



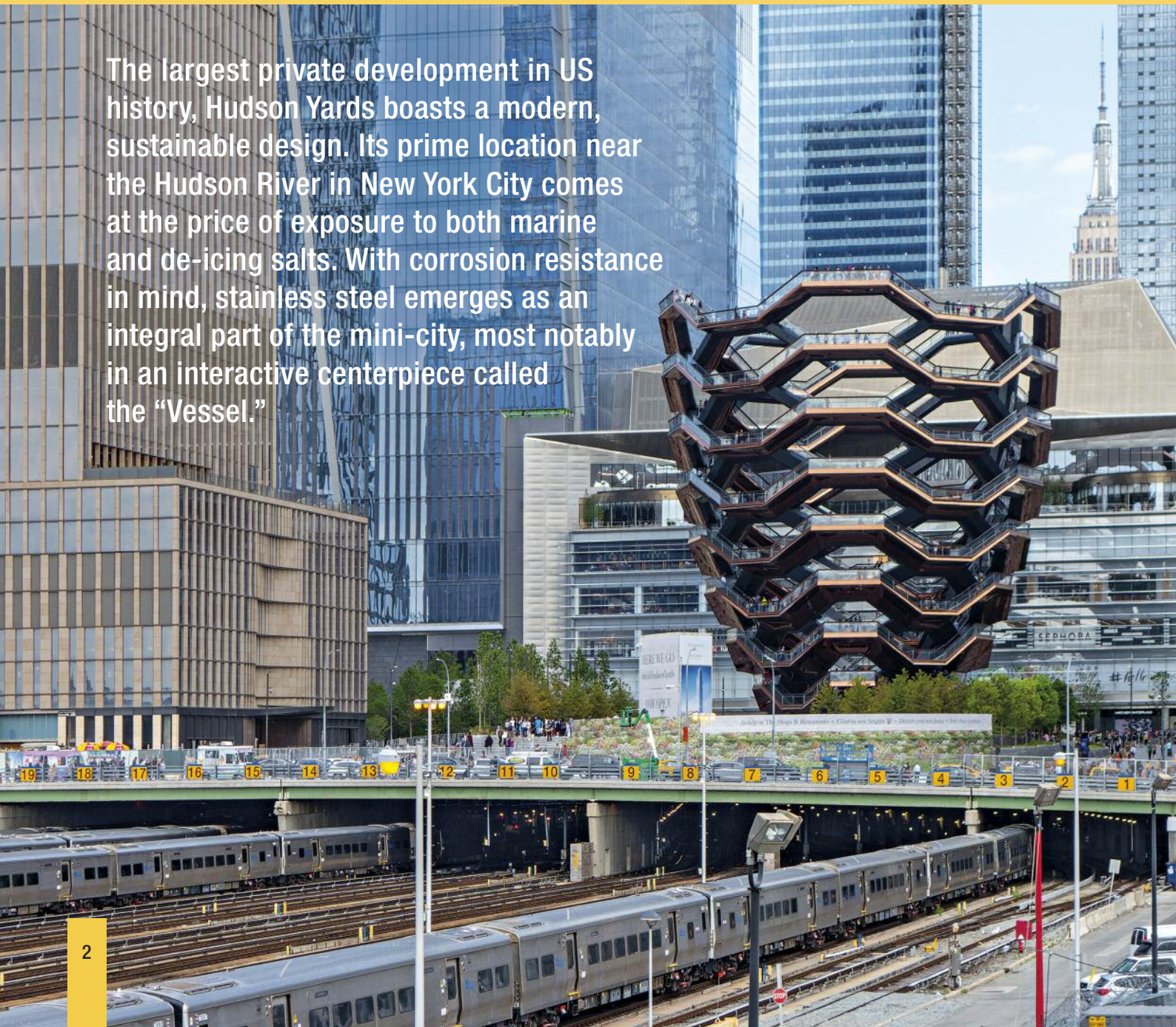
01/2021 MOLY REVIEW

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Hudson Yards: from railyard to riches

The largest private development in US history, Hudson Yards boasts a modern, sustainable design. Its prime location near the Hudson River in New York City comes at the price of exposure to both marine and de-icing salts. With corrosion resistance in mind, stainless steel emerges as an integral part of the mini-city, most notably in an interactive centerpiece called the “Vessel.”



Since its initial groundbreaking in 2012, Hudson Yards has transformed a busy railyard into a chic, multi-functional space. The \$25 billion development will have 2.5 million square meters of commercial, entertainment, educational and residential space upon completion, with over 56,000 square meters of public space and greenery. Some of the buildings and structures in the project boast glimmering surfaces and a clean geometric design. Multiple elements make significant use of Type 316L or 2205 stainless steels. The 2% molybdenum content in Type 316L stainless steel provides heightened corrosion resistance. With 2205 duplex stainless steel, the molybdenum-content rises to 3%, providing even greater resistance to atmospheric corrosion. New York is coastal and uses significant amounts of deicing salts, hence the need for increased protection against aggressive chlorides. The new neighborhood has particularly high deicing salt exposure because the primary wind direction in winter blows deicing salts off the adjoining Henry Hudson Parkway towards the site. The first phase of Hudson Yards, including the Vessel sculpture first opened to the public in 2019.

