

# **ENTREPRENEURSHIP IN ENGINEERING: BRIDGING THE GAP BETWEEN ACADEMIA AND INDUSTRY**

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## **ABSTRACT**

Every year thousands of college students work on projects coming up with great ideas and lots of new technology. The problem is that many of these projects are abandoned upon graduation and filed away in someone's office, never making it to market where it could be profitable for both the students and universities. This paper looks at the things being done at the University of Colorado that help students develop their technology further so that it is able to make it into the business environment. Companies like eSpace and organizations affiliated with the university like RASEI as well as programs like the Engineering Management certificates, are crucial in helping students with their ideas. The focus will be on the HELIOS team and their idea and how they were able to develop it further. Starting as a senior design team in the Fall of 2009 students developed an innovative hybrid propulsion system for small aircraft. Using the previously mentioned resources they performed market research and started a new company TIGON EnerTec, Inc. Tigon will move the idea from a project to a product.

## **KEYWORDS**

Startup Company, hybrid engine, entrepreneurship, TIGON EnerTec

## **INTRODUCTION**

Engineering students have no trouble conceiving, designing, building and testing cutting edge technology. Research and school projects force students to be creative and innovative in finding solutions to real life problems. A lot of these solutions have potential to be sold commercially, but coming from an academic environment as opposed to a business environment, these technologies typically fall into what entrepreneurs call the "valley of despair". Most engineers lack the business skills and experience necessary to take a technology from the research stage to the market. Fortunately for students of the University of Colorado there is a vast network of assistance available to students and faculty aimed at promoting entrepreneurship. This paper discusses the evolution of a student project that developed a hybrid-electric engine for use in UAV platforms. Students saw that their innovation had a potential place in the market and sought assistance from The Center for Space Entrepreneurship (eSpace) and the Renewable and Sustainable Energy Institute (RASEI) in order to make it across the so-called "valley of death". Through this process the students refined their technology, identified potential markets and recognized market "pains", protected their intellectual property, gained valuable business skills, built a strong team, incorporated a company, and sought out investors.

## THE IDEA

The Senior Design class at the University of Colorado is a two semester capstone program in which an industry engineering environment is very well simulated. Students must work together in teams on real-world problems and come up with a solution all while learning how to manage time, integrate complex systems, test and document effectively, and manage financial resources. In fall '09, Professor Jean Koster presented his vision of a hybrid-electric aircraft to the HELIOS Senior Design team. The team spent a great deal of time brainstorming many different systems configurations for a hybrid system. Thinking outside the box, the team came up with a device that efficiently combines torque from two independent power sources and outputs the power to a single propeller shaft. The HELIOS team designed, manufactured and tested the hybrid propulsion system while a team from Daniel Webster College in Nashua, NH designed an airframe specifically intended for the propulsion system. In spring '10 the teams integrated the two systems and successfully flew their hybrid engine for the first time. Figure 1 shows the launch of the HELIOS engine in the solar powered airframe developed by Daniel Webster College.



Figure 1. First launch of HELIOS Hybrid-Electric Engine

## FINDING A MARKET

After realizing that the team had created an innovative and creative solution to hybridizing small aircraft, one engineering student from the HELIOS team partnered up with an MBA student from the CU Business School under the guidance of a local entrepreneur as a part of RASEI's Market Assessment Program. The program lasted four months in which both students investigated various markets in which the hybrid engine might be profitable. Patent searches and analysis were performed in order to determine whether or not the technology was the first of its kind. It was found the hybrid engine design did not infringe on any existing patents. Seeing that the hybrid design was unique, the students then brainstormed on how to sell it. The MAP program taught the students to think outside the box when looking for potential markets. In addition to commercializing the engine in the unmanned aerial vehicle (UAV) market, the students found that their technology could show profits in the RC hobbyist market, the general aviation market, marine and boating market, and the ATV/motorcycle market. Each of these markets was

analyzed in great detail in which the students determined the size and the potential share that a company selling the engine would have. Of all the markets investigated, the UAV market appeared to be the most promising entry point for a small company. Unmanned vehicles are becoming more and more popular as they provide a cheaper and safer way to carry out missions that are traditionally carried out by manned aircraft. The following chart from The Teal Group depicts the projected procurement of UAVs over the next decade.

