz, Tim Bauer, Paul Hudnut, and Bryan Willson gathered at their usual table at CooperSmith’s Pub in Fort Collins, Colorado. It was a beautiful warm day, and they enjoyed the clear, blue Colorado skies. Lorenz and Bauer were both mechanical engineering students who worked in Dr. Willson’s Engines and Energy Conversion Laboratory at Colorado State University (CSU). In May, they had finished a class on New Venture Management, taught by Prof. Hudnut, who worked in the university’s Entrepreneurship Center. As part of the class, their student team had presented a business plan for a new start-up venture, Envirofit International, in a national business plan competition called “Venture Adventure.” Little did these four colleagues know how descriptive this title would become for them and for Envirofit.

Halfway around the world, the skies were far from blue. In cities such as Bangkok and Manila, the skies were a sooty gray. The Envirofit team hoped to help reduce this pollution by developing and commercializing a retrofit kit that dramatically reduced emissions in dirty two-stroke carbureted motorcycle engines (Figure 1). They believed the kit was ideal for use in Asia where approximately 100 million two-stroke carbureted motorcycles, many of them used as taxis, were a major means of daily transportation—and pollution. Each carbureted two-stroke motorcycle generates air pollution equivalent to 50 modern automobiles; a toxic mix of hydrocarbons, particulates, and nitrogen oxides.

Since May, Lorenz, Bauer, Hudnut, and Willson had been meeting regularly to discuss whether to start the company and how to begin turning a student business plan into a business. Over the summer, they had traveled to the Philippines (a country with significant economic and health problems due to air pollution) to meet with taxi drivers, government officials, local nongovernmental organizations (NGOs), and potential funders. After their

Figure 1

### Air Pollution from Tricycle Taxis in the Philippines



visit, the team was enthusiastic about the potential to “make a difference” by improving air quality and driver income; however, they knew they faced several major issues including: (1) how to develop a product that would be utilized in countries halfway around the world; (2) how to design a business model that would enable them to sell to customers in base of the pyramid markets and meet their triple bottom line objectives; and (3) how they should develop their management team and key partnerships.

While the team felt comfortable with the retrofit technology (Willson was a recognized expert in combustion engines), they knew they would have to develop a working prototype and test it “in-country.” To generate support for the program, they would need to demonstrate that the technology worked—perhaps at a Tricycle Operators and Drivers Association (TODA) rally in the Philippines, city of Manila. Willson commented, “The air in Manila is filthy, and the drivers struggle to make a living while breathing this toxic air all day. Our solution cleans up the air and increases their income. I know we can get the technology to work. The real challenge is to get the price down and figure out how to deploy these kits on a massive scale.”

In working on the class project, the student team and faculty had become familiar with emerging ideas about social entrepreneurship and microfinance, and had applied these ideas in developing Envirofit’s business plan. They wanted the business to focus on a “triple bottom line,” which included performance targets on social, environmental, and financial objectives. While the retrofit improved air quality, it also had the potential to increase the drivers’ income through increased fuel mileage; thereby targeting both social and environmental objectives. A win-win situation, if the team could find a way that motorcycle taxi drivers could afford the projected price of the kit (\$220), a significant sum of money when these drivers make less than five dollars a day, had little money saved, and little access to commercial credit. The team was concerned that even at this price, they would have difficulty generating financial returns that would attract private investors or commercial lenders. In addition, their trip to Manila had reinforced the extent of what they would need to learn about many of the market, manufacturing, finance, regulatory, and cultural issues that the venture would face.

They also knew there was a lot of work to do with limited resources, and they would need a lot of help to pull it off. Lorenz and Bauer were very interested in pursuing Envirofit and they knew they could work on developing the technology as part of their graduate studies through the following spring. But when they graduated, they would need “a real job” to support themselves. Lorenz looked across the table and said: “None of us

wants to proceed without the others. I think we all are willing to spend some time over the next few months to make this happen. But it can't be a 'part time' job for long. Tim and I need to start making some money when we graduate next spring. Plus, this is a serious environmental problem, and it deserves a serious effort on our part."

While the team brought a variety of experiences, time availability, and depth of knowledge to the table, they felt they would need to recruit other individuals into the company. They would also need to develop significant relationships with the patent-holder of the core technology (Orbital Engine Corporation), the Philippine government, the TODA groups, and Philippine companies who would provide the installation of the retrofits.

While the four agreed that there were a lot of questions about how to launch Envirofit, they all felt that they wanted to move forward. Hudnut said "I don't think it will be the problems of 'how to do it' that will keep us up at night. What will keep us up at night is if we don't give it a shot."

Bauer raised his glass of Cask Punjabi Ale and said, "Let's do it." The four clinked their glasses and finished their beers. Their venture adventure had begun.

## Background

As the developing world has become more populous, more urban, and more industrialized, pollution has increased dramatically. Water pollution and air pollution both have very high societal costs, in terms of the burden of disease and reduced productivity. In Asian countries such as the Philippines, the main sources of air pollution are from cooking with biomass, burning agricultural wastes, industry, and transportation. With transportation, the predominant sources of pollution are cars, motorcycles, and diesel trucks and buses. While small in size, motorcycles contribute disproportionately to air pollution in Asia.