Building up

To maximize available space in densely developed mid-town Manhattan, part of Hudson Yards spans over an active railyard. Building over the large space with moving trains posed a formidable engineering challenge. To meet this challenge, construction teams built a series of platforms across the yard by driving caissons in between the tracks. Each platform staged the equipment for the construction of the next. In total, 300 caissons were used, allowing trains to run safely under what is now a busy neighborhood. Within the platform itself, storm water from the development is collected and pumped through a layer in the concrete to

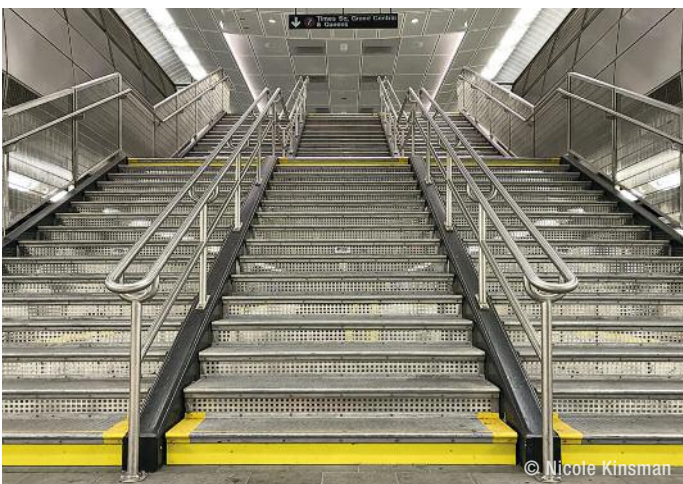
cool it and to irrigate the plant life on the surface. This system keeps the vegetation safe as the heat of the trains running below can reach over 65 degrees Celsius.

Offering all the amenities of a full-sized metropolis, Phase 1 of Hudson Yards is also sustainable, having been awarded a Gold level U.S. Green Building Council (USGBC) LEED Neighborhood Development status. It is the first neighborhood in Manhattan to attain that prestigious certification and all buildings have been rated either LEED Platinum or Gold. When completed in 2025, the development will consist of more than a dozen skyscrapers, a cultural venue, a free school, both conventional and affordable housing, and more than 100 shops and restaurants. It sits at the northern end of the recently completed High Line park, near Hudson River Park, and will include 5.7 hectares of public greenspace. These three new public spaces are the largest increase in parkland in New York City since the creation of Central Park.

A city of stainless steel

The somewhat isolated location of the Javitz Center, New York City's main convention center that adjoins Hudson Yards, inspired the extension of a subway line on the west side of Manhattan. The new 34th Street-Hudson Yards station of the 7 Train is now one of New York's largest, and stainless steel is abundant in its design. The station's impressive glass and structural stainless steel entrance canopy, bollards, turnstiles, handrails, escalator railings and interior lower wall cladding are all made of Type 316L stainless steel. This material was chosen for its aesthetics, for its low maintenance and for its ability to meet the project's 100-year design life requirements.

➤ The 34th Street-Hudson Yards subway station features stainless steel in many forms. From the treads and handrails of the main stairs to architectural features like the cladding of the tunnel on the right, Type 316L stainless steel is omnipresent.





- Soaring 100 stories above West Manhattan, the bottom of the Edge is clad in Type 316L stainless steel and features a thrilling glass floor.



- Massive stainless steel panels clad part of the base of 15 Hudson Yards.

Hudson Yards' first completed tower was 10 Hudson Yards, which was designed by Kohn Pederson Fox (KPF). The tower straddles the High Line and features a soaring atrium and floor-to-ceiling glass in a column-free space. The curtain wall is aluminum with Type 316L stainless steel accent panels. Also designed by KPF, 30 Hudson Yards is both the tallest tower in the development and the fourth-tallest in New York. The façade features the same glass shingles in a saw-tooth pattern that were used on 10 Hudson Yards. 30 Hudson Yards is home to the "Edge", now the second-highest outdoor observation deck in the Western Hemisphere after Toronto's CN Tower. Rising 335 meters above the city, the Edge is clad in Type 316L stainless steel panels with a bright linen finish. From the ground, the triangular deck juts smartly from the side of the tower, which also features Type 316L stainless steel accent panels. Visitors who ascend this observation deck can look through a glass floor to the tiny urban world below. There are even yoga classes on the deck, offering panoramic views of Manhattan on three sides.

