Flexibility Shines Bright at *Polaris*

Assembly Plant of the Year 2015

Multiple motorcycle models are mass-produced in Spirit Lake, IA.

Everyone loves a great American comeback story. Once upon a time, Indian Motorcycle was a household name. Its classic styling, reliability and performance were legendary. However, when the factory in Springfield, MA, closed in the early 1950s, Indian faded into history.

Assemblers at the Polaris Spirit Lake factory build a wide variety of products, including the Slingshot, a cross between a motorcycle and a roadster. *Photo courtesy Polaris Industries Inc.*

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Until a few years ago, that is. That's when Polaris Industries Inc., a leading manufacturer of off-road vehicles, snowmobiles and other power sports products, resurrected the nameplate to complement its start-up Victory Motorcycles brand. It's been pedal to the metal ever since.

Today, a wide variety of heavyweight cruising and touring bikes are assembled in a state-of-the-art factory in Spirit Lake, IA. The 390,000-square-foot facility is the recipient of the 2015 *Assembly Plant of the Year* award sponsored by ASSEMBLY Magazine.

The world-class plant was chosen for the 12th annual award because of the way it has combined flexible production processes and lean manufacturing principles to successfully launch an aggressive lineup of new products.

The 21-year-old plant also embraces cutting-edge production technology, such as automated guided carts, cordless screwdrivers and DC electric fastening tools. And, it recently installed a state-of-the-art paint shop.

In addition to building Indian and Victory motorcycles, the flexible factory assembles a new three-wheeled product called the Slingshot, which is a cross between a motorcycle and a roadster. Assemblers will also soon begin building a new all-electric motorcycle called the Empulse TT.

The Spirit Lake plant has the distinction of being the only Polaris facility that has built every type of recreational vehicle produced by the company. And, it's the company's only plant that assembles on-road vehicles. It also serves as the benchmark facility for a "sister" plant in Milford, IA, that assembles off-road vehicles.

"Spirit Lake is a key cog in our operations and the ongoing success of the company," says Ed Heffernan, director of operations at Polaris. "The motorcycle business is an important part of our profitability, with a three-year compound annual growth rate of 38 percent.

"In the last four years, we had significant product innovation, with the launch of the Indian motorcycle and the Slingshot," Heffernan points out. "The Spirit Lake plant has been completely redesigned to support that."

"We have created a flexible and scalable manufacturing process to quickly react to any new product introductions, as well as to provide the flexibility for adjusting production volume and production mix," adds Jason Nelson, operations director at the plant.

Spirit Lake is located in the northwest corner of Iowa. During the summertime, the town is a popular vacation destination, because it's home to a chain of six natural lakes that feature 70 miles of shoreline. The assembly plant is a four-hour drive from Polaris's corporate headquarters near Minneapolis, and a scenic eight-hour ride from Sturgis, SD, the site of a world-famous motorcycle rally (founded by an Indian dealer in 1938) that takes place every year in early August.

Innovation Pays Off

Polaris prides itself on product development and innovation. That's what has made the Medina, MN-based company one of the most profitable manufacturers in the United States.

For the past few years, Polaris has consistently posted double-digit growth in revenue, return on assets and other key financial metrics. And, the $4.5 billion company is on pace to achieve its best year ever in 2015.

Polaris posted record sales and earnings during the first half of this year. First quarter net income rose 9 percent from the same period in 2014, while sales were up 16 percent. During the second quarter, net income rose 4 percent and sales increased 11 percent.

Much of that growth was driven by the products assembled at the Spirit Lake plant. In 2014, Polaris motorcycle sales were up 55 percent in North America and 70 percent internationally.

The company is on pace to exceed those results this year. In fact, motorcycle sales increased 74 percent during the first quarter to $137 million. And, during the second quarter, motorcycle sales increased 57 percent to $162 million.

Scott Wine, chairman and CEO of Polaris, credits that phenomenal success to an aggressive product development strategy and an operational excellence initiative. "Innovation remains a cornerstone of [our] success," he claims.

During the last three years, Polaris has spent an average of $138 million annually on research and development. That's because one of the company's core philosophies is anticipating, rather than reacting to, marketplace demand.