Two-stroke powered tricycles, commonly called tuk-tuks in Asia, operate as the favored form of daily transportation in many developing nations. Two-stroke carbureted engines are preferred over four-stroke engines (a cleaner burning engine) for many reasons, but largely because two-stroke engines have the potential to pack about twice the power into the same space. The combination of light weight and better power, explains why it is not uncommon to see a tuk-tuk or tricycle hobbling down a Filipino road with eight passengers on its back (Figure 2).

Unfortunately, two-stroke carbureted engines are major polluters. Carbureted systems require that in each engine cycle, the exhaust mixture be pushed out of the combustion chamber by a new infusion of air and fuel in a process called "scavenging." During this process, some 30–40% of the new fuel is lost to pushing out the combustion products of the previous engine cycle. The high level of fuel and lubricant that escape unburned from two-stroke vehicles substantially increases the amount of hydrocarbon and fine particulate matter in the air. A comparison of the price and performance of two-strokes and four-strokes is provided in Appendix 1.

The environmental damage is significant, but the subsequent health and economic consequences are equally devastating. A World Bank study found that the annual societal cost of air pollution in Manila was ~21.3 billion PHP<sup>1</sup> (\$430 million). Motorcycles and tricycles made up over one-third of the vehicles in the Philippines and are significant contributors to this public health cost (World Bank, 2002, p. 18).

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1. PHP refers to Philippine pesos. At the time of the case 100 PHP were approximately equal to \$2 USD.

Figure 2

### A Fully Loaded Tricycle Taxi



In 1999, the Manila government passed the Clean Air Act which, among other things, required taxi drivers to meet more stringent emissions standards. However, the taxi drivers had no way of complying with the legislation other than to buy expensive new four-stroke motorcycles, and the government had no plans to assist drivers in complying with these new regulations. The situation came to a head when the National Confederation of Tricycle Operators and Drivers Associations of the Philippines (NACTODAP) held a protest in early January of 2003, and brought the transportation system of Manila to a halt (BBC News, 2003). The drivers believed their economic livelihood was threatened by these regulations. “This government continues to create laws that push our members deeper into poverty,” said Ariel Lim, the president of NACTODAP.<sup>2</sup>

### Developing the Technology

A potential solution to this social and environmental problem began when a team of CSU engineering students, mentored by Dr. Willson, and including Bauer and Lorenz, retrofitted a snowmobile for the Yellowstone National Park “Clean Snowmobile Challenge 2002.” Snowmobiles had been banned from the park due to noise and pollution, and the competition encouraged engineering students to come up with cleaner and quieter options. The core technology, originally developed by Orbital Engine Corporation in Australia,

2. “Tricycle Drivers Win Reprieve,” *Philippines Daily Inquirer*, 7 January 2003, <http://www.philsol.nl/news/03/CleanAir01-jan03.htm>, accessed 18 May 2010.

is used in marine outboard engines and European scooters as Original Equipment Manufacturer (OEM)-supplied technology. Instead of designing a new engine, the CSU/Orbital team adapted this core technology to fit onto existing engines and placed first in the emissions event in the Clean Snowmobile Challenge by reducing hydrocarbons and carbon monoxide emissions by over 99%.

Due to the subsequent publicity, Dr. Willson received an inquiry from an NGO in the Philippines, SwissContact, inquiring whether the technology would work on motorcycles. This led to the work by graduate students Bauer and Lorenz in the CSU Engines and Energy Conversion Lab as well as the decision to work on a business plan in Hudnut's entrepreneurship course. Bauer and Lorenz recruited several undergraduate business students to the team, and soon after, came up with the name Envirofit. Later in the semester, a CSU alumnus donated enough money to the lab to buy a Philippine two-stroke tricycle taxi, ship it to Fort Collins, and buy parts for building a prototype.

By using the direct injection process, Lorenz and Bauer projected they could achieve a 90% reduction of unburned hydrocarbon emissions and a 70% reduction in carbon monoxide emissions from the motorcycle engines. Based on discussions with taxi drivers in the Philippines about their driving patterns, engine sizes, and fuel usage, the team believed that the direct injection system could provide the average taxi driver with \$168 in fuel savings and \$56 in oil savings each year. This amount was roughly equal to their estimated installation cost for the kit at \$220 (see Appendix 1).