Located between the two towers, 20 Hudson Yards is designed by Elkus Manfredi Architects and KPF. The east façade is clad in perforated Type 316L stainless steel panels, which feature a unique pleated design that transitions to flat perforated panels. The 20 Hudson Yards façade facing the Vessel features the West Podium Art Wall, curved glass, designed by artist James Carpenter, on a cable wall system, engineered by sbp. It is one of the world's first cable net walls supporting individually curved glass panels and most of its structure is made from stainless steel.

Across from the Vessel, yet another stainless steel element punctuates the sightline. Where the base of 15 Hudson Yards meets the Shed, a distinctive new performing arts center, Type 316L plate cladding forms a border façade merging the two elements. This massive façade wraps around the back of 15 Hudson Yards like a ribbon. Type 316L stainless steel was used also in the structural frames of the benches throughout the development. With so many applications, stainless steel contributes greatly to a sense of rhythm among the forms at Hudson Yards.

- The Art Wall's design supports stiff glass panels on a flexible horizontal and vertical cable net substructure.



Reflections of New York

Thomas Heatherwick designed Hudson Yards' centerpiece, the Vessel, with the idea to bring people together. Staircases are natural places of meeting and interaction, and so the sculpture draws inspiration from both the famous Spanish Steps in Rome and the intricate stair construction of ancient Indian stepwells. The design team was also inspired by the inward and outward-facing aspects of ancient amphitheaters, which is evident in the side openings and oscillating trajectory of the Vessel's stairways.

The 16-story lattice of the sculpture has 2,456 steps in 154 flights of stairs connected by 80 landings. Together this creates more than 1.6 kilometers of possible interconnecting routes that create opportunities for human interaction. While there is an intriguing inner facing focus, the outward-facing voids in the stair and platform lattice provide kaleidoscopic views of the Manhattan landscape to visitors walking the unique, beehive-like structure.

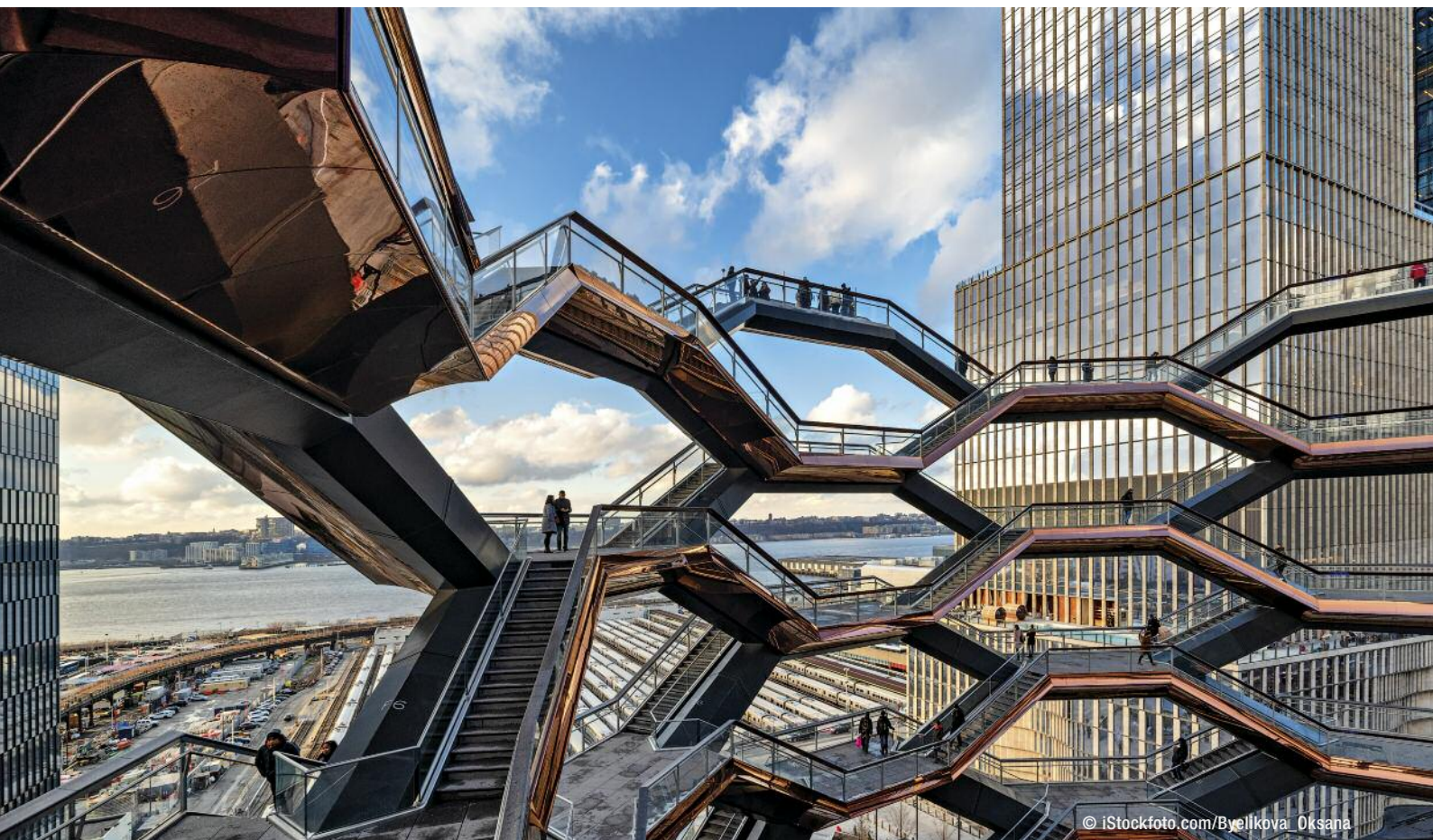
The railing posts that line the Vessel's interconnecting walkways are 2205 duplex stainless steel. These railings provide both safety and subtle lighting for evening visitors.

