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## Company Fact Sheet

### Year Founded

1998. Became Fallbrook Technologies Inc. in 2004.

### Business

Fallbrook Technologies Inc. (Fallbrook) is a manufacturing and technology development company dedicated to improving mechanical transmission-based products. The Company's core technology is its NuVinci® continuously variable planetary (CVP). The award-winning technology has been recognized as revolutionary and is potentially applicable to any product that uses a transmission including bicycles, light electric vehicles, agricultural equipment, automobiles, and wind turbines among others. Fallbrook manufactures and markets *NuVinci* drivetrains for the bicycle market. In addition, it partners with other companies to commercialize its *NuVinci* technology and provides design, development and manufacturing support. Its wholly owned subsidiary, Hodyon, Inc. manufactures and markets Auxiliary Power Units (APUs). Fallbrook currently holds over 400 patents and pending applications worldwide.

### NuVinci® Technology

Fallbrook's *NuVinci* technology is a scalable and highly adaptable mechanical power transmission technology that controls relationships of speed and torque. The *NuVinci* transmission uses a set of rotating and tilting balls between the input and output components of a transmission. Tilting the balls changes their contact diameters and varies the speed ratio. Compared to other current continuously variable transmission technologies, the *NuVinci* technology is less complex, scales and packages more easily, costs less to manufacture, and improves performance.

### Current Target Markets

- Bicycles & e-Bikes
- Continuously Variable Accessory Drives (CVADs)
- Electric vehicles
- Lawn & Garden
- Wind energy

**Ownership** The Company is privately held. Major stockholders are: Macquarie, NGEN and Robeco.

### Executive Management

- William G. Klehm III, Chairman and CEO
- Al Kammerer, President
- Nicole T. Nicks, Chief Financial Officer and Treasurer
- Sharon A. O'Leary, Chief Legal Officer, VP Human Resources and Secretary
- Robert A. Smithson, Chief Technical Officer and VP Business Development
- Alain Charlois, VP Corporate Development
- Alan M. Nordin, President, Bicycle Division
- Paul A. DeHart, Chief Operating Officer
- Robert (Rick) Meyer, VP Aftermarket Sales (powered applications)
- Jeffrey A. Birchak, VP Intellectual Property and Assistant Secretary
- Daniel Katona, VP Marketing
- David W. Markley, Director of Product Development
- Shari Binford, Director of Human Resources

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## Company Overview

Originally established in 1998, Fallbrook Technologies Inc. (Fallbrook) is a manufacturing and technology development company dedicated to improving mechanical power transmission products.

Headquartered in San Diego, California with its primary research and development facility located near Austin, Texas together with operations in Europe and China, Fallbrook's patented and award-winning NuVinci® technology has far-reaching implications. The Company's *NuVinci* continuously variable planetary (CVP) technology is potentially applicable to any product that uses a transmission, including bicycles, electric vehicles, accessory drives, agricultural equipment, and wind turbines, among others.

The *NuVinci* CVP provides the most adaptable and scalable continuously variable transmission (CVT) available today for companies that need a cost effective, easily controlled, and durable alternative to conventional transmissions or other CVTs. The *NuVinci* CVP improves acceleration, performance, cost and overall vehicle efficiency over conventional transmissions. Compared to other CVTs, it is far simpler, offers more stable control, permits more scalability across product lines, is easier to package in a vehicle, and is less expensive to manufacture and assemble.

The *NuVinci* transmission uses a set of rotating and tilting balls in elastohydrodynamic contact between the input and output components of a transmission that tilt to vary the speed of the transmission. Tilting the balls changes their contact diameters and varies the speed ratio.



Current commercial products are the NuVinci® N360™ bicycle transmission and the Hodyon Dynasys™ Auxiliary Power Unit. The NuVinci® Harmony™ auto-shifting system for e-Bikes will be commercially available starting at the end of 2011 and other commercial products utilizing *NuVinci* technology will be introduced in 2012.

The company currently has over 400 patents and patent applications worldwide.

The Company is privately funded with over \$95 million raised; Macquarie, NGEN, and Robeco are major stock holders.

## Company History

The story of Fallbrook and its *NuVinci* technology dates, in a sense, to the year 1490, when Leonardo da Vinci developed a drawing describing how a continuously variable transmission (CVT) might work. Over 450 years later, the first real-world models of CVTs for automobiles were produced, but a variety of problems (e.g., cost, scalability, size, packaging difficulty, durability, and weight) has kept CVTs from widespread adoption and has limited their practical application.

### The Quest for the World's Fastest Bike

Donald C. Miller, a cycling enthusiast, was interested in building the world's fastest bike. In analyzing the challenges involved, he quickly found that the transmission was a limiting factor. While looking around for new ideas, Don came across CVTs. His subsequent experiments led him to develop an entirely new concept for CVT-based bicycle transmissions.

Miller and a group of investors formed Motion Systems, Inc. (MSI) to develop the technology. By 2000, Don had developed a design that fully addressed all the traditional weaknesses of a CVT, and had applied for the first patents covering the technology.

### The Company Takes Shape

As part of a process to provide additional funding and guidance, Miller and The Weiss Group LLC, an investment and startup advisory firm, joined forces in 2000 to form Motion Technologies LLC (Motion Technologies). Motion Technologies acquired MSI's intellectual property and development rights, with Don serving as the initial CEO.

A second round of financing in 2003 for Motion Technologies via a private placement provided funds for the continued development of the technology. Tests on Don's transmission by a prestigious independent testing laboratory, quickly verified the potential of the revolutionary technology – providing significant gains in simplicity and durability. The testing also showed that the technology had potential applications far beyond just bicycles – to virtually any device that has a transmission. Robert Smithson, a transmission expert involved with the testing laboratory's preliminary assessment, was so impressed with what he saw that he subsequently joined the Company, first as a consultant and later as vice president of product development.

### Testing Proves the Potential

As development progressed, it soon became apparent that the technology's potential was even greater than originally anticipated. Smithson discovered that the technology would also support the implementation of an infinitely variable transmission (IVT). Additionally, Fallbrook identified potential applications in the area of wind energy. At that point, management determined that further funding and additional executive talent would be appropriate.

Motion Technologies LLC became Fallbrook Technologies Inc., in 2004, and in May of that year, auto industry veteran Bill Klehm became Fallbrook's president and CEO. Don Miller then became vice president of advanced research. The Company immediately began an aggressive funding effort and also accelerated research and development. Fallbrook obtained additional funding via a private placement and assembled a staff that includes many top engineers in the transmission field. The technology was given the name *NuVinci* CVP (Continuously Variable Planetary), in honor of its 500-year-old predecessor. The accelerated R&D effort began producing tangible results in 2004, when the Company signed its first agreements with manufacturers.

In 2005, the Company signed a manufacturing license agreement with Aftermarket Technology Corp. (ATC).

Fallbrook entered into a trademark licensing and development agreement with the Valvoline division of Ashland Inc. in 2006, enabling Valvoline to design, test and market specialty fluids that optimize the performance of the *NuVinci* CVP. Also during 2006,

Fallbrook entered into OEM licensing agreements to design and market bikes and electric scooters featuring the *NuVinci* drivetrain.

#### Production Begins

*NuVinci* CVP bicycle hubs (model N170S) began rolling off ATC's assembly line in Oklahoma City, Oklahoma in December 2006, marking the first shipment of commercial products based on *NuVinci* technology.

The Adagio-*NuVinci* bike manufactured by Batavus BV won the 2007 Bike of the Year award at the FietsVak bicycle show in the Netherlands. At the same show, the *NuVinci* drivetrain won the Innovation of the Year award. The *NuVinci* CVP also was selected for the prestigious 2007 R&D 100 Awards as one of the most important new technologies of the year. And in November of 2007, the *NuVinci*-equipped The Ride™ Performance Lifestyle bike by Ellsworth was honored by Popular Science magazine with the Grand Award for the year's "Best of What's New" recreational product.

#### Focus on Wind Energy

In 2007, Fallbrook created a wholly-owned subsidiary called Viryd Technologies Inc. to develop and produce *NuVinci* products for the wind energy market – specifically, so-called "small wind" products designed for homes and small businesses. In 2009, Viryd was spun off as a standalone company, which now licenses *NuVinci* technology from Fallbrook.

