Omniseal Solutions
SAINT-GOBAIN

GOING BEYOND

Who We Are

Where We Come From

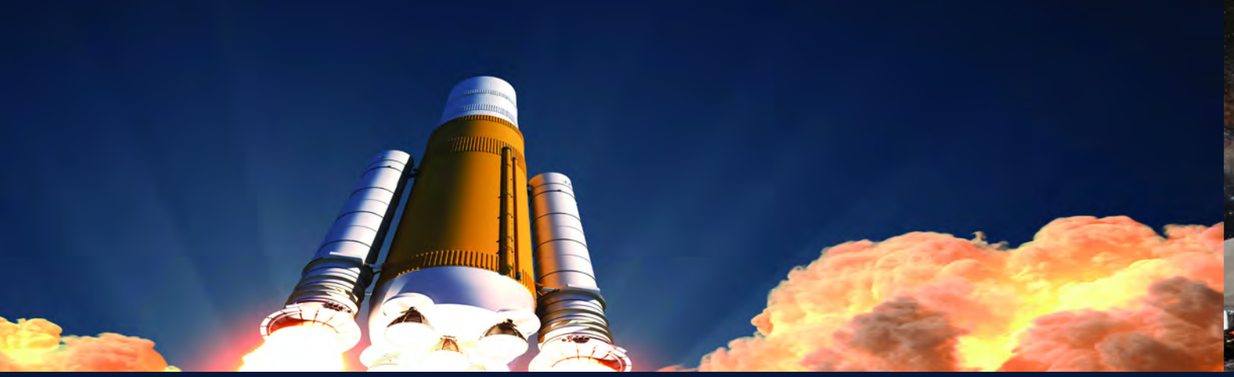
What We Will Become

History Book

SAINT-GOBAIN

TABLE OF CONTENTS

Omniseal Solutions
SAINT-GOBAIN



ORIGINAL FURON & SEALS HISTORY:

The Race To Space

Omniseal Solutions
SAINT-GOBAIN

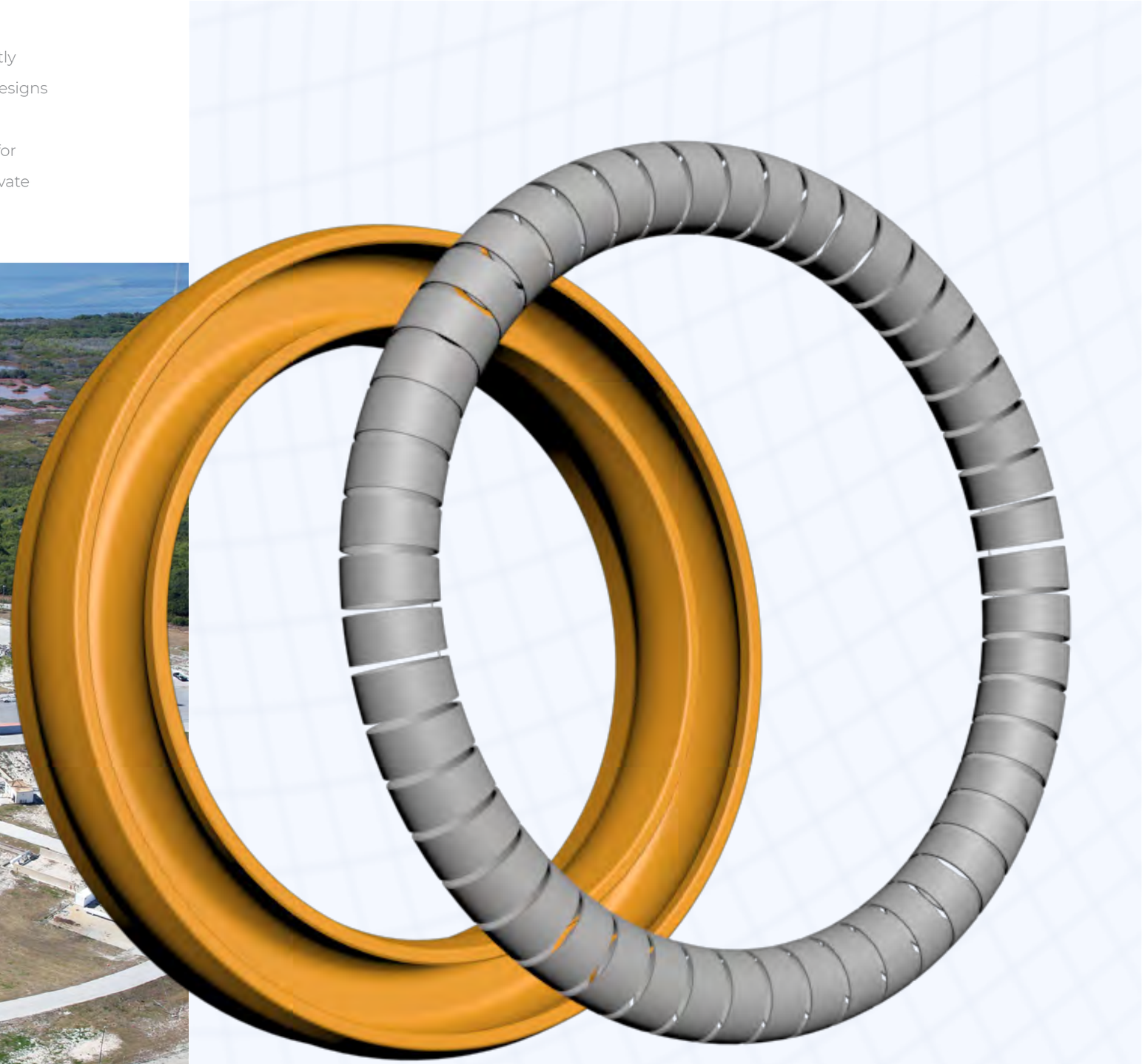
Between 1952 to 1955, the United States began to strongly pursue a variety of liquid-fueled rocket engine programs. It was determined early on that traditional soft seal materials & metal gaskets would not work with the liquid propellants being used in these new rockets.

