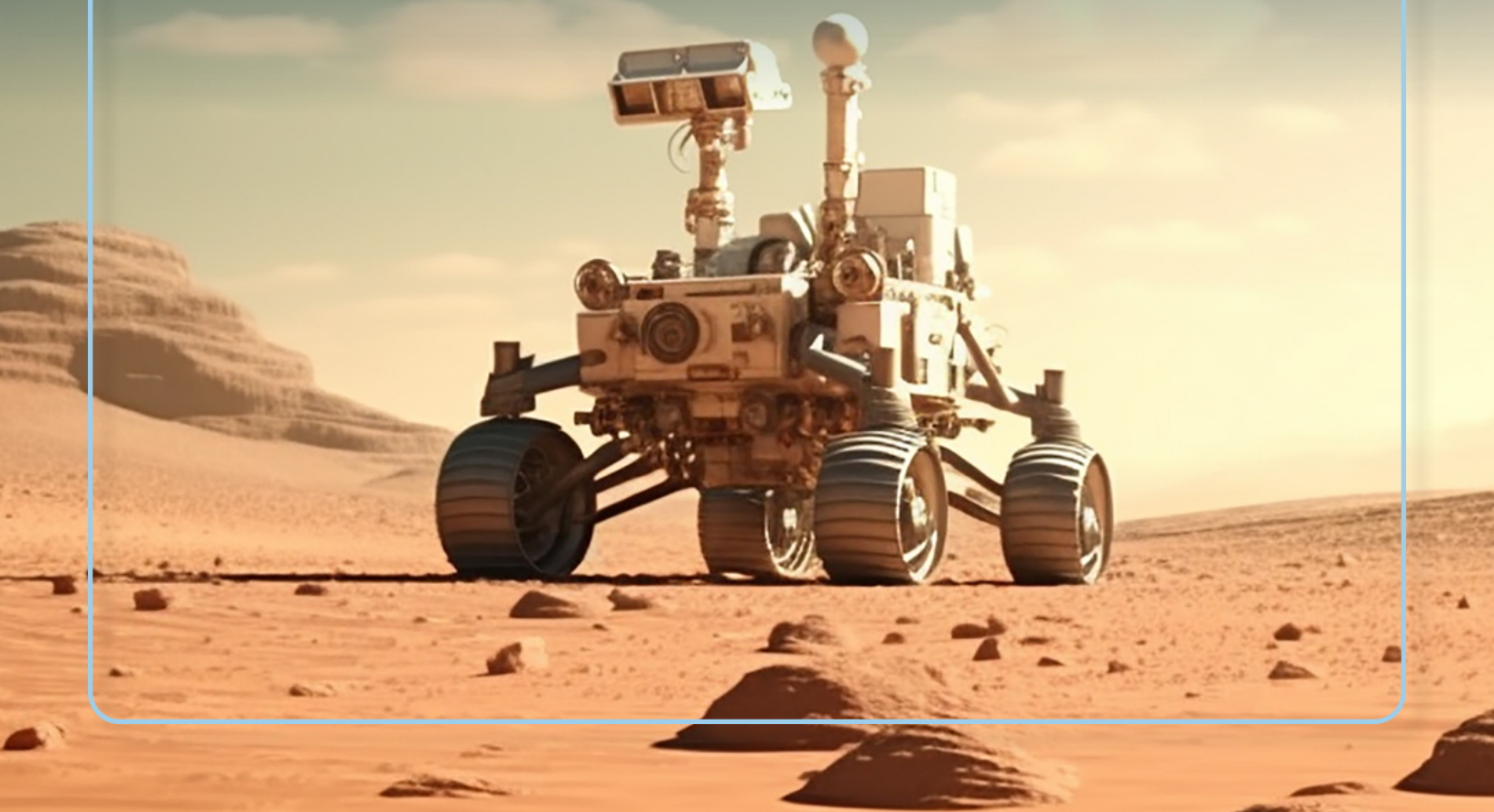
WINDINGS

A 60-Year History of Innovation



CEO Letter

From Our CEO:

Over 60 years ago, Windings began with a bold vision: to design electromagnetic components for the aerospace industry. Today, that same spirit of innovation drives us across industries—from defense and oil and gas to medical, renewable energy, and motorsports.