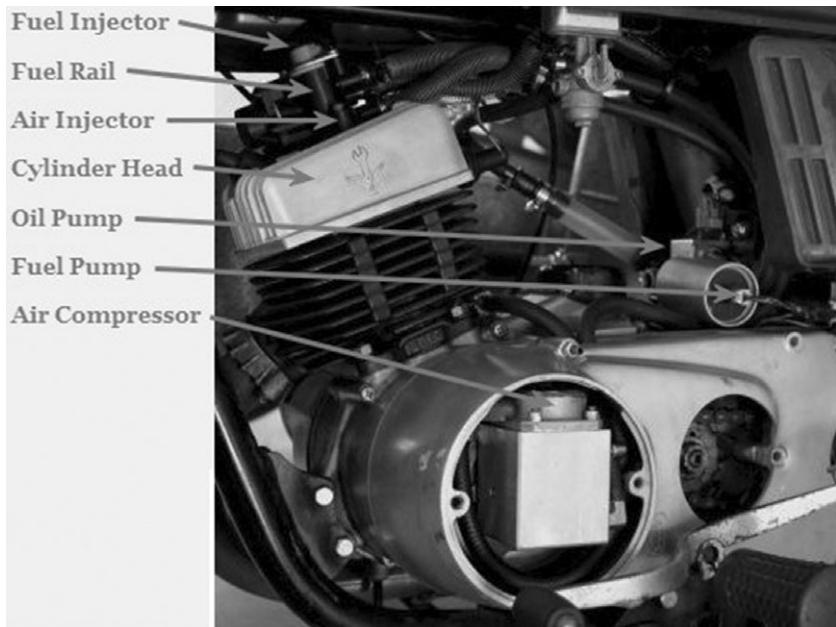
Based on their initial trips to the Philippines, the team employed several key design criteria in creating a retrofit kit that best suited the Philippines. The technology needed to be commercially available, durable, reliable, and the system couldn't have a large power draw on the motorcycle. In addition, the kit needed to be relatively easy and inexpensive to install (easily installed with a basic tool set). Finally, the kit needed to consist of parts that were commercially available, so that additional tooling costs and investments could be minimized. The prototype design, as shown in Figure 3, consisted of a cylinder head, fuel and air injectors, a piston style air compressor, a throttle body to replace the carburetor, fuel and oil pumps, and an engine control unit.

The team's plan outlined a schedule of five phases in product development that would establish the product's durability, reliability, and efficiency of operation. The first phase aimed to have a prototype Kawasaki demonstration vehicle commissioned in Manila by June of 2004. To establish public relations and generate support for the program, they wanted to demonstrate the technology of the direct injection retrofit at a TODA rally in Manila where thousands of taxi drivers would be present. Next, the team planned to conduct a field test between July of 2004 and March of 2005. This would include developing a partnership with a participating TODA in order to introduce ten Kawasaki units into service and researching other models of motorcycles (Yamaha, Suzuki) for future conversion. The units would be monitored to check their performance, durability, and emissions while working under day-to-day operating conditions in Manila. In this phase, Envirofit planned to train technicians in the TODAs on installation and basic maintenance of the Envirofit kit.

The third phase was expected to last approximately 18 months (from March 2005 through September 2006) during which Envirofit's focus would be on lowering the variable costs of production by finding contract manufacturers in Manila for the engine heads and wiring harnesses. The team believed the price of the unit would be reduced to a level that the target customer could afford. Other objectives included establishing the framework for mass production and commercialization, including franchising installation centers. The company would also need to hire staff in the Philippines to work on providing training to the TODAs in the installation and maintenance of the first 1,000 tricycles.

Figure 3

### Envirofit Retrofit Kit Components



During this phase, options for microfinancing, as well as NGO support, would be investigated to help reduce the cost of the system to the consumer.

The fourth phase would be large-scale commercialization, which was expected to begin in late 2006. This would represent the full implementation of the Envirofit technology into the Filipino market. During this phase, widespread implementation of conversion of the remaining fleet would begin. The last phase in the business plan would involve expanding on a regional level. This phase would focus on working with other potential cities and countries to set up the framework of mass commercialization through the developing world (see timetable in Appendix 2).

### Business Model

From the beginning, the team had struggled with a number of factors in trying to find a workable business model that would meet their triple bottom line objectives, allow for scalability, and provide the ability to raise start-up capital. These factors included the market, the customer, and the competition. Due to the serious pollution problem, the recently passed Clean Air Act, and the relationships they had started to form with local organizations, the Envirofit team had decided on the Philippines as its first market. The student team had found that the largest city in the country, Manila, had a population of over 11 million people and over 120,000 registered two-stroke tricycles. Their research also showed that overall vehicle population in the Philippines was growing at an annual rate of 10% (Figure 4). Envirofit's plan was to use Manila to establish a business model that could be replicated in other cities and countries where the pollution caused by two-strokes is also a problem.

Figure 4

Tricycle Taxi Stand (Manila)



The team's research showed that taxi drivers are considered micro-entrepreneurs in Manila; using the small amount of money they earn to support families. Many worked abroad to raise the initial funds required to purchase a motorcycle and have a side car attached for passengers. Bauer and Lorenz found that the cost was approximately \$1,500 for the motorcycle and \$500 for the attachment of the side car. The drivers often personalize their vehicles, with colorful paint jobs, fringing, and beads.