"Whether we create markets and trends or simply stay ahead of them, we expect to set the standard rather than follow it," says Wine. "We strive to deliver the next big thing that is and will be hot, rather than what was desired."

A good example of that homespun innovation is the Slingshot, which first rolled off the Spirit Lake assembly line one year ago. The unique machine is unlike a traditional motorcycle.

Polaris engineers created an all-new segment of the power sports industry. The low-lying three-wheeler combines elements of a motorcycle and a sports car, with two wheels in the front and one in the back. It features two waterproof seats, an open cockpit, low-profile tires, open-wheel front fenders and no doors. Polaris refers to the vehicle as a "moto-roadster."

Vehicles assembled at the Polaris plant in Spirit Lake, IA, include (top to bottom) the Victory Vegas, the Slingshot, the Indian Chief Vintage and the TT Empulse. *Photos courtesy Polaris Industries Inc.*

Automated guided carts improve safety, quality and throughput. ***Photo by Austin Weber***

The vehicle is powered by a 173-hp four-cylinder engine manufactured by General Motors coupled to a five-speed manual transmission. Drivers steer through the front wheels, but a drive belt is attached to the rear wheel. A steel space frame keeps the vehicle weight below 1,700 pounds and helps it achieve a top speed of 130 mph.

The Slingshot retails between $21,000 and $26,000, depending on options. And, because it only has three wheels, the federal government classifies the vehicle as a motorcycle.

All Polaris products are sold through a network of 1,750 independent dealers in North America and through 85 distributors in more than 100 countries worldwide.

Polaris aims to reach $8 billion in sales by 2020. The motorcycles assembled at the 2015 *Assembly Plant of the Year* will play a key role in helping the company reach that milestone. By 2018, Polaris hopes to achieve more than $1 billion in motorcycle sales, up from $100 million in 2009.

Two-Wheel Success Story

Polaris entered the motorcycle market when it launched the Victory brand 18 years ago. The made-in-the-USA heavyweight cruiser was designed to compete head-to-head with traditional manufacturers such as Honda, Kawasaki, Suzuki and Yamaha.

The original Victory motorcycle featured a big-bore, V-twin engine designed and built in-house. When the first bike rolled off the Spirit Lake assembly line on July 4, 1998, Polaris became the first American company to enter the motorcycle market in 60 years.

Polaris branded Victory as the "new American motorcycle," with a host of unique features. For instance, the first bikes boasted four valve heads when most other V-twin engines had only two. All Victory motorcycles also came equipped with fuel-injected engines at a time when other manufacturers only offered that as an option.

That bold move paid off. Polaris sold more than 1,000 Victory motorcycles in 1998. And, production increased to 3,000 units the following year when the company introduced the world's first sport cruiser.

Polaris added to its motorcycle portfolio when it acquired the iconic Indian Motorcycle brand in 2011, 110 years after the first bike bearing that name appeared. Indian, which was founded two years before arch-rival Harley-Davidson, was once America's largest motorcycle manufacturer.

After investing almost $100 million to re-engineer Indian's lineup, Polaris relaunched the brand two years ago. Since then, it's been building Indian into a "heritage brand" based on classic styling cues and art deco design. That tends to appeal to a different market segment than Victory, which is more popular with performance enthusiasts.

"When Polaris acquired the Indian brand, our goal from the outset was to leverage our engineering, manufacturing and operational prowess as a market leader in power sports to design and build a truly exceptional motorcycle that represents the perfect balance of legendary heritage and brilliant, state-of-the-art engineering and technology," says Steve Menneto, president of motorcycles at Polaris.

"Everyone involved in the design of this motorcycle line understands

Assembler use DC electric tools for safety-critical and quality-critical fastening applications. ***Photo courtesy Polaris Industries Inc.***

The 2015 *Assembly Plant of the Year* is the only Polaris facility that builds on-road vehicles. *Photo courtesy Polaris Industries Inc.*

that we are the stewards and caretakers of one of America's most storied and legendary brands," explains Menneto. "From the outset, the goal was to capture the iconic design and styling aspects of the brand's most historic models and fuse that heritage with state-of-the-art technology and progressive design elements.