What's fueling our journey is a simple question: What else can we do for you? It's not just a phrase, it's a promise. A promise to listen deeply, to understand what's standing in the way of your success, and to create solutions that transform barriers into breakthroughs.

We don't believe in one-size-fits-all answers. We believe in possibility. In turning complexity into clarity. In transforming what seems impossible into what's achievable. This mindset is woven into the fabric of Windings, into every design, every engineering challenge, every operational decision.

As an employee-owned company, our people are empowered to think beyond the expected. We are united by a shared purpose: Powering systems and empowering lives. It's why we show up every day, not just to assemble motors, but to build trust, progress, and impact.

Windings: A 60-Year History of Innovation is more than a showcase of our capabilities. It's a reflection of our commitment to you, our partners. A testament to what can happen when curiosity meets expertise, and when innovation is driven by purpose.

Thank you for being part of our story. We can't wait to discover what else we can do for you.

Warm Regards,

Heather Braimbridge-Cox

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Who We Are

About Us

At Windings, we are known and trusted for our work in designing, engineering, and manufacturing custom electromagnetic components for the aerospace and defense industries. Built on a vision to push the boundaries of electromagnetic technology, Windings has grown into a trusted partner for industries ranging from aerospace to medical devices.

Founded in 1965 to produce synchro motors used in commercial and military avionics, Windings is well-versed in the design and regulatory requirements driven by the unique packaging and performance challenges associated with land defense. Our legacy is built on decades of delivering high-performance solutions tailored to the most demanding specifications.

Who We Are

Employee-Owned

Windings is 100% employee-owned through an Employee Stock Ownership Plan (ESOP), which means every employee has a personal stake in the company's success. This ownership model fosters a culture of accountability, collaboration, and innovation, where employees are motivated to deliver exceptional results and continuously seek ways to improve.

For customers and clients, the ESOP structure translates into a team that takes pride in their work and consistently advocates for what's best for the customer. Because every employee has an ownership mindset, they are more attentive, responsive, and committed to long-term solutions, ensuring that every partnership is built on trust, quality, and shared success.

Our History

1965
Our Beginning
Windings established in 1965 by JW McKinney.

1983
JW McKinney Retires
JW McKinney retires and sells Windings to Roger Ryberg (as shareholder of Careen Inc).

1993
Industry of the Year
Windings recognized as New Ulm Chamber of Commerce's "Industry of the Year".

1998
Employee Stock Ownership Plan (ESOP)
ESOP created in 1998 as part of Roger's retirement plan.

1999
Motor Production Begins
First in-house motor build line at Windings.

2004
Generator Application
First complete design and development from Windings for a generator application.

2005
First Prototype Motors For Hybrid Automobile
First prototype hybrid automobile motors for three major automotive OEMs.

2007
Windings Adds Clean Space
Creation of clean manufacturing space to minimize foreign object debris (FOD).

2008
100% Employee Owned
Windings becomes 100% employee-owned.

Our History (Cont.)

2009
Unmanned Submersible Application
First Windings design and development effort for unmanned submersible.

2011
Tooling Facility Added
Windings adds Tooling Facility on Minnesota Street.

2014
Windings Expands
Windings expands further in New Ulm, MN, adding a customer center and office space on North Front Street.

2020
Operations Consolidated
New Ulm operations are consolidated into new building with approximately 70,000 square feet.

2021
Creation of DuraCORE™ Product Line
DuraCORE™ product line launched for harsh environments.

2022
Windings Acquires McCully Corp
Windings acquires California-based motor manufacturer "Windings Moorpark" – previously known as McCully Corp.

2024
Windings Acquires Baja Border Maquila
Windings acquires Mexico manufacturing location "Windings Mexico" – previously known as Baja Border Maquila (BBM).

2025
Mexico Manufacturing Expansion
Windings Mexico moves into new 60,000 square foot facility.

Services

Our Approach

While we can also manufacture directly from customer-supplied drawings, the majority of our work follows this collaborative, requirement-driven process. It's an approach that combines engineering expertise with customer vision, ensuring every solution is built to perform and built to last.