The high strength of this alloy made the slender hollow posts possible, but the alloy was also selected because stairways have a much higher level of deicing salt exposure than other sections. Guests with limited mobility headed for the top of the sculpture also benefit from stainless steel in an incredible elevator only made possible with amusement park ride technology. Many of its functional and decorative elements are stainless steel.

In contrast with the sharper, geometric architecture of the surrounding buildings, the Vessel boasts a softer, more rounded design, giving the illusion of movement. The mirror-polished Type 316L stainless steel panels that wrap around the floating staircases have a customized multi-layer PVD finish, bringing the rich red-bronze look of traditional sculpture to this contemporary project.

Altogether, the abundance of stainless steel in both the sculpture and throughout Hudson Yards reinforces the materials' durable performance against the challenges of the city's environment. Neither salts from the ocean and de-iced roads, nor tens of thousands of visitors will dull the project's shine. With only half of Hudson Yards completed and open to the public, the story is just beginning. (GC, CH, KW)

➤ The reflective red-bronze colored stainless steel panels create a kaleidoscopic effect on the Vessel.





Flipping the Scripps

The Ellen Browning Scripps Memorial Pier, managed by Scripps Institution of Oceanography, is one of the world's largest research piers. Since its initial construction in 1916, scientific experiments at the pier have furthered understanding of global oceans. Replacing the pier's railings with Type 316L stainless steel posts and cable infill ensures that the research projects can continue safely into the future.

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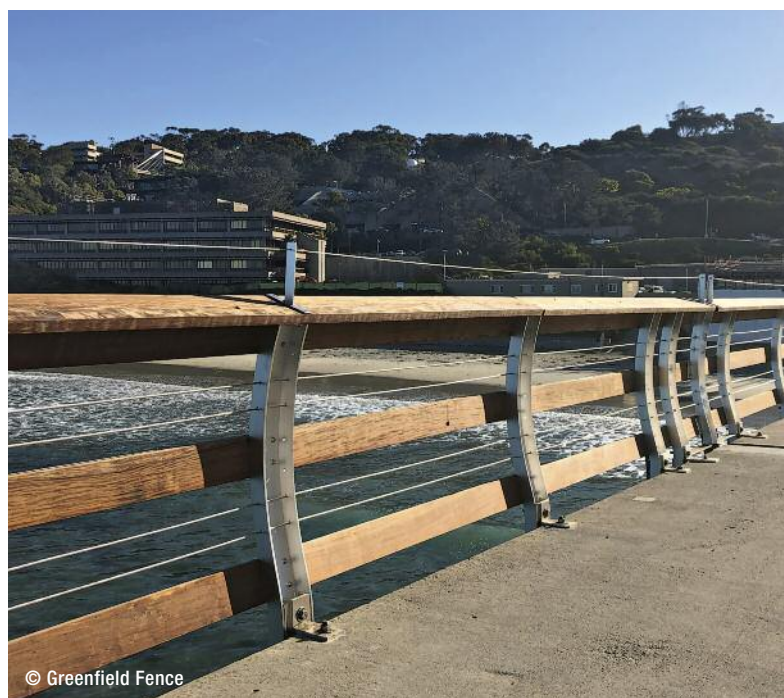
In San Diego, California, there is a classroom where sunglasses and swimwear are encouraged. La Jolla beach might seem like the domain of surfers rather than scholars, but its iconic pier is home to world-class academic research. The University of California at San Diego's Scripps Institute provides around-the-clock data on oceanic conditions, including temperature, salinity, plastic degradation and plankton levels. It also provides over 3.7 million liters of filtered seawater per day to nearby laboratories, aquaria, and other marine institutions. Researchers diligently sample air and water off the pier, sustaining the longest continuous ocean monitoring program in the Pacific Rim. Many of these daily samples are taken by hand, so the pier must remain operational 365 days a year. The pier was upgraded in 2018 with molybdenum-alloyed stainless steel to minimize future maintenance in the highly corrosive seaside environment.