#### Manufacturing Moves In-House

In February 2008, Fallbrook announced that it would manufacture its *NuVinci* hubs for the bicycle and light electric vehicle markets, while continuing to license the technology to manufacturers in other markets. Fallbrook selected MTD Products Inc. (MTD) as the prime supplier for its manufacturing efforts.

#### The N360 -- next generation *NuVinci* Bicycle transmission.

In 2009, the Company began to phase out production of the *NuVinci* N171 bicycle transmission (the model produced by MTD) in preparation for the introduction of a next generation model, the *NuVinci*® N360™. The N360 model was designed to have many improvements over the N170/N171 models including an over 30% reduction in weight, a diameter over 15% smaller, and an increased ratio range, together with an improved shift feel and responsiveness and a lower cost.

The Company terminated its manufacturing agreement with MTD and selected Tri Star Group, located in Shanghai, China, to manufacture the N360. Production of prototypes began in December 2009 and manufacturing of the N360 launched in June 2010 with initial customer shipments in July 2010. The N360 model subsequently won a 2010 iF/Eurobike award, which was the second iF/Eurobike award for the *NuVinci* CVP for bicycles.

#### Entry into Automotive Market with *NuVinci*® DeltaSeries™

In September 2010, The Company announced its entry into the (transportation market with its *NuVinci* DeltaSeries™ offering a line of accessory drives and primary transmissions are the industry's first products of their kind to increase fuel efficiency and vehicle performance with the same system. The Company has subsequently announced

#### Acquisition of Hodyon L.P.

On March 7, 2011, the Company announced the acquisition of the business of Hodyon LP, a manufacturer and distributor of energy-efficient products and systems. Hodyon's

primary product focus is its diesel-electric Dynasys™ Auxiliary Power Unit (APU) system. Hodyon operates as a wholly owned subsidiary and will incorporate Fallbrook's patented *NuVinci* continuously variable planetary (CVP) transmission to create a more efficient, next generation APU product.

#### Joint Venture with Ningbo Shentong Group

On March 14, 2011, the Company and Ningbo Shentong Group (Shentong), a Tier 1 automotive supplier to the Chinese automotive industry, announced an agreement for the establishment of a joint venture to develop and market Fallbrook's NuVinci® continuously variable planetary (CVP) transmissions for electric-powered passenger cars and light trucks in China and abroad.

#### Adoption of *NuVinci* Technology in Lawn & Garden Market

On June 6, 2011, Hydro-Gear, the market leader for hydrostatic lawn and garden transmissions, announced its intention to integrate Fallbrook's NuVinci® continuously variable planetary (CVP) technology into its product line.

The Company and Hydro-Gear began working together in 2009 the associated development program resulted in a successful demonstration of a pre-production prototype. Full production is projected to commence in early 2013, and will be the first commercial use of Fallbrook's *NuVinci* CVP technology in an infinitely variable transmission (IVT) application.

### **Doing Business with Fallbrook**

Fallbrook's mission is to develop, in conjunction with its partners, the best performing, most versatile and most reliable mechanical power transmissions in the world. To achieve this, Fallbrook's partnering program is designed to work with companies known for industry leading expertise and to create a community of technology around the *NuVinci* CVP. By sharing technology, implementation techniques and innovations, Fallbrook and its partners will ultimately speed the adoption and expansion of *NuVinci* technology to:

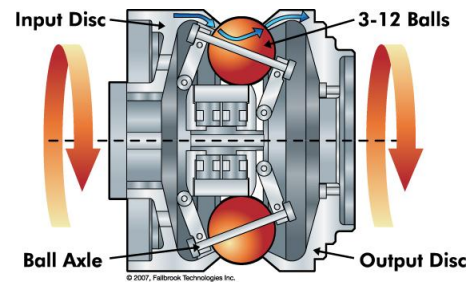
- Enhance vehicle performance and the user experience
- Enable new functionality for existing and first-time applications
- Improve fuel economy and/or energy consumption in the operation of the end product
- Provide a sustainable competitive advantage

Fallbrook has *partnerships* with *Manufacturers*, companies who manufacture *NuVinci* CVPs and/or parts, and with *Original Equipment Manufacturers* (OEMs), companies who integrate the *NuVinci* CVPs supplied by Manufacturers into products or vehicles that are then ultimately sold to consumers.

Fallbrook also offers engineering services to its partners. Through its engineering services, Fallbrook is able to help its partners develop new *NuVinci* CVPs that are specifically designed and optimized for the partner's unique applications and the requirements of those applications.

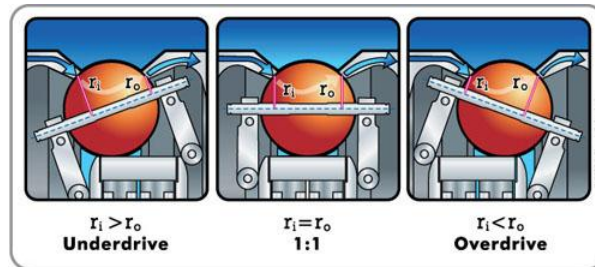
## Technology Overview

The patented NuVinci® technology developed by Fallbrook Technologies Inc. (Fallbrook) is the most practical, economical and universally adaptable continuously variable transmission (CVT) for human-powered and motor-powered vehicles and machines. Because it is functionally analogous to planetary gear sets, the NuVinci technology defines a new species of CVT, the continuously variable planetary (CVP) drive. The NuVinci CVP is ideally suited for applications in many major industries including bicycles, light electric vehicles, automobiles, tractors, trucks, and wind turbines among others.



The NuVinci transmission uses a set of rotating and tilting balls positioned between the input and output components of a transmission that tilt to vary the speed of the transmission.

Tilting the balls changes their contact diameters and varies the speed ratio. As a result, the NuVinci CVP offers seamless and continuous transition to any ratio within its range, thus maximizing overall powertrain efficiency, with no jarring or shocks from the shifting process, and improving acceleration, performance and overall vehicle efficiency over conventional transmissions. When compared to traditional CVTs, the NuVinci CVP is less complex, has considerably fewer parts, offers more stable control and scalability across product lines, is better packaged, and is less expensive to manufacture and assemble.



### Distinguishing the NuVinci CVP from Traditional CVTs

There is a clear distinction between Fallbrook's NuVinci CVP drive and more traditional CVT technologies.

A CVT is a transmission that is infinitely variable between its high and low ranges, unlike a conventional geared transmission where the number of fixed speed ratios between high and low is limited by the number of gears.

The CVT has been called the "holy grail" of transmissions because it eliminates the multiple gears, shifting clutch(es), and many other parts found in conventional transmissions. In place of gears, most CVTs use one or more cones, discs, balls, belts, toroids, or other shaped devices for gradually changing ratios. These geometric shapes

allow the input or output contact points on any particular device to vary in diameter, thus changing the input to output speed.

The use of CVTs has not become widespread due to multiple problems inherent in conventional designs. These problems include shifting control difficulties, packaging problems, scalability challenges, questionable reliability and durability, high cost, increased weight, and other factors.

The *NuVinci* CVP represents a quantum leap forward from other CVTs as well as conventional mechanical transmissions. These advantages include:

- Higher torque density
- Smaller size/weight
- Easily scalable
- Simpler, more elegant design
- More adaptable and versatile
- Improved overall performance
- Easy to package (less space required)
- Lower manufacturing and maintenance costs

### **The *NuVinci* Transmission**

The *NuVinci* CVP is continuously variable and infinitely applicable to almost any product using a mechanical power transmission. *NuVinci* technology combines the advantages of a toroidal traction CVT with the time-proven versatility of the planetary gear arrangement. It uses rolling traction to transfer torque, just as do toroidal transmissions. However, unlike toroidal CVTs, it distributes the transmitted torque over several spheres in an inherently stable configuration, thus lowering total clamping force required and significantly improving durability, control stability, and torque density.

This arrangement makes the *NuVinci* CVP the only practical CVT to combine the smooth, continuous power transfer of a CVT with the utility of a conventional planetary gear drive. Torque inputs can be summed or divided, just as in a conventional planetary. Ratio control is stable, and can be actuated down the center line of the transmission, which again is similar to the proven planetary transmission. Part shapes are simple and relatively easy to manufacture, and in most applications, there is no need for power-robbing, high-pressure hydraulics.

The *NuVinci* CVP reduces energy consumption through its continuous speed changing characteristics, allowing the power input prime mover (such as a gasoline engine or electric motor) to operate in its most efficient speed range. Overall, the *NuVinci* CVP's mechanical and manufacturing characteristics improve performance and reliability while reducing costs over conventional CVTs and stepped transmissions. As a result, the *NuVinci* CVP can potentially replace the planetary gear transmission in most mechanical devices.