In their conversations with taxi drivers in Manila, the team learned that drivers typically earned \$3–5 per day (after expenses for fuel and fees). Many owned their own vehicle, and a few paid fees to rent a vehicle from another taxi owner (taxi owners were restricted to only running a few vehicles, so large company-owned fleets did not exist). Some drivers bought their motorcycles with loans from family, and there did not appear to be commercial credit from banks for purchasing a tricycle taxi. When the team described the retrofit idea to the drivers, they asked questions about fuel savings and engine power. The drivers did not like the air pollution, and pointed out that they spent their days breathing each others' exhaust. When asked about their ability or willingness to pay for a retrofit, they would typically reply that the government or the United States should provide it to them. Or as one laughingly put it, pointing to the other drivers, “all those guys should buy one, so I can breathe cleaner air.”

The team felt that one way to reach the large population of taxi drivers would consist of marketing to the TODAs. In most Philippine cities, taxi owners and drivers had organized into TODAs for vehicle storage, maintenance, and logistics. The size of each TODA group ranged from a dozen members to over 300. TODAs often have mechanics that repair and maintain the vehicles for the members of the association. These mechanics, the team reasoned, could be trained to install and maintain its retrofit kits.

In order to gain acceptance among TODA members, Envirofit believed the environmental benefits of the technology (e.g., annual fuel/oil savings, financing program) had to be emphasized through brochures and personal contacts. Bauer felt it was very important that the Envirofit's “positioning strategy focus on the environmental benefits of the vehicle. In order to gain widespread acceptance, the converted vehicles need to be accepted as ‘green vehicles,’ known for the lower levels of pollution compared to standard

two-stroke vehicles. Then passengers will choose to ride the cleaner taxis. In order to do this effectively, each retrofitted vehicle must be marked with a distinguishable symbol, identifying it as an Envirofit vehicle.”

During their research, the team did not find any direct competition to Envirofit’s retrofit kit solution to the two-cycle engine pollution problem. However, there are indirect competitors, such as those producing catalytic converters, alternative fuels, and four-stroke engines. Catalytic converters are successful in reducing the amount of hydrocarbons and carbon monoxide emissions, but are very expensive. Furthermore, the level of carbon monoxide and hydrocarbons produced by “stock” carbureted two-stroke engines was too high, and would overwhelm and subsequently destroy the catalyst. Therefore catalytic converters were only good candidates for four-stroke, or direct injected two-stroke vehicles whose emissions levels are low enough to accommodate a catalyst. They would not, the team thought, provide a feasible solution for emissions reduction in carbureted two-stroke vehicles.

Alternative fuels included electricity, ethanol, methanol, compressed natural gas (CNG), liquid petroleum gas, and bio-diesel. Each of these alternatives has advantages and disadvantages. For example, CNG is almost entirely composed of methane. While it offers 15–20% reductions in hydrocarbons and carbon monoxide, it has greater emissions of methane (which has a higher greenhouse gas impact than CO<sub>2</sub>), higher cost of fuel and conversion, decreased driving range, reduced cargo space (as large fuel storage tanks must be included), and increased refueling time.

Replacing a two-stroke motorcycle with a four-stroke motorcycle is also an alternative. The advantages of a four-stroke engine include better fuel economy than a carbureted two-stroke, less pollution, and less noise. Over time, replacing two-strokes with four-strokes may help reduce pollution, but the team found that few drivers can afford a brand new motorcycle, and some were concerned about the reduced power and more difficult maintenance a four-stroke requires.

Each of these factors played into the difficulty in determining a workable business model. Since modifying the Orbital technology and testing prototypes was going to be expensive, this prevented the team from having a bootstrap strategy. They were going to need significant additional capital. Early financial models indicated that the company could make \$10–15 gross margin per retrofit. At a high enough volume, that profit would begin to pay the operating costs of the company, but breakeven took several years, and then the operating margins were very thin. Accordingly, the net present value of many of their early cash flow projections was negative even at moderate discount rates. These were not the type of returns that would attract private investors (see Appendix 3).

The team also examined whether they could develop revenue from selling carbon credits, but at the time of the case, the Kyoto Protocol, which would have provided a mechanism for registering and selling such credits, had not been ratified and it was unclear if, or when, it might become effective, and what the price of carbon credits might be (Victor & House, 2004). The team believed that carbon revenues could be significant in the future, but that they would need to launch with a business model that would work without them.

The team also investigated forming the company as a tax-exempt charity under Internal Revenue Service (IRS) 501(c) (3) rules. This would involve forming the company as a nonprofit corporation under state law, and then filing for an exemption with the IRS. If this was approved, then donations to Envirofit would be tax deductible. The team had concerns about being a nonprofit. They felt that Envirofit needed to be run like a business by selling products, providing warranties, and parts and service. Because they would be part of a supply chain of commercial companies, they were concerned about being taken seriously by multinational companies if they were a nonprofit.

And there was a potential funding problem with a nonprofit. In initial contacts with charitable foundations, potential donors expressed concerns about the amount of time and money needed to develop the technology, and the idea that the retrofit kits would be sold, not given away. As Hudnut noted, “the foundations we have talked to are willing to pay for research identifying and scoping the size of the air pollution problem and its health impact in the developing world or to distribute known solutions to the problem. But none seem to be willing to support development of a technology to fix the problem. They say they don’t do technology development and that is the job of venture capitalists.”