Our process follows a clear path:

DEFINE → ALIGN → DESIGN → VALIDATE → BUILD

From the outset, we work with customers to **define** the goals and objectives for the project so that we can take a holistic approach to addressing the challenges that need to be solved. Once there is an **alignment**, we identify the key requirements (i.e., dimensions, torque, voltage, speed, acceleration) that set the foundation for the project.

Next is **design**, where our engineering team transforms those requirements into a tailored concept, refining the details in close collaboration with the customer to balance performance, reliability, and manufacturability.

From there, we **validate** the proof of concept by developing prototypes and testing them under real-world conditions to ensure the solution meets every specification and performs exactly as intended. This ensures that when we go to **build**, our skilled manufacturing team is able to bring the proven design to life with the precision and quality that defines Windings.

Services

Our Approach (Cont.)

Advanced Simulations & Modeling

Ensure your solutions meet performance standards before moving to production.

- SolidWorks 3D Modeling and Mechanical Analysis Software
- Solidworks Mechanical Analysis
- SPEED, Motorsolve, and Maxwell - Electromagnetic Design and Analysis Software
- Motorsolve - Thermal Analysis
- Basic Circuit

Optimized Motor Solutions

Reduce lifetime costs, streamline your project timeline and maximize the efficiency of your components.

- Custom Electric Designs and Prototyping
- Complete Motor Assemblies
- Reverse Engineering Legacy Designs
- Dynamometer Testing
- Laser Welding

Precision Engineering

Optimize your mission-critical applications to meet the performance demands of your industry.

- Application Analysis
- Custom Prototyping
- 3D Printing
- Reverse Engineering

Industries

Aerospace

INDUSTRY OVERVIEW

Custom engineering and manufacturing of electric motors for aviation and space is our specialty. For over 60 years, we have been recognized for our expertise in aerospace components, providing diligent support to key industry players in manufacturing, prototyping, and design. As a trusted resource in electromagnetics, we have established a reputation in the industry for high-quality, high-performance custom parts that consistently outperform our customers' expectations.

AREAS SUPPORTED

- Space
- Military Aviation
- Commercial Aviation
- Advanced Air Mobility

PROJECT HIGHLIGHT

Curiosity Drives Innovation

OPPORTUNITY

NASA's Jet Propulsion Laboratory (JPL) was moving into the next phase of Martian exploration with the planned launch of the Curiosity Rover. Curiosity was the largest rover to date, so past methods to land it on Mars would not work. So, NASA devised a plan to develop a "Sky Crane," the first of its kind, to land the rover safely.

APPROACH

Size, weight and reliability are all critical factors in spacecraft design. Powerful yet compact electric motors that could survive the harsh conditions of space travel and work flawlessly upon arrival in the Martian atmosphere were required to drive the Sky Crane's hoist system. Windings worked closely with JPL engineers to develop electric motor components that could be tightly integrated into the Sky Crane's hoist mechanism.

Industries

Aerospace (Cont.)

RESULTS
Curiosity was launched on November 26, 2011. After traveling for 254 days in the frigid cold and deep vacuum of space, Curiosity arrived at Mars on August 6, 2012, where the **Windings' motors on the first-ever rover, Sky Crane, successfully lowered Curiosity to the Martian surface**.

PROJECT HIGHLIGHT
Airborne Electronic Warfare Systems Remain Cool Under Pressure

OPPORTUNITY
To protect sophisticated airborne electronic warfare (EW) systems from damage due to excessive heat, a major motion control supplier to the United States Air Force (USAF) developed a liquid cooling system that utilized a highly customized pump driven by high-power, lightweight custom electric motors. However, the encapsulation process for producing stator components for the electric motors yielded inconsistent results.

APPROACH
Windings Engineering Services team worked closely with the motion control supplier's engineers to develop a consistent shape and form for the finished stators by incorporating higher temperature-rated thermal switches inside the potting compound and more reliable connections to the motor.

RESULTS
Recognizing Windings' advanced manufacturing capabilities, the motion control supplier shifted responsibility for the stator potting to Windings. In doing so, there was a **significant reduction in manufacturing time, scrap and rework to the customer**. What's more, the supplier received a **turnkey product** with consistent form and reliable construction.