### **Key advantages of the *NuVinci* CVP**

Compared to conventional transmission technologies, the *NuVinci* CVP provides:

- **Less complexity.** There are significantly fewer parts than conventional transmissions and it is potentially much less costly to manufacture.
- **Overall improved system efficiency.** With the *NuVinci* CVP, it is easy to keep an engine or motor running at its most efficient speed.

- **Greater acceleration and optimum performance.** Acceleration is faster and smoother – right up to the vehicle’s acceleration limits - because it keeps the engine running at peak performance.
- **Easier shifting.** There is no jarring associated with shifting gears.
- **Ability to accept multiple inputs while varying speed and ratio, managing torque and providing single or multiple power outlets.** A *NuVinci* CVP is the most practical CVT technology to perform all of these tasks simultaneously.
- **Support for a torque demand rather than a speed demand control solution.** The *NuVinci* CVP solves the low-speed acceleration problem inherent in some torque-demand vehicles.
- **Scalability and potential to reuse tooling.** The *NuVinci* technology is highly scalable. The design and implementation of a low-torque application utilizing four balls may involve the same basic parts as a higher torque application with eight or sixteen balls. Also, tooling can be used across a wide variety of applications.
- **Improved hill-climbing.** The *NuVinci* CVP allows a driver to drive up a hill at the desired speed and in the proper transmission ratio without having to choose, as with traditional geared transmissions, between a gear that is too high and bogs the engine down resulting in a lower speed or a gear that is too low and results in an over revving engine speed.

Compared to CVT alternatives, the *NuVinci* CVP offers:

- **Coaxial input and output.** The input and output shafts may be either in-line, offset, or in a U configuration (input and output both coaxial and coplanar), making the transmission simpler, smaller, lighter, and easier to package
- **Better torque density.** A *NuVinci* CVP delivers a large amount of torque capacity in a relatively small space. It is smaller and easier to package than other CVTs because it does not require an offset shaft and because it can spread torque across any number of traction contacts by using many balls.
- **Lower manufacturing cost.** The transmission uses simple geometry and very simple parts, which results in a lower cost. The *NuVinci* CVP can also be scaled across a wide variety of vehicles, in many cases without significant retooling.
- **Lower control cost.** Transmission control is stable, linear and does not require a major control system development effort.
- **Power path variability.** The technology is easily integrated into a wide range of applications with varying power path requirements or options
- **Scalability.** The *NuVinci* CVP’s simple design and low part count make it easily scalable.

### **Technology Applications for *NuVinci* technology**

While the *NuVinci* CVP has application potential in virtually any mechanical device requiring speed changes, Fallbrook has selected five major target markets for its initial development of *NuVinci* technology:

- Bicycles
- Electric vehicles
- Continuously variable accessory drives (CVADs)
- Lawn & Garden
- Wind energy

**Fallbrook selected these initial markets because they offer:**

- High potential for early adoption by manufacturers
- Large market size
- Short time to market
- Companies seeking a competitive advantage through improved technology



## NuVinci® Model N360 CVP

Released in 2010, the *NuVinci* N360 CVP is a major enhancement of the *NuVinci* bicycle drivetrain.

As with previous *NuVinci* hubs, the N360 uses spheres instead of gears to transfer torque, but the number of spheres has been reduced from eight to six.

The N360 is 30% lighter, weighing just 2.45 kg (5.4 lbs.), and has a 17% smaller overall diameter than previous *NuVinci* models. Shift effort is significantly reduced, even under high pedal forces.



The N360 also provides an enhanced shifting interface. There is a more direct feel for the rider, with 50% less shift grip rotation required between the lowest and highest ratios. Shift effort under pedal torque is also less, so riders can shift at any time, in practically any condition. The redesigned shifter display now includes the icon of a rider on its unique “inchworm” indicator. Additionally, the new hub interface is inside rather than outside of the frame dropout, which reduces the likelihood of damage in the event of a fall.

These changes dramatically widen the range of bike models that can now benefit from the smooth, seamless-shifting *NuVinci* drivetrain. These model types include Trekking, Mountain, Sportive and Flat Bar Road bikes, as well as Urban, Commuter, Folding, Hybrid, Cruiser, and e-Bikes.

### Technical Data

Hub Colors:	Silver or Black
Spoke Configurations:	32 or 36 Hole
Brake Configurations:	Disc, Rim, or Roller
CVP Weight:	2,450 grams
Speed Ratio:	Infinitely variable within ratio range
Ratio Range:	360% Nominal (0.5 Underdrive to 1.8 Overdrive)
Shifting:	Variable twist grip, $\frac{3}{4}$ Turn
Drop-out:	135 mm Wide, Horizontal or Vertical
Chainline:	49.0 ± 0.5 mm (also compatible with belt drives)
Sprockets:	Standard 9-spline (not included); 17 - 22 tooth supported
Sprocket Ratio:	1.8:1 Minimum (17/31, 18/33, 19/35, 20/36, 21/38, 22/40, larger chain rings can be used without exception)
Corrosion Resistance:	ISO 9227, Neutral Salt Spray, 384 hours



## NuVinci® DeltaSeries™ - Continuously Variable Accessory Drives

A continuously variable accessory drive (CVAD) is a device that helps the front-end accessories on a car or truck engine (alternator, air conditioner, water pump, etc.) run more efficiently. These belt-driven accessories have always been connected directly to the engine, so their speeds are tied to engine RPM. A CVAD sits between the engine and these accessories, allowing their speed to vary according to performance needs rather than engine RPM.

The *NuVinci DeltaSeries* line is a power management system that offers seamless and continuous transition to any ratio within its range, thus maximizing overall powertrain efficiency. A *NuVinci*-based CVAD produces more torque at low input speeds, providing improved performance for belt-driven accessories. It improves fuel economy by decoupling accessory speed from engine speed. In addition, *NuVinci* technology is quiet, smooth, compact, and easy to package.

The *NuVinci* CVP has several current and potential areas for accessory drives, including:

- **Air conditioning compressor:** improves AC compressor performance by decoupling the engine speed from the compressor speed, enabling the compressor to operate in its optimal range based on demand regardless of engine speed.
- **Alternator-mounted:** extracting additional power from the alternator to increase power at idle without overspeeding the alternator, or even slowing it down for fuel conservation, at higher speeds
- **Crankshaft-mounted:** optimizing the performance of belt-driven engine accessories to improve fuel economy
- **Supercharger:** providing significant boost at low RPM by enabling high turbine speeds at low engine speeds

### **Air condition compressor:**

A *NuVinci DeltaSeries* AC compressor drive improves AC compressor performance by decoupling the engine speed from the compressor speed, enabling the compressor to operate in its optimal range based on demand regardless of engine speed. As a result, the *NuVinci* compressor drive delivers the ideal compressor speed all the time – optimizing AC operation and performance, thereby enhancing performance, increasing system efficiency and improving fuel economy. Other benefits include:

- Increased compressor output at low engine speeds
- Reduced compressor speed during cruise improves fuel economy
- Flexible packaging
- Opportunity to rightsize AC compressors
- Reduce startup torque transients to clutch, compressor, accessory beltline, thereby reducing noise, vibration, and harshness (NVH)

- Optimized, demand-based compressor performance during cruise and acceleration

### **Alternator-Mounted**

A *NuVinci DeltaSeries* improves alternator performance by decoupling engine speed from alternator speed, enabling the alternator to produce maximum current regardless of engine RPM. As a result, *NuVinci* technology:

- Increases power at idle
- Increases capacity of front-end accessories
- Enables downsizing of accessory capacity
- Reduces engine startup torque requirements
- Improves battery life

### **Crankshaft-Mounted**

A crankshaft-mounted *NuVinci DeltaSeries* decouples belt-driven accessories from engine speed, enabling them to run at the minimum speed required to meet accessory load. At higher engine RPM, decreasing accessory speeds decreases power, thus saving energy. Additional energy savings can be realized by optimizing the accessories for a narrow speed range operation. Conversely, at low engine RPM, the accessory belt speed can be increased to provide additional battery-charging power or to increase the water pump speed. Thus, the *NuVinci*-equipped crankshaft CVAD:

- Improves fuel economy
- Improves acceleration by under-driving the accessories to a greater degree than would be practical with fixed ratio pulleys
- Provides smooth accommodation of engine/load transients
- Creates opportunities to add “smart” controls for accessory drives
- Enables downsizing of accessory capacity

### **Supercharger**

The *NuVinci DeltaSeries* is a power management system for engine accessories that enables significantly more boost at low RPM by enabling high supercharger speeds at low engine speeds, providing increased torque for launch and towing. The *NuVinci CVP* does this by offering an infinite number of speed ratios between its high and low ratio extremes, with programmable instantaneous, smooth and continuous ratio changes. Operation is completely seamless and transparent to the driver. The *NuVinci*-equipped supercharger CVAD enables:

- Supercharger speed control independent from engine speed
- More boost, providing higher performance, especially at lower engine speeds
- Engine downsizing without sacrificing performance:
  - Improved fuel economy
  - Reduced operating costs of heavy-duty fleets
  - Diesel-like performance from gasoline engines



## NuVinci® – Powering Electric Vehicles

Today's electric vehicles (EVs), for the most part, do not use multi-speed transmissions. That means every time a driver starts from rest, climbs a hill or carries a heavy load in an EV, they're reducing the amount of energy that they can get out of the batteries because in driving conditions like these, high flow rates of electrical current are required from the battery, which causes the battery to run down faster. Simple logic dictates that someone might want to do something to reduce the amount of time that the EV powertrain spends sucking a lot of amps so that they could maximize what they get to use versus what you put into the battery – something that could get them up to speed faster, or reduce the amps required to climb a hill, for example.

EV's traditionally have not used multi-speed, "clutch and gear" transmissions for a number of reasons, chief among them:

- Conventional multi-speed transmissions do not work well with electric powertrains because the abrupt steps between gears cause problems with durability and driving comfort.
- Conventional transmissions suffer from gear noise, which when an internal combustion (IC) engine is present, is drowned out by the engine noise. That background soundtrack is not present in an EV. Smaller, lighter, and more optimized vehicles cannot hide the excessive noise like a larger vehicle with an IC engine can.
- EV designers were driven by high electronics and battery costs to minimize the cost of the rest of the powertrain, and an electric motor's inherent high torque at zero speed allows the design crutch of eliminating the transmission, at the expense of higher amp draws and a single compromised overall final gear ratio.

The present single speed transmission forces the designer of the EV to select a much bigger VFD (Variable Frequency Drive) because of the higher current requirement. Consequently the cabling must be adequate in size to handle the larger VFD's output (the larger wire size is heavier, more expensive, and harder to package because it does not bend as readily as smaller cables do). With CVAD a smaller motor-controller system with lighter harness can produce the same performance of the single speed transmission that uses a larger motor-controller.

This is where Fallbrook Technologies come in with Fallbrook's *NuVinci* continuously variable planetary (CVP) system. The technology solves the issues of abrupt steps by smoothly and continuously varying speed ratio while also operating very quietly and, at the same time, increasing torque multiplication at low speed.

- The *NuVinci* CVP's ability to change torque multiplication on the fly provides the following advantages to the EV designer:
- Amp draw in a start from rest is reduced in both amplitude and duration because the extra torque available from the motor/CVT combination accelerates the vehicle faster with less load on the motor. As a result, a smaller copper cable is needed to connect the motor terminals to the motor controller.

- A smaller motor can often be fitted while maintaining the same or improved acceleration performance, again because of the ability to change torque multiplication on the fly. The smaller motor draws still fewer amps to get its job done, and requires less in the way of power electronics.

With the smaller amp draws, a smaller battery pack can now be fitted, which results in extra benefits from reduced pack weight (a large fraction of an EV's weight lies in its batteries), and reduced pack size. Taking out weight improves EV performance in every dimension.



## Frequently Asked Questions

**Q: What is Fallbrook Technologies Inc.?**

**A:** Fallbrook Technologies Inc. (Fallbrook) is a manufacturing and technology development company headquartered in San Diego, California with engineering, operations and customer support in Cedar Park, outside of Austin, Texas. The company also has operations in Europe and China.

The Company's core technology is its traction-based, NuVinci® transmission – a continuously variable planetary (CVP) drive ideally suited for applications in virtually any mechanical device that has a transmission or requires speed variation.

**Q: What is the NuVinci® CVP?**

**A:** The *NuVinci* CVP is a continuously variable and broadly applicable technology, with applications for almost any product using mechanical power transmission. *NuVinci* technology combines the advantages of the inherently smooth and quiet traction continuously variable transmission (CVT) with the advantages of a time-proven planetary gear arrangement. The *NuVinci* CVP is the only continuously variable transmission that has a planetary gearset's advantages of high torque density, versatility of use, inline shafts, capability to sum and divide torque from one or multiple input devices, and low production cost. As a result, *NuVinci* technology is the only technology potentially capable of replacing the planetary gear transmission – in every application – as virtually a plug-and-play, yet vastly more capable, replacement.

**Q: How does the NuVinci CVP work?**

**A:** The *NuVinci* transmission uses a set of rotating balls between the input and output components of a transmission that tilt and vary the output speed of the transmission. Tilting the balls changes their contact diameters with the discs, which varies speed. As a result, the *NuVinci* CVP improves acceleration, performance and powertrain efficiency over conventional transmissions. It is far simpler, permits more stable control, provides more scalability across product lines, is better packaged, and is less expensive to manufacture and assemble than traditional CVTs.

**Q: Why is the technology named NuVinci?**

**A:** The name represents a “tip of the hat” to Leonardo da Vinci who, over 500 years ago, sketched what is considered to be the first documented continuously variable transmission.

**Q: CVTs have been around for a long time. Why have they not become commonplace?**

**A:** The use of CVTs has not become widespread due to multiple problems including scalability challenges, questionable reliability and durability, high cost, and other factors. Despite some obvious drawbacks, some manufacturers such as Ford, Nissan, Honda, and Audi have implemented limited production with old CVT technology because the market need was so great. However, with the development of the *NuVinci* CVP, the technical roadblocks have now been eliminated – clearing the way for a wide range of CVP applications for which markets are ready and waiting.

**Q: How is the *NuVinci* CVP different from conventional transmissions?**

**A:** The *NuVinci* CVP offers a wide range of advantages over conventional transmissions. These advantages include:

- Less complexity
- Greater powertrain system efficiency
- Greater acceleration and optimum performance
- Easier shifting
- Ability to accept multiple inputs while varying speed and managing torque
- Multiple power outlets such as for a power take off (PTO) application
- Easier to package and potentially lighter
- Easier and less costly to manufacture
- Greater scalability and potential to reuse tooling
- Improved hill-climbing

**Q: How is a *NuVinci* CVP different from other approaches to CVT technology?**

**A:** There are four widely accepted alternative approaches to CVT technology:

- **Toroidal.** The *NuVinci* CVP, comparatively offers better torque capacity in the same package volume and simpler control, and is more easily packaged for inclusion in a given application due to its concentric input and output shafts. It is also much more effective to scale across a vehicle range because of its modular nature and is more durable because of its greater number of traction contacts.
- **Push Belt.** The *NuVinci* CVP is simpler in design, more scalable, easier to control, allows for inline shafts and is less expensive to manufacture. It also does not have the ultimate torque capacity limitations of the push belt and is expected to be more durable.
- **Hydromechanical.** The *NuVinci* CVP is much easier to manufacture, easier to control, lighter, more scalable, inherently quieter, and easier to maintain.
- **Chain.** The *NuVinci* CVP has greater torque capacity, allows for inline shafts, and is easier to control, more scalable, inherently quieter, and less expensive to manufacture and maintain.

**Q: What markets have the greatest potential for *NuVinci* technology?**

**A:** While the *NuVinci* CVP has application potential in virtually any mechanical product that has a transmission, Fallbrook has identified five initial major industries for the *NuVinci* technology:

- Bicycles
- Electric vehicles
- Continuously variable accessory drives (CVADs)
- Lawn & Garden
- Wind energy

**Q: What companies are currently using *NuVinci* technology?**

**A:** Fallbrook currently has agreements with:

- Leading vehicle system and component suppliers under development programs in a variety of industries/
- Hydro-Gear, to manufacture IVT (infinitely variable transmission) for lawn and garden equipment using *NuVinci* technology.