While the source of funding remained a concern, the founders believed there were significant opportunities for value creation, both for the society overall and for the taxi drivers. First, the team estimated that the 120,000 registered taxies in Manila could be retrofitted for a total cost of \$25 million; thus, an annual societal cost of hundreds of millions could be reduced dramatically by a single investment of a fraction of that amount.

Second, with an initial projected cost of the retrofit kit at \$220 USD, the taxi drivers could break even within 1 year due to fuel and oil savings. Due to the short period of time required to pay back the investment, it was possible to finance the purchase for the driver. The team had begun to look into the emerging field of microfinance to see whether they might find a microfinance institution they could partner with in the Philippines. The Envirofit team determined that microfinance mechanisms did exist in the Philippines and that annual interest rates varied from 12–20% for these loans. Although the duration of most of these loans were far less than a 12-month period, some were for as long as 2 years. In addition, if Envirofit could figure out how to monetize the carbon credits, the kit cost could be further reduced. On both a macro and micro level, there was economic value that could be captured, if the founders could come up with a viable business model that could attract the capital to develop the technology.

## Team Development

Lorenz and Bauer were very interested in pursuing Envirofit. They could work on the technology as part of their graduate studies for at least 9 months, but then they would need to start making money. Hudnut and Willson had full-time jobs at the university, and neither could make a full-time commitment to the venture. Willson was a tenured full professor in Mechanical Engineering, and Hudnut split his time teaching business classes and working for the Office of Research (see Appendix 4 for bios). Both were allowed to do some outside consulting under university policies, which would allow them to help get Envirofit started. As the venture grew, more full-time people would need to be recruited for the management team.

The team also needed to develop key partnerships. The retrofit utilized Orbital’s patented technology, and Envirofit would need a license to obtain specialized parts. Orbital also possessed significant know-how about direct injection that could help Envirofit as it developed the retrofit kit. While several Orbital executives were supportive of Envirofit, they also wanted to ensure that the company properly developed and tested the technology and did not damage Orbital’s reputation.

In addition, Envirofit would need to form relationships with local distributors, the TODAs, local suppliers, government agencies, NGOs, and microfinance institutions. Early in the project, the team realized that it would be beneficial to get local partners to help. Not only would this give the business concept credibility, it would make the business more effective and efficient. They had started to build several important relationships during their recent visit to the Philippines, including SwissContact, a worldwide

economic development NGO with offices in Manila, and the Asian Development Bank (ADB). Both were involved in a local effort called the Partnership for Clean Air, which involved NGOs and governments in efforts to clean up the air in Philippine cities. These entities provided local expertise and connections and were excited about working to help implement the Envirofit technology. They also had connections to Filipino microfinance institutions that might be interested in working with Envirofit. The ADB executives suggested setting up a multistakeholder entity to develop, distribute, and finance the product. The team was not exactly sure what this would entail, but were pleased that these organizations wanted to help.

## Conclusion

The founding team of Nathan Lorenz, Tim Bauer, Paul Hudnut, and Bryan Willson were excited to get started on their venture adventure, but faced many complex decisions. First, they needed to develop a prototype and prove that the retrofit kits would work on tricycles in the Philippines. What are the key issues in this area? What recommendations would you make to Envirofit regarding technology development? Second, the team needed to make decisions about an appropriate business model that would allow the venture to meet the team's desire for a triple bottom line impact, scalability, and financial sustainability. What are the key issues? What business model would you recommend they pursue? Finally, they needed to develop the team and key partnerships. In what areas do you identify a gap between the strengths of the team and the necessary responsibilities of a start-up venture? Based on the recommendations you made about the technology development and the business model, which partnerships are critical for Envirofit to pursue?

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## Appendix 1

Comparison of Emissions, Costs, and Performance for Carbureted 2-stroke, 4-stroke, and Envirofit Retrofit (Estimated 2003 Data from Envirofit)

	Carbureted 2-stroke (baseline)	Replace with New Carbureted 4-stroke motorcycle	Install EnviroFit Retrofit
Cost	\$875	+\$1500	+\$220
<b>Emissions</b>			
Emissions Carbon Monoxide (g/km)	1.2	0.8 (33% reduction)	0.7 (41% reduction)
Emissions HC + NOX (g/km)	3.8	1.0 (73% reduction)	0.9 (76% reduction)
<b>Fuel Consumption</b>			
Fuel Economy(mpg)	117	135 (15% improvement)	165 (41% improvement)
Avg. Annual fuel savings	Annual cost of 25,000 Ph. pesos (\$425)	Saves 3,750 Ph. Pesos (\$ 67)	Saves 10,250 Ph. Pesos (\$185)
<b>Performance</b>			
Life expectancy	15–18 years	7–10 years	15–18 years
Vehicle weight	—	+30 kg	+3 kg
Power output	—	-1 bhp (-8%)	+1 bhp (+8%)
<b>Payback period</b>	—	22 years	<12 months

## Appendix 2: Proposed Timetable for Product Roll-Out

May 2003	September 2003	June 2004	March 2005	September 2006	December 2006	December 2007
Business Plan Complete	The Venture Adventure Begins	Prototype Demonstration at TODA Rally	Field Test with TODA Partner (10 units)	Initiate Production in Manila; Installation and Maintenance Training	Begin Large-scale Commercialization in Philippines	Begin Regional Expansion to Other Countries