The corrosion of the ocean

Decades of exposure to punishing wind and waves took their toll on the pier. By 1988, it needed a major renovation. That year, the pier's wood planks and railings were replaced with concrete and steel. But after 30 years, the upgrades were beginning to fail, battered day in and day out by the unrelenting Pacific. Several members of the Scripps family donated more than \$2.6 million to replace the railing yet again. This time a more resilient construction material, Type 316L stainless steel, was chosen to withstand the constant exposure to wind, waves and aggressive chlorides. The 2% molybdenum in this grade provides added resistance to atmospheric corrosion in marine environments. The pier remained fully operational during the renovation, allowing the researchers to continue their sampling without interruption.

The stainless steel channels that serve as the pier's new railing posts are laser fused, a process that creates crisp architectural corners. Each of the sleek, slightly curved channels is about 15 centimeters wide and weighs 5.4 kilograms. Stainless Structural supplied over 900 meters of these sharp-cornered channels, weighing more than 17 metric tonnes altogether. The cable infill strung parallel to the horizontal hardwood rails is also Type 316L stainless steel.

The fabricators bent the channels in their shop to the required geometry. The channels, cables and fittings were all electropolished to provide optimal corrosion resistance. Electropolishing removes micro imperfections, that can lead to corrosion, by removing a microscopic surface-layer from the material. Eventually, the posts were installed by bolting them into the pier's existing bolt sleeves. These railings exemplify a growing trend of using structural stainless steel in both renovation and new construction. Not only do the railings look attractive, but they are also built to last in a taxing environment.



➤ Curved stainless steel posts combine with hardwood rails for a nostalgic yet modern look.

Beyond basic science

Some of the research conducted at Scripps underscores the need for more molybdenum-alloyed stainless steels in coastal environments: sea levels, temperatures and humidity are rising, storms are intensifying and oceans are becoming more acidic, all contributing to a more corrosive environment for building materials. The Scripps Institute has collected data on climate change for over 60 years, when researchers there first identified increasing levels of carbon dioxide in the atmosphere over time. While up to one-third of the CO₂ produced by human activity is absorbed by the world's oceans, which is slowing down climate change, this is not without consequence. The changes in water chemistry cause its pH to drop. A more acidic ocean is bad news: it impedes the growth of shells and corals in marine life and may accelerate corrosion of human structures near the coast. Scripps' rigorous sampling contributes to one of the most comprehensive data sets on Pacific Ocean acidification and carbon levels anywhere.

Though the subject of Scripps' research itself was eating away at the pier with a growing fervor, thanks to a significant assist by molybdenum, the structure is now better protected. This type of structural stainless steel application foretells exciting possibilities in durable coastal construction, allowing human activity to continue beside the ocean with improved safety and lessened impact on the environment. (KW)



> Winds of change

How can a building with a roof as thin as paper withstand typhoon force winds? A new airport in Qingdao, China, shows the world how it's done: with molybdenum-alloyed stainless steel. Known for its famous beer, Qingdao is also a major industrial and financial center. With its new infrastructure, the city hopes to attract more air travelers. The star-shaped airport features the world's largest continuously welded stainless steel roof, just 0.5 millimeters thick.



Standing-seam metal roofs, common in large construction projects, are susceptible to failure in adverse weather conditions such as high winds and heavy rain. A technique known as continuous-seam welding takes the resilience of metal roofs to a new level. Qingdao's new Jiaodong International Airport incorporates this flexible welding method on its ferritic stainless steel roof. Upon its inauguration in 2021, the Jiaodong airport will be the largest in Shandong province.

Welcoming in all weather

Qingdao is a major seaport, naval base and industrial center in eastern China. Briefly occupied by Germany at the turn of the 20th century, Qingdao features soaring gothic churches alongside a 2200-year-old preserved ancient town. These antique fixtures mingle with modern architecture, including the new airport. The Jiaodong airport will be one of the most advanced commercial airports in China, twice the size of London's Heathrow. It will serve over 35 million passengers annually, with flights taking off and landing as frequently as every 73 seconds – one of the busiest in the country. The airport features two runways, each 3,600 meters long, and a 450,000 square meter terminal building. It is also designed to capture, store and recycle rainwater for later use.

The new airport replaces the existing Qingdao Liuting International airport. Built in a dense part of the city, the original airport had no room to expand to accommodate a growing number of annual passengers. The Jiaotong airport is further out of the urban core, about 60 kilometers from the city center. However, it is only 25 kilometers from the Yellow Sea and even closer to Xiaocha Bay, exposing it to high levels of corrosive salts. The city also experiences seasonal strong rains, high wind pressure and moderate typhoons. To welcome travelers in all kinds of weather, stainless steel, with its excellent ductility, corrosion-resistance and yield strength, spans the entire roof of the building.