- Viryd Technologies Inc., formerly a Fallbrook subsidiary, for wind turbines using *NuVinci* technology.
- More than 40 bicycle OEMs manufacturing over 40 models in the U.S., The Netherlands, Switzerland, Denmark, and Germany. Visit [www.fallbrooktech.com/08\\_gallery.asp](http://www.fallbrooktech.com/08_gallery.asp) to see a number of the models.
- Distributors
  - Quality Bike Products, a leading distributor to the cycling industry and authorized reseller of *NuVinci* CVP kits.
  - Seattle Bike Supply, a full service bicycle and bicycle parts distributor, and authorized reseller of *NuVinci* CVP kits for the bicycle aftermarket business.
  - Norco Products Ltd., Canada’s leading bicycle manufacturer. Based in Port Coquitlam, British Columbia,
  - Southcott Cycles, located in Victoria, Australia, one of Australia’s largest bicycle distributors. Southcott Cycles is a subsidiary of Southcott Pty Ltd.
  - Cycle Supplies, located in Christchurch, New Zealand, which provides components to bike shops throughout New Zealand.
- Development partners including Valvoline, a division of Ashland Inc., who works closely with Fallbrook to develop fluids specially formulated to work with *NuVinci* CVPs.

A number of agreements have not been announced.



## Bicycle FAQ's

**Q: How does the NuVinci® hub impact the riding experience?**

**A:** The short answer: It is unlike anything you have experienced before.

You'll find yourself shifting without thought, whenever you feel like it - while you're pedaling, when you're coasting (freewheeling), when you're pedaling backwards, even when you're stopped. There's no hesitation, no noise, no waiting for the mechanism to "hunt" for the gear you've selected, nothing to synchronize, nothing to guess at, a simple twist of your wrist and you're at a new ratio. Say goodbye to racking your shins and dropped chains due to derailleur mis-shifting.

You'll easily find your sweet-spot; adjust your cadence for max power, or up-shift at will to work your legs a bit more. With the NuVinci hub, you're easily in charge of your riding experience.

**Q: What are people saying about hubs with NuVinci technology?**

**A:** Reaction to the NuVinci CVP hub has been nothing short of phenomenal. Bicycle industry executives and consumers alike are quoted as saying:

- "Smooth", "very smooth" "very smooth, unbelievable", "silky"
- "It's so easy to shift and maintain a perfect cadence."
- "Takes the worry out of shifting"
- "I haven't missed riding a bike until now"
- "It is the best transmission on a bicycle"
- "I have seen nothing like it"
- "[this] technology is a great fit..."
- "The ride quality is ready now!"
- "I want it now!"

**Q: How durable is the NuVinci CVP hub?**

**A:** The NuVinci CVP hub has a two-year limited warranty.

**Q: Is there any required maintenance?**

**A:** Unlike derailleurs, only periodic light cleaning (depending on usage conditions) is recommended.

**Q: What is the ratio range and efficiency of the NuVinci CVP hub?**

**A:** The ratio range of the N360 Model is approximately 360%. As a traction drive transmission, the NuVinci CVP will be less mechanically efficient than direct drive transmissions. However, because the rider can always be in the "appropriate" gear with no gaps and no power losses during shifting, mechanical efficiency should not be the primary measure for the NuVinci CVP. In getting a non-expert rider from point A to point B, the NuVinci CVP compares well with internally geared hubs and derailleurs on the market today, while delivering a superior ride experience.

**Q: How much does the *NuVinci* CVP hub weigh?**

**A:** Weights will vary between model and application. The latest N360 model weighs approximately 2450 grams. While the weight of the NuVinci rear hub may be greater than that of a rear derailleur drivetrain, multiple chain rings, a cassette and dual shifters are not required.

**Q: What does a *NuVinci* CVP hub cost?**

**A:** Fallbrook is dedicated to developing affordable, advanced technology. The Suggested Retail Price (SRP) for a NuVinci N360 kit, including drivetrain and controller available from bicycle dealers is \$399.

**Q: Where can I buy a bicycle equipped with a *NuVinci* hub?**

**A:** An increasing number of bicycle dealers either stock or can order bicycles equipped with *NuVinci* technology. Contact a local bicycle dealer. For a list of brands currently offering *NuVinci*-equipped models or to search for a local dealer, visit the Bicycle area of [www.fallbrooktech.com](http://www.fallbrooktech.com).

**Q: Can a *NuVinci* CVP be installed in an existing bicycle??**

**A:** Hubs are available with either 32 or 36 spoke holes but only for a 135mm dropout. Normal installation is in a horizontal dropout. Installation in a vertical requires a chain tensioner...

Consumers may order or purchase a *NuVinci* CVP drivetrain and controller from local bicycle retailers as a standalone kit or pre-laced into a replacement wheel.

In Europe, bicycle retailers can order NuVinci CVP kits from Fallbrook at [www.nuvinci.com/eurosales](http://www.nuvinci.com/eurosales).

Bicycle retailers elsewhere can obtain *NuVinci* CVP kits from the following distributors:

- Quality Bike Products [www.qbp.com](http://www.qbp.com)
- Seattle Bike Supply [www.seattlebikesupply.com](http://www.seattlebikesupply.com)
- Norco Products Ltd. [www.norco.com](http://www.norco.com)
- Southcott Cycles (Australia) [www.southcott.com.au](http://www.southcott.com.au)
- Cycle Supplies (New Zealand) [www.cyclesupplies.co.nz](http://www.cyclesupplies.co.nz)



## Electric Vehicle FAQs

**Q: How will NuVinci® CVP technology improve the performance and capabilities of an electric vehicle?**

**A:** *NuVinci* Continuously Variable Planetary technology allows an electric motor to operate in a more efficient manner by not overloading it in normal operation. Vehicle performance and rider experience is enhanced with improved hill climbing ability, smoother/quicker acceleration, higher top-end speed, increased load carrying and towing capacity, better accommodation of larger adult riders, and extended range and battery life.

*NuVinci* CVP technology coupled with an efficient motor, an intelligent shifter and motor controller, and state-of-the-art batteries provides manufacturers a technical canvas to design LEVs never before possible. This is a major step forward in the continuing quest to make LEVs that are truly practical commuter vehicles.

**Q: How will a *NuVinci* CVP transmission be shifted?**

**A:** An intelligent CVP controller will be integrated into the vehicle allowing fully automatic control for both performance and economy operation, or a manual-shifting mode for a fun and different rider experience. Under normal operation, the *NuVinci's* shifting will be completely seamless and silent, with no disruption to torque, jerks, clunks or other undesirable characteristics that would detract from the inherent smoothness of an electric drivetrain.

**Q: Is there any required maintenance with a *NuVinci* CVP transmission?**

**A:** The *NuVinci* CVP contains a fully synthetic "traction" fluid. The only recommended maintenance is that the fluid be changed periodically. The change interval will be determined by the manufacturer and type of use, with most applications being fill-for-life. Some more aggressive applications, such as off-road vehicles, may require regular fill intervals due to contamination and/or heavy usage.

**Q: When will an electric vehicle with a *NuVinci* CVP be available in the market?**

**A:** Electric vehicle applications are pending but may be available as soon as 2012.

**Q: What will a *NuVinci* CVP drivetrain cost?**

**A:** Fallbrook is dedicated to developing affordable, advanced technology. However, the price of an automatic shifting system for electric vehicles will be determined by electric vehicle manufacturers.

**Q: How can I get a *NuVinci* CVP drivetrain?**

**A:** To help facilitate the design of new vehicles, Fallbrook has made available the *NuVinci* CVP Developer's Kit. The Kit includes the *NuVinci* CVP transmission, shift actuator, user-programmable shift controller, wiring, mounting hardware, software and technical documentation. The system is ideal for electric motors from 250W to 5KW and for gas-powered engines under 7 hp. For more information, go to [www.fallbrooktech.com/kit](http://www.fallbrooktech.com/kit)



## Traction Fluid FAQ's

**Q: What is a traction fluid?**

**A:** Traction fluid is a transmission fluid with properties specifically designed for transmitting torque between two smooth rolling elements. The fluids are generally based on special synthetic oils. The ability of a traction fluid to transfer torque is measured by its Coefficient of Traction, or Ct. While most fluids have some measurable Ct, the Ct of a fluid engineered as a traction fluid is 3x to 10x greater than the Ct of a typical standard lubricant. The synthetic base oil used in a traction fluid is tailored to give them high traction coefficients over wide operating ranges.