Extremely low temperature cryogens such as LOX & LH 2 precluded the use of ‘soft’ & ‘hard‘ seal materials as elastomers became as hard as aluminum and metals became brittle, losing their ductility. Another problem inherent with metallic gaskets was the tremendous bolt load required to affect a seal. These high loads meant heavy flanges & numerous large bolts resulting in unacceptable weight penalties. Another obstacle to using conventional seals was their chemical incompatibility with hypergolic propellants such as UDMH, nitrous tetroxide and oxidizers. Some of these propellants could wreak chemically induced damage due to leakage while others such as UDMH created serious and sometimes deadly health problems in vapor form.

This caused major disruptions in the industry, Key space companies such as Aerojet General, North American Rocketdyne, Lockheed & others spent millions of dollars (or lost millions due to contract delays) to solve these seal leakage problems. Most of the manufacturers experimented with or attempted to use PTFE (Teflon) but rejected its use as a sealing material early on due to its propensity to exhibit excessive creep (cold flow), even at room temperature.

Finally, within a year or so of each other, three entrepreneurs from Southern California patented sealing solutions that overcame the rocket propellant sealing problems. Interestingly, they all used similar technical principles to achieve their purpose. Bill Reid of Long Beach, CA, utilized a helically wound, flat wire spring (round wire rolled flat) to energize a ‘U’ shaped PTFE cover/jacket. The spring, when squeezed in arch compression, supplied resilience to an otherwise semi-rigid material and provided the necessary dimensional stability after the PTFE had stabilized in its cold flow mode. The spring also compensated for wear of the PTFE in dynamic applications. Bill called his device “**Omniseal**”. Charles Tanner of Wilmington, CA, patented a similar device which he called a **TEC RING** (TEC = Tanner Engineering Co.). He utilized a slit spring material that he pre-stressed to achieve the required physical characteristics. Mr. Tanner also invented the Quad Ring, a clever improvement over rubber o-rings for reciprocal motion applications. Roy Creath of Santa Monica, CA, patented the **RACO** seal (Roy A. Creath Co. = RACO). Creath took a slightly different approach from Reid & Tanner in that he used a ‘U’ shaped spring and its cantilever beam principle to supply resilience to a ‘U’ shaped cover or jacket. Creath’s design found broader use in cryogenic applications as his comparatively high spring loads did a better job of yielding the RACO, PTFE jacket at very low temperatures. This RACO seal has been used in space missions for over 60 years from the Mercury mission to Space Launch System (SLS) now.

Charles Tanner, Bill Reid and Roy Creath are among the unsung heroes of the space age. All three of these seal products and the firms which made them were purchased by Furon. Furon was later bought by Saint-Gobain and became **Omniseal Solutions™**, which currently manufactures some of the original designs at our Garden Grove, CA, seal facility and has expanded to other facilities for global government agencies and private companies.