"This application required a compact, power-dense BLDC motor capable of sustaining high speeds and thermal loads over long-duration missions. The use of carbon fiber magnet retention sleeves allowed the motor to operate safely beyond 30,000 RPM without magnet failure risks."

-Jim Spoon, Technical Sales & Compliance, Custom Motor Manufacturing For OEM

Industries

Defense

INDUSTRY OVERVIEW

Windings has been a trusted supplier of motors, generators, and electromagnetic components to the aerospace and defense industries for over 60 years. Our electromagnetic solutions are engineered to meet the demanding specifications of the defense industry, ensuring dependable performance in critical situations. Windings is well-versed in the design and regulatory requirements driven by the unique packaging and performance challenges associated with military operations.

AREAS SUPPORTED

- Land Defense
- Air Defense
- Sea Defense
- Weapons Systems

PROJECT HIGHLIGHT

Engineering Services Keeps Missile Development Program on Target

OPPORTUNITY

Faster missiles are more difficult to intercept and destroy. As missile speed increases, however, so does the difficulty of maintaining or increasing target accuracy. Commercial off-the-shelf electric motors could not meet the necessary dynamic response; therefore, a domestic supplier of controls and electromechanical actuators to major US Aerospace and Defense industry prime contractors needed to develop a highly customized solution optimized for the best possible dynamic response.

Industries

Defense (Cont.)

APPROACH
Windings' Engineering Services team worked closely with the customer to refine the design for manufacturability without sacrificing performance. On top of delivering working prototypes to the customer for proof-of-concept testing, Windings also further refined the design to allow automated assembly to support full-rate production. JPL engineers to develop electric motor components that could be tightly integrated into the Sky Crane's hoist mechanism.

RESULTS
The collaboration between both teams and Windings' deep motor design and manufacturing engineers working together throughout the project **helped the defense contractor achieve their performance objectives** while maintaining an aggressive project schedule.

"Our full-service model provided a seamless path from reverse engineering to validated production design. Windings gave the customer full design ownership and IP rights, helping them de-risk the program long-term. The collaborative approach allowed the customer to hit their timeline for missile development milestones without compromising on performance or quality."

-Jim Spoon, Technical Sales & Compliance, Custom Motor Manufacturing For OEM

Industries

Oil & Gas

INDUSTRY OVERVIEW

Windings' electromagnetic solutions for the oil and gas are built to withstand the extreme conditions of the industry, ensuring dependable operation in challenging environments.

DuraCORE™ motors, Windings' latest innovation in providing downhole drilling motor solutions for the oil and gas industry, are one of the most rugged, resistant, and reliable electric motors on the market today. Made possible by GORE Magnet Wire's revolutionary insulation, this technology has been transformative for the industry.

AREAS SUPPORTED

- Well Drilling
- Downhole Exploration

PROJECT HIGHLIGHT

Tool String Electrification of a Deep Subject

OPPORTUNITY

A global well solutions provider designing a next-generation tool string was seeking a replacement for an existing electric motor solution that could provide similar power output in a shorter package while consuming less current.

APPROACH

Windings' engineers worked closely with the customer's engineering team to develop a brushless DC motor solution that provided the required power and speed in a form factor that was half the length of the induction motor it replaced, delivering a 35% increase in efficiency. The result was a custom 5kW, 8,000 RPM permanent magnet motor in a stainless steel 3-1/8" O.D. x 11" long housing, rated for 260°C operation while submerged in hydraulic fluid.

RESULTS

Overall length reductions allowed the new tool string to be used on offshore platforms with limited rig height, opening up new opportunities for the customer. The increase in efficiency **enabled the customer to complete wells more quickly**, resulting in **millions of dollars of additional annual revenue**.

Industries

Motorsports

INDUSTRY OVERVIEW
For more than 20 years, Windings has helped pioneer the development of brushless DC electric motor solutions that support the electrification of motor vehicles. From hybrid and electric passenger cars to commercial vehicles to Formula 1 racing, Windings has partnered with automotive industry leaders.

PROJECT HIGHLIGHT
Electrification Energizes Formula 1 Racing

OPPORTUNITY
An Energy Recovery Systems (ERS) supplier was enlisted by a Formula 1 constructor to convert waste energy expelled as part of the engine exhaust gas, as well as heat energy generated during heavy braking, to electricity for later use during acceleration.

