

AIMING HIGH

By **Eric Besnard**
 Chief Technical Officer
 Vice President of Engineering and Co-Founder
 Vector, Tucson, USA

MICROSATELLITES represent a new opportunity to provide connectivity for the Internet of Things, as well as to capture images and data from space, at a relatively low cost — but the challenge is getting them into orbit in a timely and cost-effective manner. By making satellite launches both routine and affordable, startup Vector is opening up the space race to a new generation of small and mid-sized businesses that can deploy entire swarms of tiny satellites. With its risk-taking engineering strategy, Vector is poised to disrupt the satellite industry, one launch at a time.

nce the domain of large companies and oversized technology, the satellite industry is evolving in exciting ways today in response to a huge, and growing, market for satellite capabilities. The growing Internet of Things (IoT) demands new levels of global connectivity, autonomous vehicles require GPS positioning data, and concern about climate change means that weather conditions on Earth must be continuously monitored.

A new generation of microsats — some measuring only 10 centimeters across — has emerged to answer this need, providing uninterrupted connectivity and information capture more affordably than previous technology. These tiny, lightweight satellites are ideally suited to meeting a number of urgent market needs. Deployed in swarms, they provide a powerful solution by enabling communication and supporting data capture and exchange around the world.



While it's relatively inexpensive to manufacture these small satellites, the final frontier is sending them into orbit affordably. The prohibitive cost of traditional launch technology — as well as long wait lists for a launch date — are currently keeping small and mid-sized businesses from entering the growing microsatellite market. While these businesses can manufacture thousands of tiny satellites, they cannot afford to wait years to launch them.

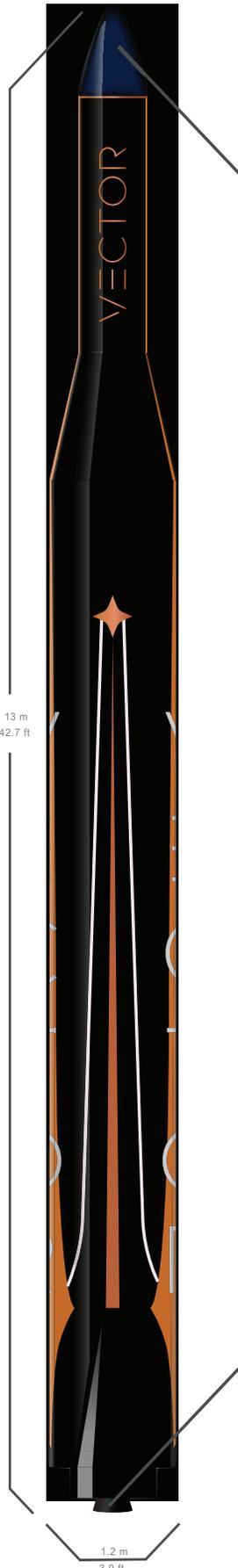
A NEW INDUSTRY SEGMENT TAKES OFF

Recognizing this market need, Vector was founded in 2016 to design, engineer and manufacture rockets capable of sending customers' microsatellites into orbit. The executive team includes a co-founder of SpaceX, as well as a number of experts who have worked at NASA, Virgin Galactic and other aerospace leaders. The Vector team also brings together a wide range of experience in software and high-technology, engineering, rocket science and business management.

Small to mid-sized businesses must wait for an opportunity to “hitchhike” on a larger launch mission as a secondary or tertiary payload. Vector is aiming to change that by offering dedicated, frequent, reliable launches. With no competition in the microsatellite launch category — defined as payloads of 60 kilograms or less — Vector sees a unique opportunity to create and then dominate this new industry segment.

FIRING UP INNOVATION

The key to success for the Vector team is quick development and commercialization of the complex technology systems needed to accomplish this goal. Both the launch system and the rocket push the boundaries of physical performance, because significant stresses are placed on every system and subsystem involved. Components in the rocket must withstand speeds in excess of Mach 6, along with temperature variations ranging from -160 C to 3,000 C. All electronics must be miniaturized to keep the rocket small and lightweight, increasing the technical complexity.



While NASA and other large aerospace concerns have generous budgets devoted to research and development, Vector was funded with just \$21 million in venture capital. In order to sustain itself and support its future profitability, Vector must keep its team small, minimize development costs and get its products to market as soon as possible. This means implementing a number of new-generation engineering practices.

Engineering simulation represents a critical way for Vector to dramatically cut the time and financial investments required to develop its launch systems. By using a unified set of multiphysics simulation tools acquired via the ANSYS Startup Program, Vector developers can design products in a virtual space, exploring a range of engineering problems across the launch system.