Omniseal Solutions
SAINT-GOBAIN

ORIGINAL DIXON & RULON® HISTORY:
The Industrial Ride

Omniseal Solutions
SAINT-GOBAIN

In the late 1800s, textile and cotton mill factories produced an incredible range of new products, ushering in an era of industrialization in the United States and replacing the old artisan and agricultural way of life.

New England, in particular, enjoyed a rapid growth of mill towns where some of the local inventors and engineers gained a reputation for ingenuity that survives today. One of these pioneers was **Ezra Dixon** who came from one of the oldest New England families. Interested in machinery from boyhood, he spent much of his youth around the mills of Spencer, Massachusetts; and almost forty years of his adult life employed in all operations of cotton manufacturing (back-boy, cleaner, frame spinner, mule piecer and doffer). Dixon was **devoted to manufacturing and passionate about solving the problems** which challenged industrial owners. After serving in the Civil War, Dixon ventured to Rhode Island to work in several textile mills, installing spinning frames. These mills used saddles on their machinery, a type of wooden bearing to weigh the top rolls on textile spinning frames.

In 1876, Dixon founded the **Dixon Lubricating Saddle Company in Providence, which was moved to Bristol four years later.** Dixon understood that a more advanced saddle design could significantly enhance productivity, and soon **invented and patented a metal bearing used on machines for spinning cotton yarn**. The bearing became the global standard for this modest but nevertheless critical part. Ironically, Dixon's relentless dedication to improve the performance of a simple mechanical component became the groundwork for the Rulon® fluoropolymer solutions you see today – with the evolution of the Dixon Lubricating Saddle Company into the next century.

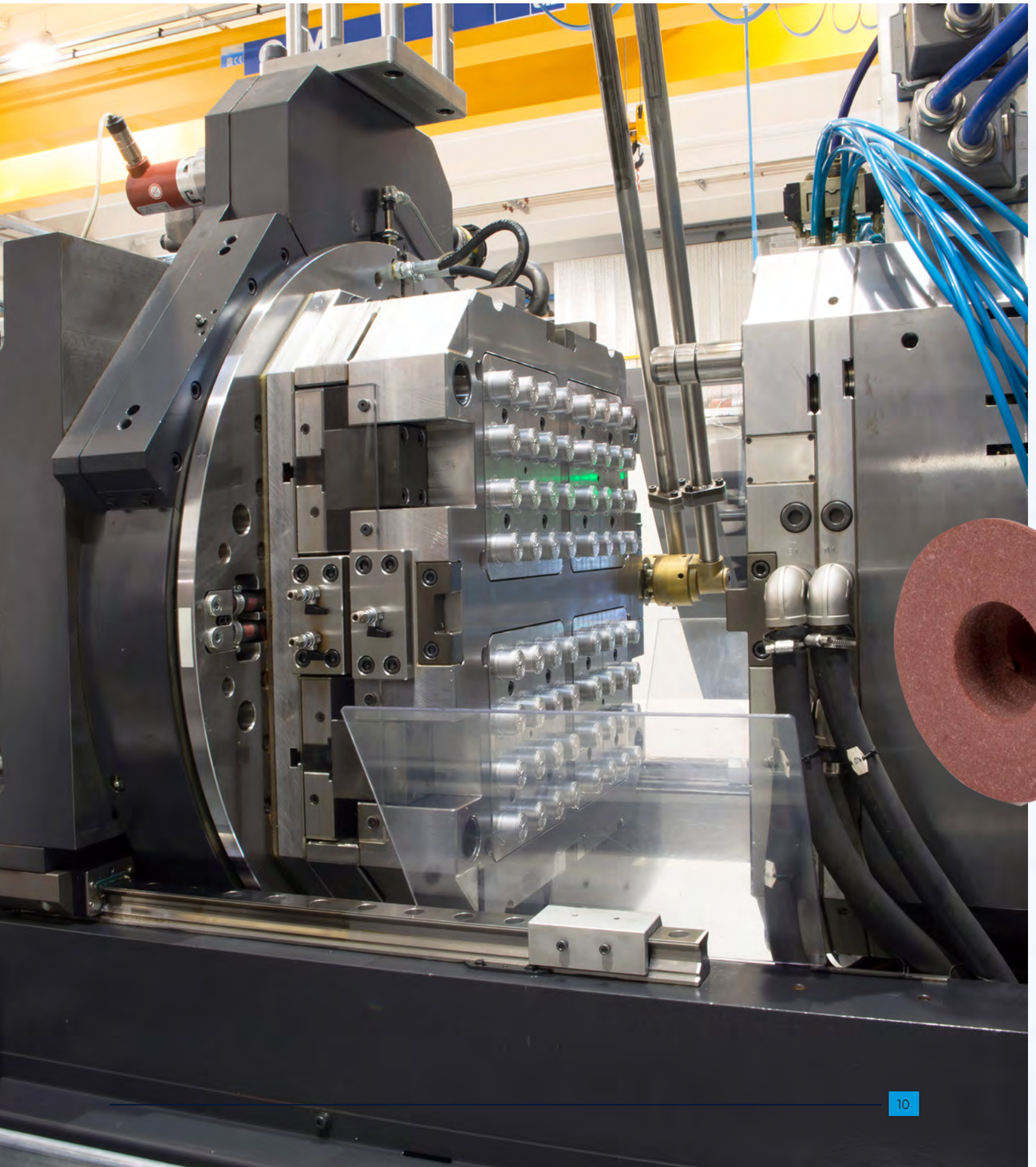
During the late 1940s, **Robert Rulon-Miller** (who married into the Dixon family and was President at Dixon Industries Corp.) was experimenting with a new material, which utilized DuPont® Teflon® (tetrafluoroethylene), for a part in a new plastic saddle design to ensure smoother function and longer wear life. He discovered **a new formula and called it "Rulon."** This material would have the lowest coefficient of friction, be resistant to chemicals, withstand extreme temperatures, and be an important engineering element in numerous applications. In 1957, the solution was officially trademarked as Rulon®. This first type of Rulon® material was dubbed "Rulon A" (which was later replaced by AR).