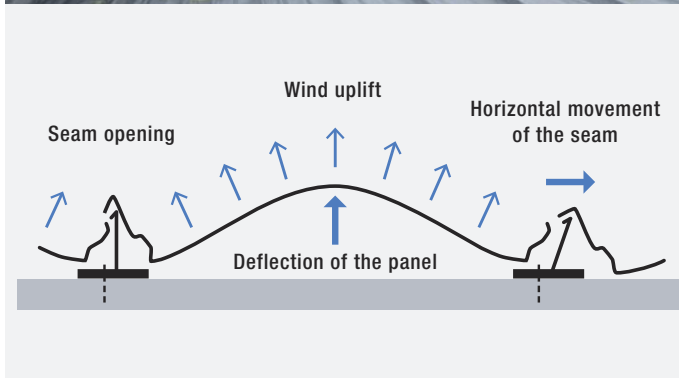
Learning from mistakes

Metal roofs have been preferred for covering large structures, such as airports, stadiums, convention centers, as well as commercial and industrial buildings, for decades. These roofs are light, easily and efficiently assembled, attractive and have low-life cycle costs, making them crucial in large venue construction. Among metal roofs, the “standing-seam” variation, consisting of interlocking metal panels, is most popular. However, because of the need for a minimum slope to allow for efficient rain drainage, this system is not suitable for flat or very low-pitched roofs.

Standing-seam roofing is characterized by roll-forming of coiled metal to form U-shaped panels of the required length, with subsequent joining of the vertical “legs” along their long sides. Depending on the system used, the legs are folded, hemmed, snapped or clipped together. The panels are generally attached to the roof deck with an invisible clip that is fastened to the substructure, without any visible screws punching through the roofing panels.

However, in areas with typhoons and other extreme weather like Qingdao, large roofs can be susceptible to wind uplifts that result in water leakage. The long joints between the panels are particularly vulnerable. These connections work well in most situations, but in a very heavy wind, the lower pressure above the roof panel creates uplift like an airplane wing. The force on the metal sheets causes the joints, that are only mechanically fastened, to loosen, disengage or even pull apart. Such damage often causes leaks or, in extreme cases, the metal cover to rip off. Besides the direct cost of roof repair or replacement, any unscheduled construction at an airport is hugely disruptive. Construction not only causes delays but also ripple effects such as increased traffic and congestion in the

➤ **Strong winds can lead to leakage or even lifting of conventional standing-seam metal roofs, as they are only clipped in place.**



surrounding areas, as well as compromised travel and freight shipment. Fortunately, continuous-seam welded stainless steel roofing provides a solution to both joint damage and roof uplift from wind.

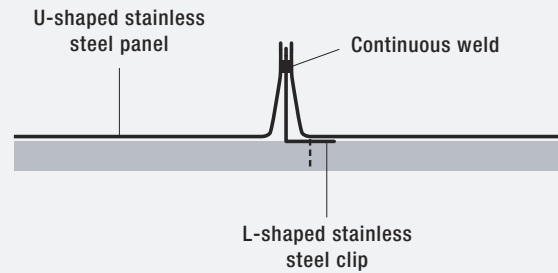
A better solution

The continuous welding method for stainless steel standing-seam roofs originated in Northern Europe in the 1960s. However, the method remained more of a niche technology in Europe. It is utilized primarily for flat metal roofs, where other metal roofing systems cannot be used. An emerging need for corrosion-resistant, wind-resistant and waterproof buildings made this kind of metal roofing increasingly compelling in Japan. Introduced in the 1980s, the continuous-seam welding method is nowadays a well-established technology there, as well as in neighboring South Korea. In Japan and elsewhere, these systems are incorporated formally into the “Steel Roof Construction Standard”. For China, where aluminum and galvalume metal roofs dominate, stainless steel roofing represents a paradigm shift.

Thanks to the strength and corrosion resistance of stainless steel, it is possible to design an exceptionally thin roof covering. Using less material is not only cost-effective but also environmentally responsible. Increased strength and corrosion resistance allow stainless steel to withstand a greater variety of environments. Attractive and clean, it also offers the architect unlimited design possibilities, from the simple to the spectacular. Because it does not require any coating, stainless steel is comparatively low maintenance and saves on operating costs. Without any coating, it is also 100% recyclable, and its reflectivity minimizes solar heat gain, which in turn reduces the need for air conditioning. These features, along with its long service life, make stainless steel a sustainable roofing option.

How it works

With the continuous-seam welding method, metal panels are welded together continuously along their 90° upward bent legs. To keep them from lifting, L-shaped support clips or cleats are fastened into the substructure at regular intervals, their density depending on the expected wind load. Once the U-shaped panels are set in place between the clips, they are tack welded together with a handheld spot welder to keep them from moving during the final welding process. The permanent weld connects the adjoining legs and incorporates the clips. It is applied just below the tack welds, with a self-propelled automatic resistance welding machine or a handheld welding machine at joints and corners. This highly efficient method fully seals the roof skin and dramatically improves the roof's ability to resist wind.