**Q: How does a fluid transmit torque?**

**A:** Torque is transferred between the rolling elements through shear forces in a thin fluid film. Under normal conditions of hydrodynamic lubrication, the shear forces transmitted are very small. However, under specific operating conditions (i.e., certain relative surface speeds and contact pressures), the fluid transitions into the elastohydrodynamic lubrication (EHL) regime and exhibits shear force transmitting properties similar to those of elastic solids. In engineering terms, materials like steel and aluminum are elastic solids. So, in effect, the traction fluid serves the same purpose as the steel gear teeth of a conventional transmission.

**Q: Won't the rolling elements slip at higher torques?**

**A:** Most traction drives, including the NuVinci® CVP, incorporate mechanisms to dynamically control the contact pressure as torque is increased. The properties of the traction fluid and the geometric and material properties of the rolling elements and the pressure-control mechanisms are designed to manage internal forces to prohibit slipping. Therefore, design of a traction drive includes careful selection and testing of the traction fluid. All traction transmissions have a very small amount of what is called creep that occurs within the fluid under normal conditions. The amount of creep is generally small enough that precision instrumentation is required to measure it.

**Q: Does the traction fluid also provide lubrication?**

**A:** Yes. In addition to a high traction coefficient, a traction fluid is designed to provide lubrication to protect elements from wear, dissipate heat, and dampen vibrations in the transmission, just as conventional transmission fluids do in gear type transmissions.

**Q: Why haven't I heard of traction fluids before?**

**A:** Though traction CVTs have been used for vehicular and industrial applications for nearly a century, advances in material and fluid properties over the last decade and a better understanding of the elastohydrodynamic phenomenon were required to enable widespread use of traction drives. The NuVinci CVP and Valvoline traction fluid leverage these technology advances to provide a solution that is more broadly applicable than previous designs.



## NuVinci® Milestones

### 2004

- Technology branded *NuVinci* Continuously Variable Planetary; previewed at Interbike 2004 Expo, Las Vegas

### 2005

- Fallbrook closes \$8.2 million private funding round
- Fallbrook and *NuVinci* technology officially introduced
- National Renewable Energy Labs presents *NuVinci* technology at WindPower 2005 Conference. Reports significant savings in cost of energy.
- *NuVinci* CVP prototype selected as “Most Potential” at Interbike show
- ATC becomes first *NuVinci* manufacturing partner

### 2006

- Valvoline signs development / trademark licensing agreement to supply *NuVinci* traction fluid
- Ellsworth becomes first bike maker for *NuVinci* CVP; announces plans to introduce new line of performance lifestyle bikes around *NuVinci* technology
- Fallbrook business model featured in Intellectual Property article
- Fallbrook closes \$16 million funding round
- *NuVinci* commercial product officially introduced at Interbike 2006; Batavus bike and IZIP scooter e-bike customers deals announced; Ellsworth *NuVinci* bike unveiled

### 2007

- ATC ships first commercial products in volume
- Batavus Adagio-*NuVinci* bike wins Bike of the Year Honors at FietsVak Netherlands; *NuVinci* wins Innovation of the Year
- *NuVinci* LEV technology presented at EV Conference in Taiwan; Company proposes e-bike ratings standard
- Fallbrook announces agreement with ATC to produce *NuVinci* drivetrain for Outdoor Power Equipment
- *NuVinci* bikes, LEVs, Lawn & Garden and Automobile technology featured on SD ABC television news
- *NuVinci* featured on BBC broadcast; LEV technology presented at European EV Conference in Brussels, Belgium
- *NuVinci* CVP wins 2007 R&D 100 Award
- Ellsworth The Ride™ Performance Lifestyle bicycle powered by *NuVinci* drivetrain wins Popular Science Magazine's 2007 “Best of What’s New Grand Award – Recreation Product”

## 2008

- Fallbrook purchases ATC's *NuVinci* manufacturing assets.
- Fallbrook announces decision to create in-house manufacturing capability for *NuVinci* drivetrains for bicycle and LEV markets
- Fallbrook selects MTD Products Inc as its prime supplier for the manufacture of *NuVinci* CVPs
- *NuVinci* CVP drivetrain wins iF Design EUROBIKE Gold Award 2008
- Fallbrook extends *NuVinci* hub warranty to industry-best six years, which is triple the industry average

## 2009

- Fallbrook spins out its Viryd division as a standalone company, which licenses *NuVinci* technology for use in wind power applications.
- Fallbrook closes \$25.4 million venture investment round, led by NGEN III, LP and Robeco.
- Fallbrook begins offering the *NuVinci* Developer Kit
- Fallbrook introduces *NuVinci* CVAD (continuously variable accessory drive) capability
- Fallbrook signs licensing agreement with Hydro-Gear to manufacture IVT (infinitely variable transmission) for lawn and garden equipment using *NuVinci* technology
- Fallbrook creates Bicycle Products Division

## 2010

- Fallbrook Technologies Inc. to Enter Automotive Market with NuVinci® Delta Series – accessory drives, drivetrains first in industry to increase both fuel economy, vehicle performance
- Fallbrook Technologies' NuVinci® Delta Series drive test demonstrates potential for annual fuel savings of up to \$1,500 for bus AC unit
- Fallbrook brings updated N360™ CVP to market
- *NuVinci* CVP drivetrain wins a second iF Design EUROBIKE for the N360 Model.
- Fallbrook Technologies Inc. Raises US \$39 Million in Series E Financing to Accelerate Commercialization of NuVinci® Transmission Technology

## 2011

- Fallbrook Technologies Inc. Establishes Advisory Board for Automotive Product Definition and Development
- China's Shanghai (Yangpu District) government selects Fallbrook Technologies, ASL to develop transmission drives for electric vehicles
- Fallbrook acquires the business of Hodyon LP, developer and manufacturer of the Dynasys™ Auxiliary Power Unit (APU). Hodyon operates as a wholly owned subsidiary.
- Fallbrook Technologies, Shentong to form a joint venture to develop and market NuVinci® Technology in China

- Breezer Uptown Infinity Featuring Award-Winning, Smooth Shifting NuVinci® N360™ Transmission Named Bicycling Magazine's 'Editor's Choice' for 2011 Commuter Bike of the Year
- Lawn, garden transmission market leader Hydro-Gear to integrate Fallbrook Technologies Inc.'s NuVinci® CVP technology
- Fallbrook Technologies, TEAM Industries, and Tomberlin® accelerate integration of NuVinci® DeltaSeries™ system in electric vehicles



## Management/Director Biographies

### Management Team

#### **William G. Klehm III**

*CEO and Chairman of the Board*

Bill Klehm brings over 20 years of automotive-related experience to Fallbrook Technologies Inc. (Fallbrook). With numerous leadership positions in the automotive business, including finance, marketing, sales, product development, and manufacturing operations, he has a proven track record of leading and growing successful organizations. Most recently, Bill served as the president and general manager of Newgen Results Corporation, an automotive customer relationship management firm. During his three-year tenure, Newgen's revenue and profit grew from \$60 million to over \$108 million and \$6 million to over \$15 million respectively.

Prior to joining Newgen, Bill served as president and SBU director for Visteon Climate Control Systems. He was instrumental in developing and launching Visteon's \$1 billion Aftermarket Division. Bill started his career with Ford Motor Company in 1985 and held a variety of posts within the Ford Customer Service Division where he was responsible for developing and executing the marketing/growth strategy for the \$5 billion customer service parts business.

Bill holds a B.A. in Management and Marketing from Northwood University and also participated in the Harvard Business School Executive Education Programs.

#### **Al Kammerer**

*President*

Effective September 1, 2011, Al Kammerer, who has been and will continue to be a member of the Board of Directors, will also serve as Fallbrook's President reporting to Bill Klehm, Chairman and Chief Executive Officer.

Al is a seasoned automotive industry veteran who spent 34 years with Ford Motor Company before retiring in 2008 as product development director for Jaguar Land Rover. Prior to this assignment, he served as executive director for SUV and body-on-frame vehicles in North America, where he led product development activities for Ford, Lincoln and Mercury vehicles with these platforms. In his previous work with Ford, he also served as vehicle line director for the group that developed the critically-acclaimed Ford Focus.

Al holds a B.S. in mechanical engineering from California State University at San Luis Obispo, and an M.S. in mechanical engineering from Stanford University.

#### **Nicole T. Nicks**

*Chief Financial Officer and Secretary*

Nicole Nicks has over 12 years of accounting, financial reporting and SEC filing experience and has worked in various industries such as database management and customer retention, real

estate investment trust, home building & land developing, healthcare, public sector-enterprise fund, manufacturing, and not-for-profit.