In the six decades since the Rulon® material came on the scene, first with Dixon Industries Corp., then Furon (who purchased Dixon in 1989), and now presently Omniseal Solutions™, the fluoropolymer solution has been expanded from the original formula to many varied grades, each with unique properties designed to serve a wide range of applications and industries that go beyond its industrial heritage.

The precision components we now create are bearings, rings, tapes, basic shapes,

wear parts and formed parts. The material can be machined, molded, extruded, skived, stamped, and hot and cold formed.

Can you guess how many formulations there are now? The possibilities are endless!



Omniseal Solutions
SAINT-GOBAIN

ORIGINAL DIXON & MELDIN® HISTORY:

A Tale of Two Materials

Omniseal Solutions
SAINT-GOBAIN

In the late 1960s, a material called '**melamine**' was introduced to the market for high temperature applications. A thermoset plastic material, it was previously used in the late 1940s in many factories and dinnerware production. Due to its nostalgic value, the everyday items are considered very collectible today. Your grandmother may still have a piece in her home!

Melanine was actually discovered in 1834 by Justus von Liebig, a German scientist, who first isolated the material as a colorless, crystalline compound. However, there was no practical use for the substance at that time. In the late 1930s, the cost of melamine in its raw form dropped to their lowest, and manufacturers began to consider practical applications for it. Called a "wonder plastic," melamine was virtually unbreakable and dishwasher-safe, withstanding under conditions where brittle Bakelite and water-soluble resins had failed.