## Appendix 3

### Five Year Pro-Forma Financial Statements 2004–2008<sup>1</sup> (in 000s)

	2004	2005	2006	2007	2008
Revenue					
Sales	0	1,170	4,320	8,100	9,900
Emission Cr	0	0	39	183	453
Total Revenue	0	1,170	4,359	8,283	10,353
Cost of Goods Sold					
Licensing	20	20	20	20	20
Product Cost		1,014	3,168	5,940	5,940
Royalties		42	158	297	363
Total COGS	20	1,076	3,346	6,257	6,323
Gross Margin	(20)	94	542	1,303	1,927
Op Expenses	229	394	532	541	629
EBIT	(249)	(300)	10	762	1,298

## Assumptions

### *Revenues*

- Units sold in Philippines in 2004 (0), 2005 (7,800), 2006 (28,800), 2007 (54,000), 2008 (66,000)
- Envirofit's unit selling price is \$150 to distributors; estimated price to driver of installed kit is \$220
- Emission credit based on the potential to sell carbon credits on the open market at \$5/ton based on cumulative number of retrofits at end of prior year

### *Costs of Goods Sold*

- Licensing fees to Orbital estimated at \$20K per year
- Total royalty fees (Orbital and CSU) estimated at \$5.50 each unit sold
- Per unit cost of components for retrofit estimated at \$130 in 2004 and 2005, \$110 in 2006 and 2007, \$90 in 2008

### *Operating Expenses*

- Research and development includes two costs—Orbital consulting fees and internal costs reflected in salaries
  - In 2004, salaries include two internal R&D at \$40K, one executive director at \$75K, one staff at \$30K, and one admin. asst. at \$20K, benefits at 20%. In years 2005, additional staff are added in Philippines and Colorado.
  - Rent estimated at 150 sq ft per employee @ \$15 per sq ft, utilities and R/E taxes total 20% per month
  - Insurance \$250 per month
  - Travel 6 trips in 2004 increasing to 12 in 2008 @ \$2,000/trip
  - Legal fees \$3,000 per year
  - Other miscellaneous \$60/employee per month

<sup>1</sup>Financial numbers derived from Envirofit 2003 student team business plan.

## **Appendix 4: Envirofit Founder Bios 2003**

### **Tim Bauer (26)**

Tim is currently seeking an MS in Mechanical Engineering from CSU with an emphasis in engine development and technology for international development. Tim has nearly five years of experience working with many types of engines as an employee of CSU's EECL, where he is a student leader, and technical supervisor. He obtained a BS in Mechanical Engineering from CSU in 2002.

### **Paul Hudnut (44)**

Paul is an entrepreneurship instructor at CSU's College of Business and also works for the Office of Research on technology transfer issues. Prior to joining CSU in 2003, he held executive management positions in several biotech companies, including Heska Corporation, a NASDAQ listed company. From 1988–96, he held various positions in business development, marketing, and general management with a telecommunications company, US WEST (NYSE). Prior to his positions in industry, Hudnut practiced corporate law with Davis, Graham & Stubbs in Denver, CO. He received his JD from the University of Virginia and his BA from Colorado College.

### **Nathan Lorenz (24)**

Nathan is currently seeking an MS in Mechanical Engineering from CSU with an emphasis in engine development and technology for international development. Nathan has experience in industry in the field of large bore natural gas compressor engine retrofits. He obtained a BS in Mechanical Engineering from CSU in 2002.

### **Dr. Bryan Willson (43)**

Dr. Willson is the founder and Director of the Engines and Energy Conversion Laboratory at Colorado State University. He received his BS degree from Texas A&M and MS and PhD (ME) degrees from the University of Texas. He teaches in the areas of design, dynamics, and energy conversion and his research focuses on internal combustion engines. He is interested in technology as a means of progress in developing countries and has travelled extensively in Asia, Africa, and Latin America.

### **Instructor's Note Envirofit International: A Venture Adventure**

### **Introduction**

This case focuses on the factual account of the efforts of a student-based team to create a triple bottom line company for a base of the pyramid (BOP) market. The Envirofit start-up utilizes a university-generated retrofit kit for two-stroke carbureted motorcycle engines, which is ideal for use in Asia where approximately 100 million of these motorcycles, many of them used as taxis, are a major means of daily transportation—and pollution. The founders are two graduate engineering students who developed the business

plan in an entrepreneurship course, and two faculty members, one in engineering and one in business. The team is now wrestling with several major issues with respect to starting the venture, including (1) the development of a prototype and demonstration of proof of concept for the technology, (2) a business model that meets triple bottom line objectives and customer needs, and (3) a team that will be able to build a “born global” business in BOP markets.