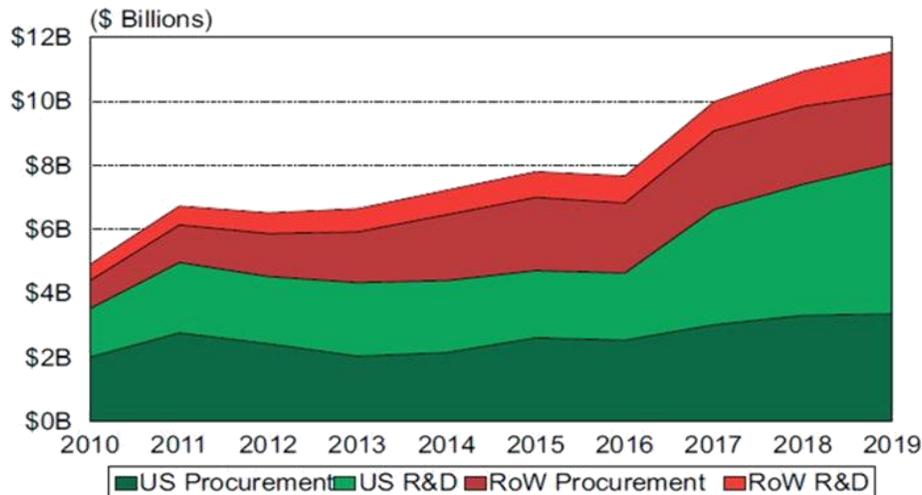


Figure 2. Projected UAV Market [1]

This chart numerically predicts that sales in the UAV market will increase dramatically in the coming years. In addition, a report by Frost and Sullivan shows a lack of understanding of current UAV propulsion in that “Of all the platform technologies in UAVs, the engines or power plants remain the most sought after and least investigated” [2]. At the end of the MAP program, the students were even more excited about the hybrid engine design than ever before as they had evidence that their technology would fare well in the commercial marketplace. Subsequently RASEI saw the potential as well and gave additional funding to begin the process of starting a company.

### **BUILDING THE RIGHT TEAM**

It has often been said that the management team of a startup company is just as important as the product the company is selling. In order to be successful, the team knew that they must form a team that has a solid technical knowledge base, a strong entrepreneurship motivation, and a wealth of industry contacts. The four students involved: Alec Velazco, Derek Hillery, Cody Humbargar, and Eric Serani were all graduate students in Aerospace Engineering Sciences at the University of Colorado. They held the necessary technical knowledge as they were the students responsible for designing and refining the hybrid-electric engine. Dr. Jean Koster provided additional technical knowledge and as an excellent link to the academic world. Dr. Koster was able to promote the technology through his network and attract the attention of many interested parties.

Although the team's technical skills were strong, they still lacked a leader. Many interviews were held until the team found the right person for the job. Les Makepeace, a retired navy pilot, former production lead for the F/A-18E/F at Boeing, leader of various early stage startup companies, and serves as Adjunct Faculty for Entrepreneurship at the Daniels College of Business, University of Denver. He filled in the missing pieces of a strong management team with his vast connections to the military and aerospace companies and his previous experience with entrepreneurship. With a solid foundation, the team incorporated their company, TIGON EnerTec, Inc. in the fall of 2010.

## **PROTECTING INTELLECTUAL PROPERTY**

The results of the MAP program showed that the hybrid-electric engine design was something truly unique. In order for the team to enter the market as the first hybrid UAV propulsion system manufacturers the intellectual property had to be protected. The Technology Transfer Office (TTO) at the University of Colorado handles patent filings for university developed knowledge. TTO let the students of the original HELIOS team decide whether they would like to file the patent themselves or let the university handle it. Since most of the original team was graduating and heading off in various directions and lacked the finances necessary to file a US patent, they decided it would be easier if the patent was filed through the university. During the patent process it was of utmost importance that the team kept the technical design out of the public eye. This process resulted in the filing of two US patents on the hybrid technology in December of 2010.

## **BUILDING BUSINESS SKILLS**

An additional service offered by the University of Colorado to help engineers bridge the "valley of despair" is the Engineering Management Program. Sponsored by Lockheed Martin, the Engineering Management Program provides an education to those seeking a career in management opportunities in engineering and technology. One of the certificates offered with this class is the engineering Entrepreneurship Certificate. This certificate is offered in partnership with the Deming Center for Entrepreneurship. It provides the student with the essential knowledge, understanding and skills to successfully practice entrepreneurship in a start-up venture.

The focus of the Engineering Entrepreneurship certificate program is on how to launch, lead and manage a viable business starting with concept validation to commercialization and business formation. The program culminates with the development of a business plan for a project you choose that you then pitch to business community leaders and venture capitalists. The undergraduate curriculum is comprised of four core courses totaling 12 credits.