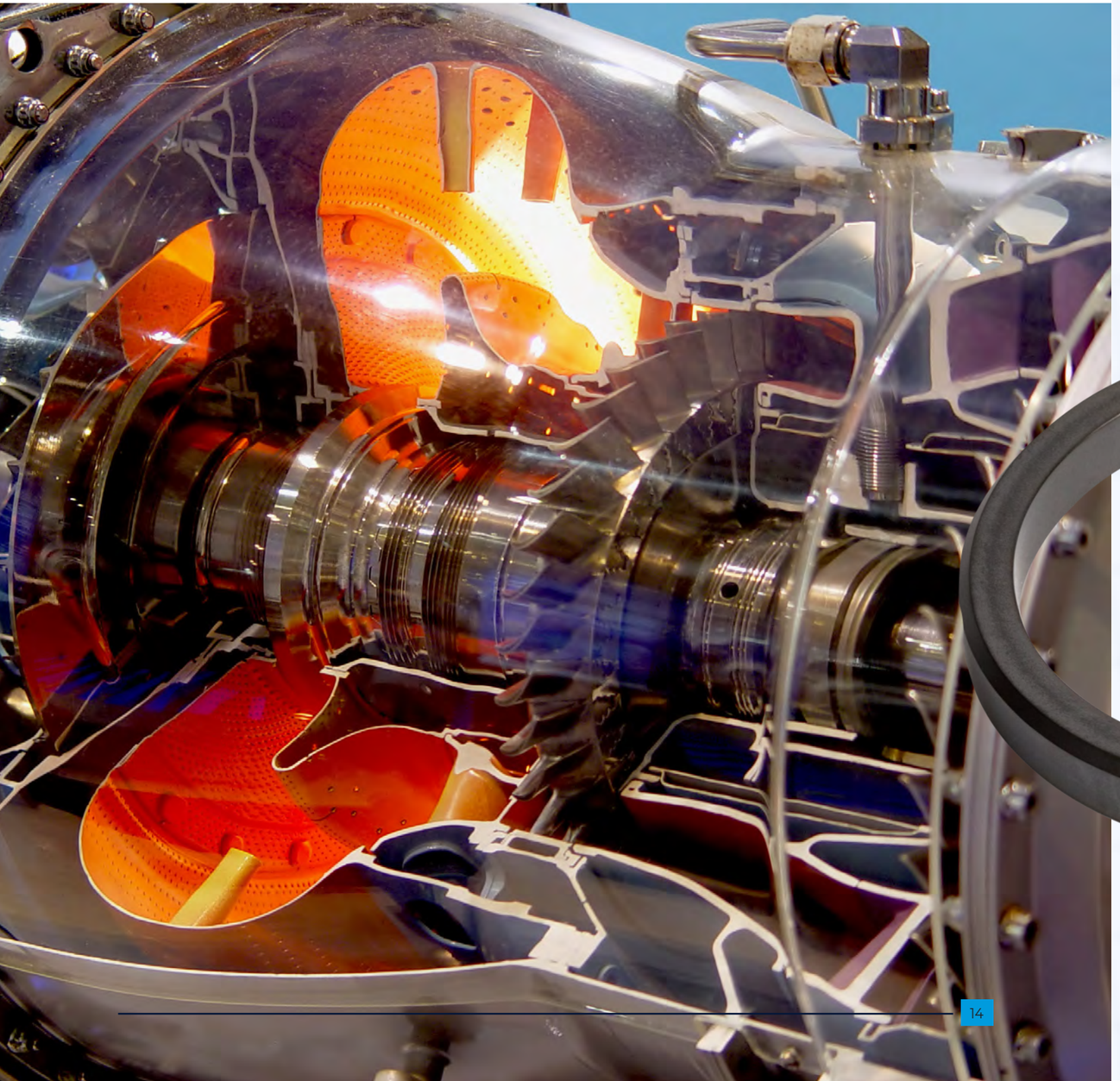
In the early to mid-1970s, Dixon Industries in Bristol, Rhode Island, concentrated their efforts to develop a material that would compete with melamine and be a filler for their patented and widely used Rulon® material (created by Robert Rulon-Miller who was President at Dixon). This led to **Ted Rulon-Miller** creating "Melamine from Dixon," which eventually became an early form of Meldin® thermoset polyimide material. **The "Mel" from the beginning letters of melamine and "din" from part of the letters in Dixon were used to create this Meldin® name**. First came the Meldin® 2000 series followed by the Meldin® 9000 & Meldin® 8100 grades, which were porous polyimide structures.

In 1970, Draper Laboratories collaborated with Dixon on an U.S. Air Force sponsored research project that required a new, porous, non-metallic, single-base ingredient bearing retainer material. Meldin® 9000 material was the resulting porous polyimide. By 1980, it was qualified for additional U.S. military programs due to the material's successful completion of 3,000 hours of life testing at the customer's testing facilities - **a significant technology advantage compared to a life of only 300 hours or less for other traditional materials!**

Passionate about discovering other uses for the material as well as pushing the boundaries of process techniques, Dixon initiated an exploratory project in 1987 that would lead to a commercial porous bearing solution that was more cost-effective but still provide performance superior to the presently employed composites. The Meldin® 8100 material was born out of this relentless dedication. Not only were thermoset polyimides at the forefront of their research and development but also thermoplastic materials. The Meldin® family of thermoplastic products was launched in 1980, starting with the Meldin® 1000 and 5000 series. The Meldin® 4000 series was added in 2014 after the L+S acquisition.