- A fully automatic welding machine joins and seals the stainless steel panels. Clips which are anchored to the roof substructure are simultaneously incorporated into the weld.

The standing-seam weld is easy to access, inspect and repair if necessary, ensuring a perfect seal. To finish the seam, it is either folded over by a crimping machine or a stainless steel cap is installed, protecting the joint while making it both safe and attractive.

Because the stainless steel sheets are only 0.5 mm thick, they can be cut and bent easily with roofing hand tools and welded where necessary to fit custom geometries around skylights, ventilation ducts, roof junctions and others. However, good workmanship involving experienced craftspeople is paramount in ensuring a high quality roof.

corrosion resistant than other standard roofing metals, and even more resistant than Type 316 stainless steel. This translates to both significantly longer service life and lower maintenance costs. Ferritic stainless steels are priced attractively and are popular for roofing because of their higher strength and lower coefficient of thermal expansion compared to austenitic stainless steels. The lower thermal expansion coefficient, similar to that of carbon steel, reduces distortion of the panels as they expand due to solar heating.

Incorporating the method at Jiaodong airport

The continuous-seam welded stainless steel roofing technology makes its debut in China at the new Qingdao Jiaodong Airport. Its location near the sea is highly corrosive and experiences both seasonal torrential rain and typhoon-level wind loads. The China Southwest Architecture Design and Research Institute Co. (CSWADI) in Chengdu and Beijing Qixia Architectural Technology Co. in Beijing conducted comprehensive studies beforehand, to develop the custom solution. They included wind tunnel measurements and a study of corrosion resistance, thermal expansion and mechanical properties. Not only the roofing but also the substructures had to be extensively analyzed and optimized.

In the end, an ultra-pure ferritic stainless steel 445J2 produced by TISCO was chosen, with a thickness of 0.5 mm. This is substantially thinner than most metal sheets used for roof coverings. The U-shaped panels have a width of 400 mm. The 445J2 stainless steel grade contains 2% molybdenum and 21% chromium, making it much more

- With stainless steel roofing systems, connections to skylights, exhausts, gutters or drain pipes can easily be integrated and completely sealed.





© Zhou Yong, Taiyuan Iron and Steel Group Co., Ltd (TISCO)

➤ The vast roof of the new Qingdao airport is expected to withstand typhoons and rain storms for decades to come.

The designers chose a shallow embossed surface finish that reduces reflectivity and glare, important for air traffic safety. The embossing makes for a safer roof by improving slip resistance and rigidizes the panels, making them stronger. The embossing also absorbs some of the thermal expansion and contraction from temperature variations, reducing distortion and “oil canning” of the panels. Oil canning describes a mostly visual effect, which makes flat metal panels look wavy.

The installation of the 220,000 square meters stainless steel airport terminal roof, equivalent to 31 standard soccer fields, was completed at the end of 2019. The roof has already proven its excellent performance, withstanding the torrential rains and typhoon winds that occasionally ravage Qingdao. Since then, the same grade of stainless steel has been used for three other large-scale roofing projects in China, including a convention center in Pintan city, Hunan province, a stadium in Shantou, Guangdong Province and the new Zhanjiang airport scheduled to open in 2022, also

in Guangdong Province. This flourish of continuously-welded stainless steel roofing activity signals increasing acceptance of the material as highly cost-effective roofing.

The unique properties of stainless steel roofs greatly expand the possibilities for design and location of new projects. Unlike traditional standing-seam roofs, continuously-welded stainless steel roofs are completely watertight, making them suitable even for flat, low slope and undulating roofs. Securely anchored to the substructure, these roofs can sustain major storm force winds. When an appropriate molybdenum-containing stainless steel is selected, they also resist corrosion, even in marine environments like Qingdao. The incredible thinness and flexibility achieved with stainless steel roofing enable designs once thought impossible to properly function. For the Jiaodong airport and other roof construction with continuous-seam welded stainless steel, the sky is truly the limit! (GR, MH)

> Swiss Army Knives still cut it

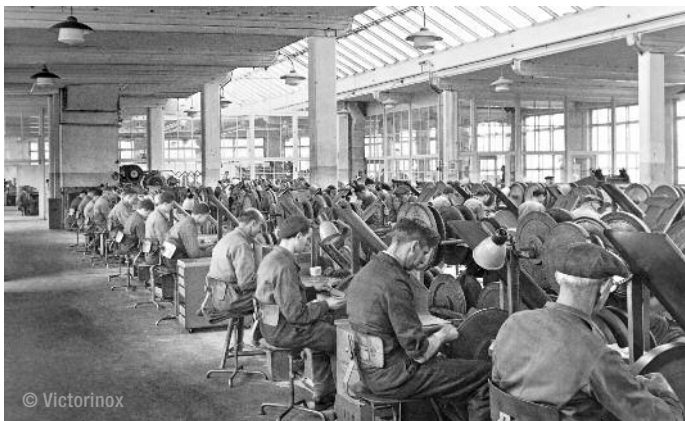
From preparing meals around a campfire in the wilderness to fixing a faulty toaster in a city apartment, the multi-purpose Swiss Army Knife embodies both adventure and reliability in a pinch. With the help of molybdenum, this durable product “still cuts it” and remains popular around the world.