Immediately prior to joining Fallbrook, Nicole worked as an independent consultant specializing in Sarbanes-Oxley compliance. Previously, she served as controller for Newgen Results Corporation where she helped support the company's revenue growth from \$60 million to \$108 million in 2003. Nicole also served as Senior Audit Accountant for the San Diego office of Deloitte & Touche, LLP.

Nicole holds a Business Administration/Accounting degree magna cum laude from San Diego State University's Honors Business Program. She is a California Certified Public Accountant.

### **Alan M. Nordin**

*President, Bicycle Products Division*

Al Nordin has 20 years of successful sales, product development, and business development experience in the automotive component industry, both in the US and international markets. He most recently served as Fallbrook's vice president of sales and business development. Prior to joining Fallbrook, Al served as vice president of sales for Newgen Results Corporation, an automotive customer relationship management firm. While at Newgen, Al managed a sales group of over 100 people, and was instrumental in building company sales from \$60 to \$108 million over a three-year period. During that period, Al grew Newgen's automotive dealer base by over 35%.

Al's previous experience also includes service as divisional manager of Global Aftermarket Operations for Visteon Corporation and global sales/marketing roles at Federal-Mogul and Echlin Inc.

Al holds a B.A. in Business Administration from Western Michigan University.

### **Paul A. DeHart**

*Chief Operating Officer*

Paul has more than 25 years' experience in manufacturing management, program development and strategic planning. He oversees Fallbrook's engineering and manufacturing operations, which are based at the company's facility in Austin, Tex.

Prior to joining Fallbrook, Paul served as president of Alex Dean Consulting, a manufacturing-focused interim management and consulting firm based in Ortonville, Mich. His extensive career includes a track record of success in a series of increasingly responsible and management roles with various divisions of General Motors. After General Motors, Paul served as general manager and director of international development at L&L Products of Romeo, Mich. and then chief operating officer of Springfield Wire Corporation of Springfield, Mass.

Paul holds a BSEE from the University of Rochester and an MBA from the Harvard Business School.

### **Robert A. Smithson, FSAE**

*Chief Technology Officer and Vice President Business Development*

Rob Smithson is an author of several publications in the area of motor vehicle transmissions with over 21 years of engineering and management experience in the automotive, aerospace,

and robotics fields. He previously served as Fallbrook's vice president of product development and was instrumental in the Company's early focus on intellectual property. Prior to joining Fallbrook, Rob served as group leader of the Drivetrain Design & NVH Group for The Southwest Research Institute (SwRI) in San Antonio, Texas and as an advisor to several early stage companies in the clean tech sector.

Rob's career includes serving as a product development engineer for The Ford Motor Company in Dearborn, Michigan. He also was vice president of robot design and a co-founder of ARM Automation, Inc., and worked as a spaceflight hardware engineer for the McDonnell-Douglas Astronautics Company. Rob was the first to recognize that the *NuVinci* variator was kinematically equivalent to a variable ratio planetary gearset, hence the term "Continuously Variable Planetary" or CVP.

Rob holds a B.S. in Mechanical Engineering from Auburn University and an M.S. in Mechanical Engineering from the University of Texas at Austin. Additionally, he holds an Executive M.S. in Science & Technology Commercialization (named Kozmetzsky Scholar and Outstanding Graduate) from the IC2 Institute at the University of Texas at Austin. In 2009, Rob was named a Fellow of the Society of Automotive Engineers (SAE).

### **Alain Charlois**

*Vice President of Corporate Development*

Alain Charlois has a proven track record of building organizations, and establishing and executing growth strategies. He also has extensive international experience having worked and lived in France, Canada, and China.

Before joining Fallbrook, Alain served as the President of the \$12 million NAFTA region for HEF Group, a \$200 million global company specializing in tribology, surface treatment and specialized bushings. Prior to HEF, he worked for 15 years at TRW Automotive where he held a series of increasing responsible positions in program management, product planning and business development. His last position at TRW was vice president of Product Planning for TRW chassis, occupant restraint and electronics business units. In that role, Alain had global product marketing and portfolio management responsibilities for those \$11 billion product lines.

Alain began his management career as the General Manager for Southern Europe at SDRC, a \$200 million provider of software tools and engineering services. Previously he had served as an R&D Engineer in France and a mechanical officer in the French Navy.

Alain holds a BS. in Mechanical Engineering from the University of Nancy, France and a Six Sigma Green Belt.

### **Daniel Katona**

*Vice President of Marketing*

Dan Katona has nearly 40 years of marketing, sales, customer service and business development experience in the automotive industry, including extensive experience in retail and wholesale dealership operations. He spent over 32 years with Ford Motor Company before retiring in early 2011 as National Sales Manager of Ford's aftermarket parts division.

Dan's assignments also included: Senior Auditor, Finance Staff, Ford General Auditors Office; Global Customer Satisfaction Manager, Ford Global Marketing Operations; Marketing Manager,

Ford Heavy Truck Vehicle Center; and Regional Manager in several different Ford, Lincoln & Mercury U.S. regional field office locations.

Dan holds a B.A. in Economics from Oakland University and a Six Sigma Green Belt.

**Robert (Rick) Meyer**

*Vice President of Sales*

Rick Meyer has an extensive background as a senior sales executive in the automotive industry. His most recent position was Senior VP Sales & marketing for ETX Inc., an automotive parts holding corporation in Alma, Michigan, that has several units involved in the manufacture and sale of compressors, transmissions, and air conditioning parts.

Prior to ETX, Rick served as a general manager at Visteon Corporation responsible for all aftermarket operations and \$1.3 billion in sales. He began his career as the OEM sales manager Monroe Auto Equipment for Ford Motor Company and subsequently held a series of increasingly responsible positions at Monroe, culminating as Executive Director of Sales. Between his time at Monroe and Visteon, Rick also served as the Executive VP Sales for Exide Corporation.

Rick holds a general business degree from Adrian College, Adrian Michigan.

**Sharon A. O'Leary**

*Chief Legal Officer*

Sharon A. O'Leary has over 25 years of increasingly responsible legal experience. Her experience includes leading the way for a company to establish the necessary internal controls and corporate governance mechanisms to implement the Sarbanes Oxley Act as well as leading a company to a successful IPO. Prior to joining Fallbrook, Sharon served as the General Counsel at Phorm, Inc., working in the London office. Phorm provides a product to Internet Services Providers.

Sharon began her legal career as an assistant deputy attorney general for the New York State Organized Crime Task Force. Subsequently, she served in a variety of legal capacities for U.S. West, was a partner at Browning, Kaleczyc, Berry & Hoven, P.C. in Helena, Montana, and served as the Vice President – Law at MediaOne Group, Inc. when it was spun off from U.S. West.

Sharon left MediaOne in 2000 to become the Senior Vice President & General Counsel for LoneTree Capital Management, a private equity fund formed by former MediaOne executives. She subsequently joined TeleTech Holdings, Inc., a customer relationship management firm, as Senior Vice President, General Counsel & Secretary. In 2005, Vonage Holdings Corp. hired Sharon as its first in-house general counsel and she assumed a leadership role in managing the provision of all legal support necessary to take the company public.

Sharon holds a Bachelor's Degree cum laude from Dominican College, and a J.D. cum laude from New York Law School.

**Jeffrey A. Birchak**

*Vice President Intellectual Property and Secretary*

Jeff Birchak is an intellectual property (IP) attorney specializing in IP portfolio management and strategy as well as patent defense and enforcement strategies for mechanical devices. Prior to joining Fallbrook, Jeff was an associate at Knobbe, Martens, Olson & Bear LLP, a world-renowned California-based IP law firm.

Previously, Jeff served as a nuclear engineering instructor in the U.S. Navy submarine force, and worked as a program engineer for AlliedSignal Corporation.

Jeff holds a B.S.E. cum laude in Mechanical Engineering from Arizona State University and a J.D. cum laude from California Western School of Law where he was the managing editor of the California Western Law Review and the California Western International Law Journal. He is a member of the State Bar of California and is admitted or registered to practice before the Supreme Court of the United States, the U.S. Patent and Trademark Office and the U.S. District Court for the Southern District of California.