The most popular polyimide solution remains the Meldin® 7000 series, which was developed in the late 1990s and

commercialized in 2001. To this day, the Meldin® solution continues to provide the most complete range of high-performance thermoset polyimide materials and a diverse array of engineered thermoplastic products based on polyphenylene sulfide (PPS), polyetheretherketone (PEEK), and polyamide-imide (PAI). Each series is designed with unique characteristics and has been proven for specialized applications in aerospace, automotive, electronics, and other industries where **high thermal resistance and good mechanical properties at high temperatures are required**.



Omniseal Solutions
SAINT-GOBAIN

ORIGINAL HYCOMP™ HISTORY:

From Man-Made Fibers to Carbon Fibers

Omniseal Solutions
SAINT-GOBAIN

Like a piece of fabric with many threads and man-made fibers that crisscross and touch, Hycomp's story is interwoven into a tapestry of innovative people connecting and adding their own "touches" to build and become a trusted expert of carbon fiber composite and thermoplastic material solutions today.

The first stitch started with **Courtaulds**, a United Kingdom manufacturer of fabric, artificial fibers and chemicals established in 1794. It became the world's leading, man-made fiber production company with a longevity lasting almost a century. In order to focus on fibers and chemicals, Courtaulds joined Dexter in 1986 (based in Cleveland) to create HySol Graphil Composites Components Company - a startup that manufactured finished components using high-performance raw materials for aerospace applications. HySol Graphil's team included several pioneers like **John Thorp and Eugene Gargas, Sr. and Jr.,** who had many years of machining and manufacturing expertise.

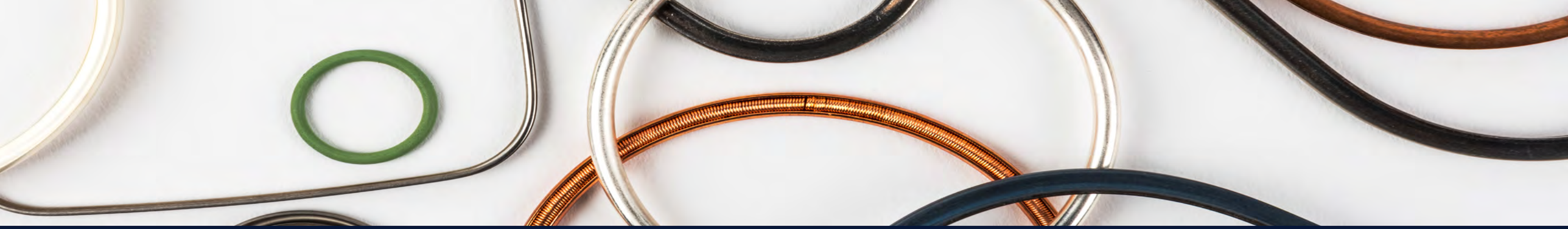
In 1991, John along with Bernie Nowak, Bob Scoular, Don Moyer, Gene Gargas, Joe Reardon, and Leon Zaczek bought Dexter and formed Hycomp™ LLC. This is where HyComp™'s thread of innovation begins as the new owners focused on developing **proprietary, self-lubricating, high-temperature composite materials** for use in general industries and aerospace as well as provide integrated manufacturing capabilities. Passionate about materials, the Hycomp™ team built the business rooted in **five core values: integrity, work ethic, technical expertise, innovation and trust**.

Initial business development focused on domestic aluminum/steel rolling mill and aerospace markets, later shifting globally in the mid-90s when a sales office was opened in Germany to capture new sales in Europe. As international sales grew from new rolling mill construction, SMS became a strategic customer, leading to their interest in acquiring Hycomp™ . When John retired in 2000, SMS bought Hycomp™ and appointed Bob Scoular as President, starting a new pattern toward industrial sales, which grew in the **aluminum beverage and food canning equipment markets**.

Aerospace sales had also grown through the 1990s due to expansion of air travel and material qualifications with GE, Hamilton Sundstrand, Honeywell and Pratt & Whitney that provided opportunities for injection molded thermoplastics. As industrial segments declined in 2008, aerospace sales steadily increased based on the need for lighter and more fuel efficient aircraft. Mark Scoular, who had previously worked as Aerospace product development engineer, joined Hycomp™ sales to grow the aerospace business. In 2014, under the leadership of Gene Gargas as President, the business increased its commitment to aerospace and its future by expanding the facility. In 2016, Mark was appointed GM of Sales & Product Development and with the Hycomp™ leadership team, they focused on developing the next generation of materials business in strategic aerospace applications and new industrial markets.