The setting of the case is a September afternoon in 2003 as the new venture team meets to make the final decision about moving forward with their venture. After completing their business plan in the spring, the team competed in an undergraduate business plan competition called Venture Adventure. At the heart of the case is the idea that start-ups are indeed an adventure, and require a mix of planning and doing in the face of much uncertainty. The idea that a start-up is an adventure that includes both planning and doing is described in the academic literature as processes of causation and effectuation (Sarasvathy, 2001). The case allows instructors to facilitate student learning through analysis of the situation, development of options, and determining a course of action with multiple tasks. There are no “right answers”; instead, there are many options for these founders, just as there are in most start-up ventures.

The case is timely not only because of its focus on the process of bringing student projects developed in entrepreneurship courses to the market, but also because of the current trend to investigate entrepreneurship as a powerful tool to address the economic, social, and environmental issues facing the world today (Bornstein, 2004). The dimension of serving customers struggling to make a living and working in a heavily polluted environment makes the decision-making process more difficult. As one of the protagonists in the case states, “what will keep us up at night is if we don’t give it a shot,” referring to the pressure social entrepreneurs face to take action in the face of environmental damage or social injustice (Dees, 2001). Some instructors may want to have students examine the personal cost of not doing something, which may be higher than the cost of a failed effort.

## Key Issues and Discussion Points

In entrepreneurship courses around the world, students are investigating their own ideas as well as other university-developed technologies (motivated in the United States by the Bayh-Dole Act) to determine their applicability in the marketplace. This case allows students to follow the new venture creation process and engage in critical decision-making points. The case allows students to consider questions about their personal motivations and opportunity costs of starting a venture, as well as to consider something much larger than themselves—a potential solution to a real environmental and health problem.

There is growing recognition that capitalism and entrepreneurship are powerful tools to address the economic, social, and environmental issues facing the world today. Elkington (1998) and Hart (2005) argue that the private sector is the only entity with the resources and global reach to transform our world into global sustainability and Prahalad (2005) makes a compelling argument that multinational companies could find a “fortune at the bottom of the pyramid” by addressing these underserved markets to drive future growth, while at the same time reducing poverty.

The first major issue the students encounter in this case is how to develop a technology and provide proof of concept for a product that would be utilized in countries half-way around the world. This issue can be used to discuss the importance of demonstrating a technological solution and the related cost for a start-up. Issues of “designing for extreme

affordability” (Polak, 2008) may also be discussed, with questions probing ways that the company could reduce costs of the retrofit (as well as increase customer income or access to financing—see business model discussion). The technology and business model issues are connected, in that the cost of technology development (tooling, vendor relationships, salaries, and consulting) prevents bootstrapping the venture and requires outside funding.

The second issue concerns the type of business model that makes sense when the customer base includes individuals in BOP markets who may make less than \$5 per day and have little or no savings. The business model needs to be able to provide an affordable solution to the customer, but also attract investment capital to pay for technology and market development. The authors define a business model as the way an organization creates and shares value among its stakeholders. It is easy to see how Envirofit’s success would create societal value by reducing air pollution and how it would create value for its customers by increasing their income. But how would it create value for its investors? This allows for a discussion of the goals of different types of investors, from professional investors seeking solely financial returns, to angels seeking both financial returns and involvement in the venture, to emerging venture philanthropists (Venture Philanthropy Partners, 2004).

Instructors could encourage students to evaluate Envirofit’s business model using “three S’s”: (1) Is the business model sustainable (can it pay its expenses and eventually make a profit?), (2) Is it scalable (and what are the aspects that will govern the pace of growth and ultimate scale of the enterprise?), and (3) Will it make a significant impact on a real problem? The discussion can focus on ways the company can design a business model to make the retrofit affordable to the customers (microfinance, carbon credits, payment terms, distribution) and provide an acceptable return on investment (financial return and/or social impact). Once the business model has been designed, some have advocated that “microfranchising” can be an effective means to scaling BOP businesses (Fairbourne, Gibson, & Dyer, 2007).

Instructors may ask students to review the financial information in the case and design microloans for drivers. This will help them understand how finance could build the market, but may also raise ethical issues about a social enterprise charging what seem like high interest rates to the poor. They may also want to have students examine ways that inventory could be managed to reduce cash needs (by negotiating favorable payment terms, for instance). And they may want to examine scenarios for what would happen if the Kyoto Protocol became effective.<sup>1</sup> To conclude the business model discussion, instructors may want to ask “Can a for-profit business model provide enough return and scale to attract private investors?” And “Will a nonprofit company be able to achieve the impact that the founders want to achieve?”