For example, fluids simulation software enables the Vector team to study the rocket engine's internal flows, which are associated with propellants, reacting gases in the combustion chamber and heat loads on the hot chamber walls. Mechanical simulations reveal how the rocket will respond to the huge environmental changes it will have to endure, including extremely high structural, mechanical and thermal stresses.

The combined rocket-launcher system has an enormous degree of numerical complexity. Simulation supports Vector's engineering team as it seeks to bring all those pieces together successfully. Using design exploration, product developers can change parameters very quickly and see how the entire system will respond.

This greatly accelerates the iterative design process and allows the Vector team to arrive rapidly at a rocket and launcher that have a high degree of robustness — before the construction of a physical prototype, which can take months.

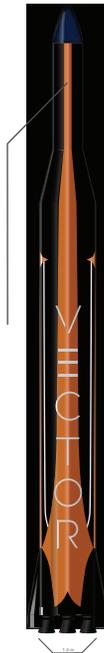
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FAIL FAST, FAIL OFTEN AND FIX IT

While Vector’s product development team does try to minimize the cost of physical testing, the company also has a unique risk-taking spirit, probably because many of its executive team members have experience in Silicon Valley and the software industry.

Just as software and consumer electronics companies are not afraid to launch imperfect products — then gradually announce new releases with additional features — Vector is willing to test early product prototypes, knowing that the designs are not yet perfect. The Vector engineering team knows that these early rocket designs may not perform flawlessly, but there is much to be learned from failures — and those lessons can actually accelerate the ongoing product development effort. By combining simulation and physical testing, the Vector development team can work quickly to capture



the market opportunity, while also making the best use of the limited private funds that are typical of a startup business.

Vector is currently working with the Federal Aviation Administration (FAA) for licensing orbital launches, and in the meantime the company is conducting low-altitude launches, which have a less stringent approval process. Based on these tests, the engineering team is learning about stresses during launch, failure modes, materials strength and other key design issues.

This agile engineering approach distinguishes Vector from traditional aerospace companies, which follow a “waterfall” process in which they design rockets and other systems over the course of years — then build and test prototypes only after years of design work. In addition to being time-intensive, this process consumes large amounts of capital, but it is a necessity

because large companies, working under the scrutiny of shareholders and board members, are usually risk averse. They cannot have a spectacular failure, with its accompanying media attention. Vector, on the other hand, embraces the testing that may result in a spectacular failure if it will reveal important engineering insights and inform future design iterations.



BLUE SKIES AHEAD

In its engineering and business philosophy, Vector brings together the best of both worlds: the risk-taking nature of a startup company combined with deep aerospace industry experience and technical depth. That combination should help propel Vector toward its goal of a first orbital launch in 2018.

With two low-altitude test launches on the books, Vector is making steady progress toward redefining the global satellite industry. The company's long-term goal is to schedule 100 launches annually for customers — which means engineering and building 100 rockets per year. Just as the company is applying advanced rocket and launch technologies to invent a new market category, Vector is embracing new-generation engineering practices and tools, including digital design exploration through simulation, to arrive at its ultimate destination faster. 🚀



ABOUT ERIC BESNARD

Dr. Eric Besnard is a well-known expert in aerospace system design and rocket and spacecraft propulsion, as well as launch vehicles. He has been involved in liquid propulsion research and launch vehicle technology development funded by NASA and the Air Force, including the development of innovative launch vehicle flights and technologies such as the first known aerospike and LOX/methane rocket engine flight tests. In addition to his work with Vector, Besnard is on the faculty of the Mechanical and Aerospace Engineering Department at California State University, Long Beach.

VECTOR AT A GLANCE

Founded: 2016

Number of employees: 100

Headquarters: Tucson, Arizona



PROPELLING STARTUP SUCCESS

Today, engineering simulation software is used by the world's leading engineering teams to design and verify products quickly and cost-effectively, in a risk-free virtual space. Because the cost of licensing simulation software might be prohibitive for startup ventures like Vector, the ANSYS Startup Program was created to help eligible startup companies around the globe bring their innovative product ideas to market. These entrepreneurial businesses can compete more effectively by leveraging the advanced capabilities of ANSYS software, while also benefiting from the world-class engineering processes and workflows that ANSYS has developed over the course of 40-plus years.

“Our ability to access ANSYS software has been a key factor in establishing credibility and securing funding, as well as supporting our engineering success to date,” notes Eric Besnard of Vector. “We have very complicated problems to model, and our engineering staff consists of a relatively young team of graduate students and recent graduates. With training and support from ANSYS, we are now conducting incredibly complex design explorations and engineering at the same level as much larger aerospace companies. That is helping us move forward quickly, with a very high degree of confidence in our designs.”

For more information on the ANSYS Startup Program, visit ansys.com/startups.