Instead of man-made fibers from the past, the Hycomp™ team is now forming carbon fibers and thermoplastic solutions that are critical in friction and wear. Let's see what other colorful and inventive connections will be added today and tomorrow.

Omniseal Solutions
SAINT-GOBAIN



ORIGINAL ASE HISTORY:

At The Root & Core of Metal Seal Solutions

Omniseal Solutions
SAINT-GOBAIN

It seems to be a perfect fit that American Seal & Engineering (ASE) has its founding roots in Connecticut, a state with the longest foliage season in New England. What often comes to mind when thinking of fall in New England is the bounty of apples. Apples have been a part of history in many inspiring stories. Legend has it that a young Isaac Newton was sitting under an apple tree when he was hit on the head by a falling apple, a 17th-century “aha moment” that prompted him to suddenly come up with his law of gravity.

ASE has their own inspiring story. The company was incorporated in 1971 in Connecticut and purchased by the Pritchard family in 1991. Their initial products included MS O-rings for aerospace and military markets, which then expanded to high performance metal solutions such as C-rings and spring-energized rings. Their **first patented product was the lip seal** around 2004 followed by their seal support system with National Coupling and the X-seal, and the NCCM coating developed in 2017. Starting with only five team members, the team grew to 20 by 2004 and then quadrupled to 80. What the Pritchard family planted grew from a moderate success to a sales increase when they successfully partnered with a global diesel engine / power generator company followed by two others, where profits increased significantly. The reason for this success was ASE focusing on hiring people who shared a common goal. It was fun and a challenge to grow the “apple” and eventually pass it to another owner to grow even more. This vision originally came from entrepreneurs **Joe Kedves and Jack Pritchard**. Even though the road to cultivate the “apple” was long, it was rewarding for team members to dedicate themselves to a common vision and achieve technology advantages along the way.

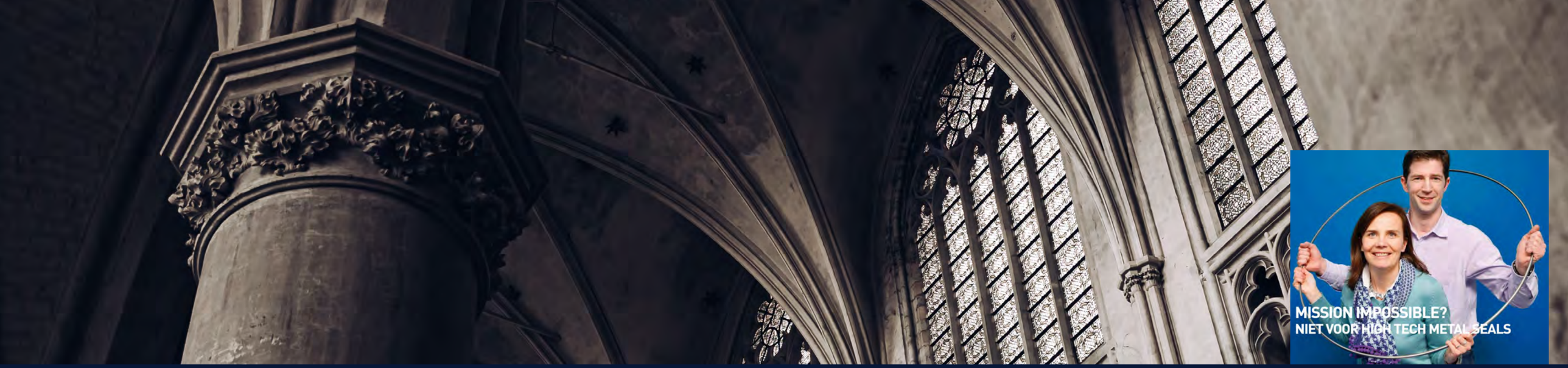
After supporting several diesel and power businesses, a partnership with a subsea oil & gas company was next – a challenge from the view of production and function. Production methods and tooling were upgraded to automotive level production and quality acuity, which competitors did not have. The only obstacle was plating that was solved when it was brought in house for complete control. **This collaborative spirit and relentless dedication convinced the oil & gas company to sign with ASE. The end result is they now have lifetime confidence in ASE to solve all sealing problems.**

One other interesting customer comes to mind in showing ASE’s determination. The difficulty of the program was not the technical side but expectations for the quality system requirements. The deciding factor boiled down to an audit of a PVD vendor where Mark, Garrett and the customer’s auditors took off from Orange, CT, for a 350-mile drive to the vendor in upstate New York. When arriving at the destination, everyone was comfortable with

each other and the result was a signed contract.