The first course focuses on leadership and management where the students learn some of the essential skills in leading a team. We also looked into personality types using Myers-Briggs and determined how to best get different personalities to work together. The second course was focused on finance and accounting. This allowed us to get an overview and understanding of where it was that the money was actually going. The third class was focused on high technology marketing. This introduced us to how we need to go about marketing a new

invention such as the one found in HELIOS. The final class was a Business plan preparation course. This course brought together all the previous courses into one capstone project in which teams of six were formed. These teams are comprised of both business and engineering students who develop a business opportunity.

For this course, members of the HELIOS team decided to focus on their hybrid propulsion system and continue developing it into a business. In this class students go through an industry analysis, marketing and operations plan. They also developed a financial and funding plan. These were then all refined and united into one overall business plan that was then presented to industry leaders and venture capitalists. The judges were very impressed with the HELIOS opportunity and were awarded first prize in the class for business plans. Overall this certificate was imperative in preparing students for starting a company and introducing students to what they did and did not know about business.

## **THE NEXT STEPS**

With these things completed the team set off on forming the company, TIGON EnerTec, Inc. Armed with the right team and the market research, the team opened its first round of investing to start raising money. The goal is to raise \$2MM in equity to allow for all development supporting broad commercialization in the UAV, General Aviation, and motorcycle markets. The TIGON hybrid solution is inherently fast and cheap to integrate, therefore a \$2MM equity round allows two years of working capital and broad commercialization.

TIGON has the exclusive license to develop, commercialize and sell a hybrid propulsion technology that drastically reduces the time and cost associated with developing a hybrid vehicle. Already demonstrated in the aerospace market, TIGON will continue commercialization work in aerospace while expanding the technology into marine applications and small land vehicles. TIGON is poised to capitalize on the performance gap between traditional propulsion and electric propulsion by offering an affordable alternative with benefits from both traditional and electric systems.

## **REFERENCES**

- [1] "2010 Market Profile and Forecast." *Teal Group Corporation*. 23 Feb. 2010
- [2] Strategic Analysis of the European Small and Mini Unmanned Aerial Systems (S/MUAS) Markets." *Frost & Sullivan*. 8 Feb. 2008

## ***Biographical Information***

Derek Hillery is a graduate student at the University of Colorado at Boulder, with an emphasis in aerodynamics, systems, and control, and a holder of an Engineering Entrepreneurship Certificate. Derek served as the Systems Engineer and Electronics Lead on the award-winning Remote Reconnaissance Rovers project in 2009/2010, in partnership with the Jet Propulsion Laboratory. He gained experience with hardware-in-loop satellite controls and flight software

with Lockheed Martin Space Systems Company. Derek is also a founding member and Research and Development lead for TIGON EnerTec.

Cody Humbargar is a graduate student in Aerospace Engineering Sciences at the University of Colorado studying vehicle systems with a focus in fluids. Cody worked on the HELIOS project, designing an innovative hybrid propulsion system for aircraft becoming an expert in gearing systems for small engines. For this project he was the CFO as well as Assistant Project Manager and Software Lead and he continued his work with the engine for TIGON EnerTec, Inc.

Jean N. Koster is Professor of Aerospace Engineering Sciences at the University of Colorado, Boulder, Colorado and President of Tigon EnerTec, Inc., a start-up company for aerospace propulsion technologies. He is the CDIO representative from the University of Colorado and is the department course coordinator for the senior design projects courses. He is faculty adviser and PI of the Hyperion project funded by Boeing, eSpace, and NASA-CDIO-NAAP grant.

Eric Serani is a graduate student in Aerospace Engineering at the University of Colorado at Boulder and is getting his emphasis in vehicle systems and control. He was the lead systems engineer on the HELIOS Senior Design project that designed a hybrid-electric engine for use in RC aircraft. He continued with the hybrid technology and was a founding member of TIGON EnerTec, Inc. Outside of school you can find him flying or working on an experimental he and his father built while in high school.

Alec Velazco is a graduate student in Aerospace Engineering Sciences at the University of Colorado at Boulder, where he is focusing studies on hybrid vehicle systems and controls. As an undergraduate, Alec received a certificate in Engineering Entrepreneurship from Lockheed Martin, while also working on the Remote Reconnaissance Rovers project in AY2009/2010, a CU senior project partnership with the Jet Propulsions Laboratory. Alec is also a founding member of Tigon EnerTec, Inc.

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