APPROACH
Since turbochargers operate at very high speeds (often in excess of 60,000 RPM), and higher speed equates to higher efficiency, a new magnet retention system was necessary to secure the magnets to the rotor at speeds in excess of 100,000 RPM. Windings worked closely with the ERS supplier to develop a magnet retention system that would reliably secure the magnets to the rotor at the desired speed while operating in a high-heat and vibration environment.

RESULTS
The **Windings-supplied retention system has been in use for more than nine seasons of racing** across several Formula 1 race teams **without a single race failure**.

Industries

Medical

INDUSTRY OVERVIEW
Windings' electromagnetic solutions are engineered to meet the high standards required for medical devices, ensuring precision and reliability in critical applications. With a history of critical applications in harsh environments, we have made ourselves a trusted partner to our medical device clients, accelerating the latest advancements in surgical tools, infusion pumps, and laboratory automation equipment that help clinicians improve patient treatment outcomes.

PROJECT HIGHLIGHT
Supplying Stators and Rotors for Medical Centrifuges

OPPORTUNITY
Centrifuges operate on the principle of centrifugal force, spinning tubes at 6,000 RPM or higher to separate red blood cells, white blood cells, and plasma. As centrifuges advanced, so too did their motor technology, driving demand for specialized designs capable of higher speeds and lower vibration. Windings, recognized as a premier supplier of custom stators, began developing a motor to support these speeds.

APPROACH
High-end centrifuges would increasingly employ switched reluctance motors (SRMs). Within these motors, Windings developed stators that provided the electromagnetic foundation for reliable performance, capable of supporting tight manufacturing tolerances to handle extreme RPMs. These stators were optimized for torque and efficiency, ensuring rigorous quality standards.

RESULTS
Within these motors, the stator provided the electromagnetic foundation for reliable performance. By combining engineering expertise with precision manufacturing, **Windings helped ensure that centrifuges worldwide delivered dependable results in laboratories to this day**.

Our Future

The Future of Electromagnetics: Emerging Applications and Expanding Industries

The field of electromagnetics is undergoing rapid transformation, driven by advances in materials science, digital engineering, and the global demand for electrification and energy efficiency. Traditionally focused on industrial and manufacturing systems, today's electromagnetics technologies are evolving to meet the increasingly complex requirements of sectors such as defense, energy, and automotive. This evolution is creating new opportunities for innovation in electric motor design, magnet retention, and system-level optimization.

Defense and aerospace sectors are embracing custom electromagnetic solutions for mission-critical systems. Applications such as flight controls, fuel pumps, and actuation systems are moving from traditional AC induction motors to permanent magnet synchronous motors (PMSMs), offering improved torque density and reliability. However, these applications often require motors that perform reliably under extreme thermal, mechanical, and vibrational conditions. **To meet these needs, innovations like carbon fiber roving for magnet retention and advanced lamination techniques are helping to enhance durability while minimizing weight and power loss.**

Our Future (Cont.)

In the **automotive industry**, the shift to electrification is expanding beyond consumer electric vehicles to include high-performance applications like motorsports, electric turbochargers, and energy recovery systems (ERS). These systems demand lightweight, compact, and highly efficient motors capable of operating at high RPM and under intense thermal and mechanical stress. Achieving these performance levels requires maximizing slot fill and minimizing the air gap between stator and rotor components. Design choices like high-density windings, optimized coil geometry, and carbon fiber magnet retention are increasingly vital for competitive performance.

Looking forward, the future of electromagnetics is defined by integration: bringing together simulation tools, design optimization, and advanced manufacturing techniques such as additive manufacturing. **These technologies enable the development of custom motors that are faster, more precise, and highly adaptable to specific customer requirements**. Companies like Windings, with vertically integrated design and manufacturing capabilities, are positioned to deliver tailored solutions that address the full spectrum of electromagnetics challenges from concept to final production.

As industries push for more power-dense, energy-efficient, and application-specific solutions, the role of electromagnetics engineering is expanding well beyond its traditional scope. The next generation of electromagnetic systems is poised to become foundational to the technologies that shape our world.