"The new design reflects an unparalleled investment into researching the complete history of Indian power train development, including the review of volumes of historical documentation, miles of riding vintage motorcycles, and studying and dissecting a broad array of legendary Indian models," claims Menneto.

"The Indian and Victory brands continue to carry great pride for Polaris," adds Menneto. "For 2016, we've added to our lineup of state-of-the-art motorcycles, adding depth to our robust roster of products and delivering on our promise to continuously innovate."

A good example of that innovation is the new Empulse TT, the first all-electric addition to the Victory lineup.

"[The] street-legal sport bike… builds on Victory's focus on performance," claims Menneto. "With a combination of advanced technology and stylish, modern design, this unique motorcycle delivers outstanding overall performance, zero-emission output and a [high-torque] motor."

The Empulse TT features a 10.4-kilowatt-hour lithium-ion battery, a liquid-cooled AC-induction motor

and a six-speed gearbox that allows riders to accelerate up to 100 mph.

Polaris has picked a good time to launch new products and become a major player in the motorcycle industry. According to the Motorcycle Industry Council, sales were up 7 percent during the first half of 2015, with the biggest demand coming for on-highway bikes.

And, the outlook for motorcycles appears to be healthy. Worldwide demand is forecast to expand 6 percent annually to more than 132 million units in 2018, claims a recent study conducted by the Freedonia Group Inc.

All vehicles produced at Polaris Spirit Lake are built to order. ***Photo courtesy Polaris Industries Inc.***

Multiple Models

Assemblers at the Polaris Spirit Lake plant produce several types of motorcycles, including baggers, cruisers and touring bikes.

Baggers feature saddlebags and appeal to customers who like to take long road trips. They typically have windshields, large fuel tanks and deeply valanced front fenders.

Touring bikes are similar to baggers, but feature cushy features such as electronic cruise control, tire-pressure monitoring systems, a larger windshield and surround-sound audio systems. They also include a trunk that allows more storage space and provides a passenger backrest.

Cruisers are more bare bones than baggers or touring bikes and feature a lower and longer chassis. They appeal to people who like stripped-down style and cranked-up performance. The riding position usually places the rider's feet forward and hands up.

Cruisers are typically intended for only one rider and weigh less than

Two-tone paint and graphics give Indian motorcycles a unique look. ***Photo courtesy Polaris Industries Inc.***

baggers or touring bikes. They feature smaller gas tanks, lower seat heights, shorter front fenders and engines that deliver massive amounts of torque.

While a few basic parts, such as nuts and bolts, are shared between Indian and Victory products, each brand has distinct features and uses separate components. In fact, more than 98 percent of the parts content on the bikes is unique. As a result, each brand of motorcycle is produced on a separate assembly line at the Spirit Lake factory.

The Indian line is dedicated to five classic models that have been revived and relaunched in the last few years. Price tags range from $10,000 to $30,000.

The Roadmaster is a 897-pound touring bike with a 111-cubic-inch, air-cooled V-twin engine. The Chieftain, Chief Classic and Chief Vintage are classic baggers that also use big engines and weigh an average of 798 pounds. However, the latter is loaded with retro features, such as leather saddlebags and fringe.

The newest model in the Indian lineup is the Scout, a name that's legendary among bikers. "You can't wear out an Indian Scout" was a marketing tag line when the original bike debuted back in the 1920s. The powerful machine was also popular with board track racers, hill climb competitors and daredevils who performed in "wall of death" thrill shows.

The modern version of the Scout was derived from a clean-sheet design. It weighs 558 pounds and features a cast-aluminum frame coupled to a

69-cubic-inch, liquid-cooled 100-hp V-twin engine.

Victory motorcycles are designed to appeal to customers who want "modern American styling." Its product lineup includes baggers such as the Cross Country and the Magnum; cruisers such as the Hammer 8-Ball, High-Ball and the Gunner; and touring bikes such as the Cross Country Tour and the Vision Tour.

The lightest Victory cruiser weighs 638 pounds, while the heaviest touring bike weighs 851 pounds. Price tags range from $12,000 to $22,000.