The ASE family continues to grow from its strong roots, and some of their cultivated “apples” can be seen in site expansions (European expansion in 2012, automated vision system in 2016, NCCM in 2018) as well as engineering and R&D capabilities (DAS, test rigs, 3D modelling and FEA). They are now planting new roots, working with local technical schools, colleges and universities to inspire new thinkers and professionals who may have an “aha moment” that changes and innovates our future.

Omniseal Solutions
SAINT-GOBAIN



ORIGINAL HTMS HISTORY:

A Mixture of Tradition and Innovation

Omniseal Solutions
SAINT-GOBAIN

A mixture of tradition and innovation go hand in hand at HTMS, short for High Tech Metal Seals – very similar to their place of business at Mechelen, Belgium. Both may be considered a “hidden gem,” with much to offer.

HTMS was founded in 1999 by Liesbeth Schwartz and Ruud Ilegems as a privately-owned company of high quality metal seals. With Liesbeth’s commercial and quality control expertise and Ruud’s know-how in production, the business became successful because they provided solutions that were generally considered impossible … however per Liesbeth, **”Impossible is not in the HTMS dictionary.”**

For over 20 years, they have been designing and **manufacturing elastic and resilient metal sealing solutions for the most demanding applications in numerous industries**. Through this journey, the business invested in its people such as Paul Van den Broeck who was the Managing Director and Dimitri Van den Broeck who managed Engineering and Sales. They say that all things are somehow connected.

One of HTMS’ first customers was Saint-Gobain who, due to a lack of production capacity, decided to buy their metal seals from HTMS. That was a first breakthrough and a collaboration that was meant to be! In 2020, the Mechelen business was acquired by Omniseal Solutions™; they still continue to honor their history and push their technology advantages in the modern day.

Did you know that the people of Mechelen are nicknamed “**Maneblussers**” **(moon-extinguishers)**? The story goes that one night a long time ago, the St. Rumbold’s Cathedral tower was covered by a cloud and glowing from the moonlight. A local person looked up at the tower and thought the tower was on fire. An alarm was raised as the **entire city rushed to try to save the beloved tower**. This moment earned the residents this nickname. A memorable story that is thought of so fondly by the Mechelen people that all sorts of foods and souvenirs are still made in the shape of the crescent moon. This story demonstrates the **rapid response and agility as well as the collaborative**

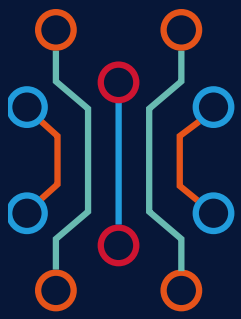
spirit that the HTMS team also shares. Mobilizing their entire team quickly to solve and “extinguish” a problem, they can deliver within two to three days when a solution is urgently required. For example, the company remanufactured a seal one day before their annual holiday period and **directly delivered the seal themselves on Christmas Eve to the CERN facility in Switzerland.** Another success was fabricating seals in just two days ready in time for a F1 race in Barcelona. They were determined **to never give up**!

HTMS’ resilient metal seals are used in a wide variety of applications where normal seals cannot cope with extreme temperature, pressure, or medium. Many precision seals are tailor-made solutions to fit the customer’s application. Available in a range of many shapes, sizes, and materials, each seal is unique as technical parameters such as the amount of spring back, seating stress, sealing surface, sealing load, and leak tightness are considered. Among their metal sealing solutions, the Metal Oysterseal® was created as a result of a bespoken collaboration with a university – focusing development and engineering of new solutions with higher educational institutions. HTMS’ metal seals are utilized by many industries: Industrial (valves, pumps and lasers); Semi-conductor (tin shooters and catchers); Energy / power generation (steam and gas turbines); Oil and gas (high temperature / high-pressure valves, compressors and couplings in upstream); Science and research / fusion (vacuum vessels, reactors, connectors); Aviation (valves, thrusters and cryogenic engines); Nuclear (reactors, pumps and valves, nuclear spent fuel casks); and Space (satellites).

They say that you can **touch the sky** when you get to the top of the St. Rumbold’s Tower as it is 318 feet (97 meters) and more than 500 steps high. You can say that **HTMS is taking this to heart and going beyond the boundaries of possible as part of Omniseal Solutions™**.





Omniseal Solutions

SAINT-GOBAIN