Finally, questions center around how to develop the team (“who should we bring on board?”) and the network to deliver on their innovative product and business model. This is a good place to examine a number of team issues. What is the commitment founders make to each other? What are the advantages and disadvantages to having a team of founders, instead of a single founder? How should entrepreneurs balance experience and passion in a start-up team (Kawasaki, 2004). The instructor should delve into what the founders know, and don’t know. This is not an experienced start-up team. Will passion and persistence trump inexperience? Also, this is a good case for examining the “make or buy” decision. What is critical for Envirofit to own in terms of core capabilities, and what can

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1. The Kyoto Protocol became effective in 2005 and carbon credits traded as high as €24 per ton that year on the European Climate Exchange. Since reaching highs in 2006, certified carbon credits have trended down to a range of €9 to €15 in 2009. Current and historical carbon prices can be found at the European Climate Exchange ([www.ecx.eu](http://www.ecx.eu)).

it “outsource” through contractors or partners? For the business model to work, it is likely that they are going to have to leverage partnerships with a variety of organizations to acquire resources and talent they cannot afford to own or hire. How can they build a network to deliver their innovative product and business model? The company will need to access resources beyond their organization, including intellectual property from Orbital and the university, supplier relationships for components, distribution relationships with tricycle operators and drivers associations or other installation centers, government agencies, and microfinance institutions. What team capabilities will this require (e.g., international negotiation and supply chain expertise) and can the company leverage their social and environmental objectives with the various potential partners (some may be more amenable to these objectives than others)?

## Potential Audience and Uses

This case is designed for new venture creation courses in entrepreneurship at both the undergraduate and graduate levels. It would be best used in the latter half of the course when students have a greater understanding of the entrepreneurial process and have had a working familiarity with product development, business models, and team development. This case would also work well in a social or sustainable venturing module and would be particularly useful in cross-discipline entrepreneurship curriculums. Because the actors in this case are from engineering as well as traditional business areas, it allows students to speculate about potential relationships between different disciplines and the “value-added” of each. Lastly, the authors hope that this case will be used by instructors to open students’ eyes to the opportunities to build companies with triple bottom line objectives.

## Suggested Teaching Approach

As noted in the Key Issues above, instructors may choose to focus on any one of the three decision points outlined in the case; however, as is true for most new ventures, one specific decision will impact the options available in the other decision areas. This is the “adventure,” and this case gives students the opportunity to observe this balance between planning and doing in the face of uncertainty. One way to structure the discussion is to first cover the basic issues in the case and then put the students into more engaged positions—either as potential employees or investors. How would they personally balance the competing aspects of the triple bottom line objectives in reaching a recommended approach for the company? They are then asked to evaluate the venture and come up with recommendations.

The first approach is to put students in the role of being offered a position of joining the company as a business development director who is responsible for multiple roles in marketing, finance, and strategy. How would they evaluate joining the company? The instructor can decide the relative mix of personal issues (“I have student loans I need to repay, so I need a high paying job”) and business issues (“what are the advantages and disadvantages of working for a start-up”). The instructor may also want to design more specific roles, such as finance director or international marketing manager. What framework would students use to evaluate this type of job opportunity? If they joined the company, what would be the top three to five priorities they would recommend for the company? The authors use this class discussion to illustrate that the approaches taught in class regarding evaluation of entrepreneurial opportunities can also be useful in evaluating job opportunities.

An alternative approach is to have the students analyze an investment in Envirofit, both as a financial investment, and as a charitable donation. How does their analysis change from these two perspectives? Why? Depending on the level of the course, this can also be used to introduce the concept of hybrid organizational structures (Hudnut, Bauer, & Lorenz, 2006). This investor perspective can be also be used in a group exercise, with several investment funds and foundations evaluating the opportunity. These student firms can then make recommendations on whether they would invest, and what steps they might take both to assist the founders (advice, new team members, and network access) and reduce the risk to investors (such as making investments contingent on reaching milestones).

## Role of the Authors

All events and individuals in the case are real. One of the authors of this case, Paul Hudnut, is one of the founders and was the company's first president. This case has been taught in undergraduate and graduate courses in entrepreneurship, sustainable venturing, and strategic management. The second author is a management professor whose research focuses exclusively on entrepreneurship.

The company started in virtual form in October 2003 with Tim Bauer, Nathan Lorenz, Paul Hudnut, and Bryan Willson as the original directors. They chose a nonprofit form and worked closely with SwissContact to develop local knowledge. Tim and Nathan developed a working "alpha" prototype that was demonstrated in Manila in November of 2003 that utilized expensive "one off" parts made at the university lab. Delays in raising funds delayed developing "beta" prototypes for field testing that would use commercially made parts for many months. It took 12 months to raise the start-up capital, and the founders spoke to, and were turned down by, dozens of foundations focused on international development or environmental issues before obtaining funding from the Bohemian Foundation. The company became operational in November 2004 with Tim and Nathan as its first employees.

The experience of starting Envirofit has led to additional BOP and triple bottom line projects at the university, as well as to its recently approved graduate business degree program in Global Social and Sustainable Enterprise. Envirofit has been recognized for its innovative approaches, being selected as a TechAward Laureate in 2005, and a winner of the World Clean Energy Award in 2007. In 2008, Tim Bauer received the \$100,000 Rolex Prize for his work at Envirofit, which he promptly donated to the company.

## Video Resources

There are several sources of video clips on Envirofit, but all from well after the time of the case, so we tend to use them after the students have prepared the case. The authors think the best clip is from the Rolex Award site: <http://rolexawards.com/en/the-laureates/timbauer-home.jsp>

Envirofit also has a channel with a number of videos on YouTube for both their 2-stroke retrofit kits and cook stoves: <http://www.youtube.com/user/envirofit>

## Outside or Supplementary Readings

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