### **David W. Markley**

*Vice President Product Development*

David previously served as Fallbrook's director of engineering. Prior to joining Fallbrook, David worked for BAE Systems where he led the award-winning Low Cost Precision Kill laser-guided missile development project. As a rotating machinery consultant with Radian International and Mechanical & Materials Engineering, he was the program manager for Datalert™, which provided engineering and maintenance services to 120 plants in the utility, chemical, and petrochemical industries. While working for General Dynamics Fighter Aircraft Division, David provided analytical and test support for the F-16, YF-22, and other military aircraft.

David holds B.S. and M.S. degrees in Mechanical Engineering from Auburn University and is a registered Professional Engineer (PE) and Project Management Professional (PMP).

### **Shari Binford**

*Director of Human Resources*

Shari Binford is a certified Professional in Human Resources (PHR) with over 15 years of varied experience. Prior to joining Fallbrook, she served as Corporate Recruiter for Education Finance Partners, a financial services company. Shari began her career at EDS as a training professional and subsequently served as a Human Resources Generalist and Recruiter at Dresser Wayne, a leading manufacturer of fueling technology for gasoline dispensing equipment for major oil companies around the world.

Among other projects at Dresser, Shari established a New Hire Program, was responsible for Affirmative Action Plan, and spearheaded an Excellence Program that enabled employees to submit new product and process improvement ideas. She also contributed to the Marketing Communications Department by coordinating a branding effort for the company.

Shari is a member of the Society of Human Resources Management and completed the Human Resources Certificate program at the University of Texas, Austin. She holds a B.S. in Communications from Texas State University.

## **Board of Directors**

### **William G. Klehm III**

*CEO and Chairman of the Board*

### **Gary E. Jacobs**

*Director*

Gary Jacobs is an investor and philanthropist. He is the Managing Director of Jacobs Investment Company, which participates in real estate development and other investment activities throughout the United States and abroad. In addition, he has multi-million dollar investments in other venture capital funds. He also owns and operates a professional minor league baseball team, the Lake Elsinore Storm, affiliated with the San Diego Padres.

Gary serves as chairman of the Board of Trustees High Tech High, a public charter high school and is a board member of the San Diego Symphony and the UCSD Board of Overseers. Gary's other philanthropic work includes being a past president of the United Jewish Federation of San Diego County. Additionally, Gary and his wife created and funded the Gary and Jerri-Ann Jacobs International Teen Leadership Institute which promotes Muslim / Jewish understanding.

Prior to his current investment and philanthropic activities, Gary worked as a Software Engineer and Senior Education Specialist at QUALCOMM, Inc. and as a Software Programmer at Linkabit Incorporated.

Gary holds a B.A. in Management Science from the University of California at San Diego.

### **Al Kammerer**

*Director*

Al Kammerer is a seasoned automotive industry veteran who spent 34 years with Ford Motor Company before retiring in 2008 as product development director for Jaguar Land Rover. Prior to this assignment, he served as executive director for SUV and body-on-frame vehicles in North America, where he led product development activities for Ford, Lincoln and Mercury vehicles with these platforms. In his previous work with Ford, he also served as vehicle line director for the group that developed the critically-acclaimed Ford Focus.

Al holds a B.S. in mechanical engineering from California State University at San Luis Obispo, and an M.S. in mechanical engineering from Stanford University.

### **Keimpe Keuning**

*Director*

Keimpe Keuning is a Senior Investment Manager at Robeco, a Dutch-headquartered asset management firm wholly owned by Rabobank. Robeco was established in Rotterdam in 1929 and has offices located world-wide. Robeco offers a wide range of investment products and services to institutional and private investors.

Keimpe joined Robeco in 2006 and his focus is on Clean Technology investments. He is also on the boards of Enerpulse Inc., the Albuquerque based maker of the Pulstar (TM) pulse plug and AWS Eco Plastics Ltd., the UK based plastic bottle recycling company.

Prior to Robeco, Keimpe worked at Fortis Bank as Associate Director where he advised a broad range of clients on numerous transactions. These included the listing of Tele Atlas on Euronext Amsterdam and the sale of the Dutch state publisher, Sdu, to ABN AMRO Capital and Allianz Capital Partners. He began his working career at Ernst & Young as a tax advisor.

Keimpe studied U.S. and International tax law at the University of Florida and received a master's degree in tax law from the University of Leiden. He has also participated in executive education at the Amsterdam Institute of Finance and INSEAD.

### **Sean McIntyre**

*Director*

Sean McIntyre is a Managing Director at Macquarie Capital. Macquarie Capital comprises the corporate advisory, capital markets, underwriting, private equity and principal investments capabilities of Macquarie Group ("Macquarie"), a global provider of banking, financial, advisory, investment and funds management services. Macquarie, headquartered in Australia, has 15,500 staff in 70 locations in 28 countries world wide. As at September 30, 2010, Macquarie had more than \$315 billion in assets under management.

Prior to joining Macquarie in 2010, Sean served 13 years as an Investment Banker with CIBC World Markets, a subsidiary of the Canadian Imperial Bank of Commerce. Sean has advised senior executives and boards of directors on numerous public and private financings, as well as M&A transactions.

Sean graduated from the Schulich School of Business, York University in 1997 with an MBA (finance) degree and has a Bachelor of Arts (Honours) degree from the University of Western Ontario.

### **Edward L. Mercaldo**

*Director*

Edward L. Mercaldo has been involved in the financing of natural resource exploration and development companies for almost thirty years. As Executive Vice President, CFO and Director of Diamond Fields Resources Inc., Ed negotiated its acquisition in August 1996 by Inco Ltd. Following that transaction, he served on the Inco Ltd. board until September 2000 where he served as a member of its audit committee. He has provided financial and strategic business advice to numerous natural resource companies and has also served on the boards of several U.S. and Canadian companies. Ed enjoyed a career of more than 25 years as an International Commercial and Investment Banker with several leading financial institutions including Wachovia, Bank of Montreal, Bankers Trust Company of New York, Gordon Capital and First Marathon Securities.

Ed is a graduate of the School of Foreign Service at Georgetown University and has completed the Advanced Management Program of the Harvard Business School.

### **Steven E. Parry**

*Director*

Steve Parry is managing partner of NGEN Partners, LLC, an investment firm specializing in the cleantech sector. He began his career as a professional geologist and worked in the minerals industry for more than 25 years. However, his career in geology focused on the development, implementation and management of deal pipelines and deal structures and he was involved in

approximately 200 transactions. Steve's pioneering efforts, popularizing a venture capital approach to early stage investment in the mining business, are well known in the industry.

Prior to NGEN, at Billiton plc and BHP Billiton, Steve held the position of vice president business development and general manager, innovation for the company's exploration subsidiary. As a principal in BHP Billiton's venture capital group, he was responsible for creating its first technology venture fund in 2001. Steve is also a member of the board at Artificial Muscle, EnviroTower, eps corp, Powerspan, SolFocus, Tioga Energy, and Venture Vehicles.

Steve holds a BSc degree from Queen's University, Canada, and an MSc degree from and the University of Western Ontario. He has been awarded the Canada 125 Medal for his activist role in support of sustainability in northern Canadian resource communities.

### **Jeremiah B. Robins**

*Director*

Jere Robins is the chairman and CEO of Great Pond Management Company (GPMC), a private equity firm which he formed in 1979. Over the past three decades, Jere has participated in the successful development of companies in a wide range of industries, including Iron and Steel, Specialty Chemicals, HVAC, and Semiconductor Packaging.

Jere also currently serves as chairman and CEO of Thermal Dynamics Corporation (TDX), a manufacturer of specialty heat exchangers for the North American OE Automotive and Industrial markets, and chairman of Rotation Dynamics Corporation (Rotadyne) a multinational manufacturer of consumables for the commercial printing industry with facilities in North, Central and South America, Eastern and Western Europe, and the Peoples Republic of China.

Jere maintains residences both in San Diego, California and Shanghai, PRC and divides his time equally between the U.S. and China.

### **Vincenza Sera**

*Director*

With more than 25 years of investment banking experience, Vincenza Sera is an advisor to senior executives and boards of directors. She is currently chair of the Ontario Pension Board, which she joined in 2004. From 1992 to 2004, she served as Managing Director of Financial Institutions Group, Investment Banking for National Bank Financial. During 2003 and 2004, Vincenza was co-head of the Canadian Financial Institutions Group (FIG) practice of Putnam Lovell NBF, which specializes in investment banking activity for global FIG clients.

Vincenza has an MBA (finance) degree from the University of Toronto and an honors bachelor business administration (accounting) degree from the University of Wind