Model-year changes follow traditional automotive cues, with new bikes typically launched in late July. That means the Spirit Lake plant is busiest between August and January, with lines rates shifting accordingly. Indian and Victory motorcycles sport approximately 5 percent to 10 percent new content every year.

Polaris distinguishes many of its motorcycles through special colors and graphic packages that change annually and are marketed as "limited editions." For instance, the company offers five different shades of black alone, ranging from suede to gloss. Retro two-tone designs, such as red and cream or green and cream, are popular on many Indian models.

Polaris Spirit Lake addresses error proofing through a variety of built-in poka-yokes and process controls. ***Photo courtesy Polaris Industries Inc.***

"Two-tone paint schemes are among the most iconic elements of vintage Indian motorcycles dating back about 80 years, giving the bikes a look and feel that is instantly recognizable and beloved by motorcycle fans," notes Menneto.

Visual work instructions at every workstation provide a common platform for employee communication. ***Photo courtesy Polaris Industries Inc.***

A newer paint scheme is the Indian Chief Dark Horse, which features a flash of chrome and a heavy dose of matte black paint. Some Victory bikes, such as the Cross Country, are available with pinstripes, flames and other custom paint jobs.

All that focus on paint and finish is a big reason why Polaris recently opened a new 160,000-square-foot paint shop at the Spirit Lake plant. The two-level automated facility features 14 robots that run seven days a week.

"The paint shop also is environmentally friendly, with low emissions, water recycling and a state-of-the-art waste treatment system," says Nelson. "Sludge and other waste is turned into nonhazardous material on site. Even though production has doubled, particulate emission is only 10 percent of the total limit."

Polaris has also taken steps to reduce energy consumption throughout the plant. All lighting has been upgraded with motion sensors, and the company has installed variable-speed fans and other energy-efficient HVAC equipment. Polaris Spirit Lake expects to save more than 1 million kilowatt-hours of electricity per year, resulting in energy savings of more than $78,000 annually.

Lean Layout

When Polaris acquired the Spirit Lake plant in 1994, it was the company's first major manufacturing operation anywhere other than Roseau, MN. The vacant building formerly housed a manufacturer of commercial ice machines. In less than two months, Polaris rehabbed the plant and began assembling several lines of personal watercraft—a new market that it had entered a few years earlier (the company subsequently divested its marine division in 2004).

Since motorcycles have now become a key market segment for Polaris, the company's manufacturing engineering team recently redesigned the plant floor to reduce bottlenecks and improve throughput.

Assemblers at the Polaris Spirit Lake plant produce several types of motorcycles, including baggers, cruisers and touring bikes. ***Photo courtesy Polaris Industries Inc.***

Polaris Spirit Lake currently operates four platform-based assembly lines that build multiple variations of Indian and Victory motorcycles, in addition to the Slingshot moto-roadster. The lines assemble an average of 40 to 60 vehicles per day in multiple configurations. And, each of the U-shaped lines ends with a test-and-inspection station where every vehicle is driven on a rolling stand for several minutes at various speeds.

"Building low-volume, factory-custom bikes on the same line as high-volume models presents a unique set of challenges," says Cosmin Batrin, director of advanced manufacturing engineering at Polaris. "We must deal with an extra layer of complexity. The Slingshot has the most complexity, due to the number and size of parts and subassemblies."

Polaris prides itself on producing innovative products such as the Slingshot moto-roadster. ***Photo courtesy Polaris Industries Inc.***

Polaris's team of manufacturing engineers tackled the challenge by carefully aligning automation, systems, tools, process flows and material deliveries to boost productivity, improve quality and increase throughput.

"The line layout for both Indian and Victory are extremely similar, with best practices that span both," says Batrin. "However, the Victory assembly line has a higher model count than the Indian line."

Victory motorcycles are built off of four basic platforms vs. two platforms for Indian bikes. "The Victory products tend to be much more complex," says Mike Hoffman, manufacturing engineer. "For instance, they use five different wiring harnesses.

"The Indian Roadmaster requires 17 painted parts," explains Hoffman. "The Indian Scout, on the other hand, uses only three painted parts, such as gas tanks and fenders. All parts are delivered to the assembly lines on sequenced carts."

"Every bike on the Spirit Lake assembly lines is unique," adds Steve Schmitz, senior manufacturing engineer. "But, all the products we build receive the same level of attention and no one product is more important than another."

In addition to paint and graphics, typical product variations include gas tanks, suspension, front-end forks, exhaust pipes, floorboards, handlebars, grips and mirrors. In addition, some bikes are equipped with options such as anti-lock brakes, keyless ignition and state-of-the-art infotainment systems.

Indian, Victory and Slingshot frames are welded together at an in-house fabrication shop at the Spirit Lake plant. Polaris builds plastic injection-molded parts in-house at its plant in Roseau. Indian and Victory motorcycle engines are assembled in-house at a Polaris factory in Osceola, WI. Other components, such as fuel tanks, instrument panels, seats and tires, are sourced from third-party vendors.

The Spirit Lake factory has been dramatically transformed over the last few years. "Five years ago, 80 percent of the plant used air tools," says Schmitz, who has worked at the facility for more than 20 years. "Today, we use cordless tools for most fastening applications other than safety-critical joints, which use DC electric tools."

Another big difference is the conveyor system. Older J-hook overhead chain conveyors have been replaced with automated guided carts (AGCs) on the motorcycle lines. However, the Slingshot assembly line uses an in-floor, chain-driven conveyor system.

All vehicles produced at the plant

are built to order, using a recently implemented retail flow management system that allows dealers to place orders daily. It has enabled Polaris to reduce its order-to-delivery time from 120 to 15 days.

Flexible Factory

Polaris Spirit Lake has grown from a workforce of 400 people five years ago to more than 1,000 employees today. Continuous improvement initiatives have played a key role in managing that expansion. The flexible factory has focused on lean manufacturing to improve productivity and maintain quality.

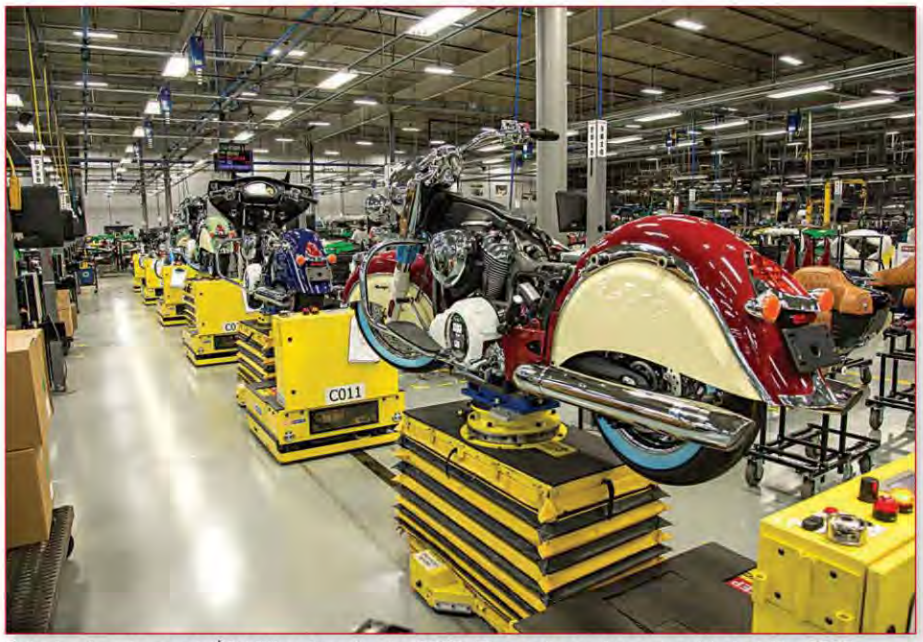
As part of its lean transformation, Polaris engineers have implemented a wide variety of methodologies aimed at eliminating waste, while improving material and information flows. Part of that philosophy has involved treating each operator as a "surgeon" by reducing non-value-adding steps in the process of selecting and picking up parts.

"Walking for parts or having to make decisions on what parts go on what bike are non-value-added steps that we strive to eliminate in every assembly process," says Batrin. "All the steps that take an operator away from producing a quality bike have been eliminated or minimized."

Components such as fenders and saddlebags are built in sequence on subassembly lines. Just-in-time parts kitting is also used for various trim components. And, only two to four hours of inventory is stored line side.

During each shift, engineers collect and track a wide variety of key performance indicators related to delivery, quality and safety. Visual management techniques communicate time and key performance indicators around the factory floor. In addition, modular andon boards throughout the plant, and visual work instructions at every workstation, provide a common platform for employee communication.

"That helps eliminate misbuilds and mistakes caused by human error," says Batrin. "Investment in paperless



Polaris aims to reach $8 billion in sales by 2020. The motorcycles assembled at the 2015 *Assembly Plant of the Year* will play a key role in helping the company reach that milestone. *Photo courtesy Polaris Industries Inc.*

systems allows us to ensure the build quality, as well as the build integrity, at each workstation."

Polaris Spirit Lake addresses error proofing through a variety of built-in poka-yokes and process controls. Quality alerts and "checkbacks" are also deployed so that downstream operators can verify the work done previously on the assembly line.

Employees throughout the plant are also engaged in kaizen events and value-stream mapping activities. "We have completed line rate changes for each line using lean tools in kaizen events to complete the changes in 48 hours and come up to rate within five working days," says Rob Hunt, lean manufacturing manager.

"Line reconfigurations to prepare for new products or processes can be done over the weekend," claims Hunt. "Just a few years ago, that type of changeover would have required three to four weeks to complete."

One reason why assembly lines can be changed quickly is because all equipment and systems have been developed with flexibility in mind. Everything is modular, mobile and easily reconfigurable.

All fixtures, flow racks, material handling carts and workstations are on wheels and casters. They are built in-house using modular profile systems. That enables Polaris engineers to bolt together framing components to tailor carts and workstations to specific assembly line needs or floor space requirements.

"All large equipment and monuments have been eliminated and replaced with smaller, more nimble and cheaper flexible equipment," says Batrin. "In addition, this has improved line of sight and visibility in the plant. All parts presentation devices and workstations are no taller than 54 inches."

However, the 2015 *Assembly Plant of the Year* has also invested in automation to improve quality, boost productivity, increase throughput and address ergonomic issues.

The Indian and Victory motorcycle assembly lines use 40 AGCs. "They are a critical part of our flexible manufacturing systems strategy," says Batrin. "AGCs allow us to be more responsive to changes in production requirements, coupled with increased productivity and high quality.

"It is a modular system," adds Batrin. "Additional carts, features or equipment can be added at a later time, with no tear out required, in a fraction of the time compared to traditional conveyor systems. Routes, tasks or cells can be immediately added or subtracted.

"The use of andon visual systems is also directly connected to the cart management systems," Batrin points out. "That allows or prohibits an AGC to advance to the next workstation based on quality interlocks."

In addition, the carriers have independent height adjustments, which can be changed based on operator size, reducing ergonomic impact and potential lost time due to injuries. This flexibility makes it possible to incorporate all models onto one line, making it easier to match customer demand, allow for greater data tracking and error proofing, and facilitate better first-pass yield.

The AGCs also allow center-aisle access for parts delivery. They enable material handlers to get parts closer to the assembly lines.

Cordless fastening tools are also used throughout Polaris Spirit Lake. "Like the AGCs, they allow operators unrestricted access," says Batrin. "Dependent on torque range, we want the majority of deployed tools to be battery powered. This allows operators the freedom to move, and it decreases potential safety issues created by cords and hoses."

In addition, Polaris Spirit Lake has deployed DC electric tools for all safety-critical and quality-critical fastening applications, such as brakes, steering and suspension. The nutrunners enable engineers to adjust tool speed to match various applications and control more aspects of the fastening process.

"The tools are interlocked to each workstation to ensure process control, resulting in increased productivity and quality," says Batrin. "The tools' capability and accuracy, coupled with the immediate result feedback, helps us lower overall production costs and ensures that a high-quality product is built right the first time.

"The cordless and electric tools have not just made the plant greener," notes Schmitz. "Today, it's also quieter. And, operators have less stress and strain, since the electric nutrunners are generally lighter and easier to use than air tools." **A**