These compact multi-functional tools can scale a fish, strip bark, remove a splinter, start a fire or tighten a screw. With 83 possible uses, depending on the model, Swiss Army Knives can also open a bottle or can, check the temperature, file fingernails, chisel, prune or strip the coating off an electrical wire. With so many applications, this acclaimed pocket knife is still one of the most trusted tools for hobbyists and handymen from Bangkok to Berlin.

The history of a trusted companion

Members of the Swiss military received the first version of the knife complete with a blade, reamer, screwdriver and can opener in 1891. Six years later, the Officer's Knife was introduced, which included the socially-essential bottle popping corkscrew. Building on its military success, the versatile tool became an international phenomenon. In 1945, the knife's popularity spread like wildfire across the Atlantic when US soldiers stationed in Europe during World War II were excited by its functionality and quality.



➤ Batteries of polishing and sharpening machines at the workshop in 1943. Even today, some knives are still assembled and sharpened by hand.

The inventor and world's top producer of this iconic product is Victorinox, the knife manufacturer and watchmaker based in the picturesque Swiss town of Ibach. The humble Swiss Army Knife has come a long way in its 130-year history. Every day some 45,000 are produced in an array of colorful styles and designs, and engineers continually improve their durability and versatility. And it's the molybdenum in the steel blade, among other elements, that keeps the knives operating at the sharp end.

Bracing nature's extremes

The combination of tradition and advanced technology means molybdenum is a vital component in the manufacture



➤ This pocket knife features a fork, suitable to spear bread for the good old Swiss standby, Fondue – and a corkscrew, to open an accompanying bottle of wine.

of the knife. The EN 1.4110 martensitic stainless steel used for the blades contains 0.5% to 0.8% molybdenum, which make it wear and corrosion resistant, enabling the knives to maintain a sharp edge. These are key features for such a dependable product, where regular use is possible even in the most challenging of environments. Swiss Army Knives' proven utility in cities, oceans, mountains and even in outer space, is a testament to their enduring appeal.

In 1978, NASA purchased 50 pieces of the *Master Craftsman* model for use aboard the Space Shuttle *Enterprise*. As anyone who has opened a toolbox in zero gravity will understand, chasing tools as they float around the space lab is not a great way to make necessary repairs. The all-in-one nature of the pocket knife consolidated most of the tools into a hand-held device – problem solved. In fact, during the 1980s, the Master Craftsman was renamed the "Astronaut" knife for its storied use in space. Extraordinary performance of the knives is found closer to home as well. During a recent trip to Egypt for a TV documentary, Sir Ranulph Fiennes, a world-renowned explorer, tutored his younger cousin, Joseph Fiennes, on defusing an anti-tank mine with the trusty knife. It is little surprise that such a compact, sturdy design finds use in the most extreme of environments.

However, the Swiss Army Knife is not just at home in intense situations. It can also be found in the New York Museum of Modern Art, the MOMA, which recognized its seminal design in 1977.

A cutting-edge process

While the pocket knife is certainly its most famous product, the company is also renowned for its household and professional knives. In total, over 135,000 knives are made each day at its Swiss factory. The firm designed and built many of the machines used in the manufacturing process



- Knife blades are stamped out of a strip of stainless steel, leaving behind scrap to be recycled (left). The raw stainless steel edges are smoothed by tumbling in a deburring machine, filled with abrasive ceramic media (middle). Each blade is heat treated to make it hard yet tough (right). © Victorinox

in-house to guarantee the quality of the more than 600 types of knives it produces, including 400 types of pocket knives. Molybdenum also plays an important role as an integral part of the manufacturing process. Each knife blade is stamped from a strip of stainless steel. The tools required for the stamping process need to be hard, tough, and long-lasting. The tool steels used for these stamping tools contain up to 4.5% molybdenum to ensure that each knife is cut as precisely as the one before.

Once the raw blade is stamped out of the stainless steel strip, it is ground to its final wedge shape and precisely sharpened. These stamping and grinding processes inevitably produce a lot of “waste” material. However, nearly 100% of it is reclaimed for recycling. The solid cutoffs are easy to collect, but the fine grinding dust is more elusive. To capture it, a custom machine separates the ground stainless steel particles from the cooling liquid used during the grinding and polishing processes. It then compresses the collected particles into pellets, which are returned to the steel producer to be recycled into new stainless steel. Of the 2,400 tonnes of steel purchased each year, nearly



- Small-series and custom pocket knives are still assembled by hand. Large-series knives use a fully automated process.

- Even grinding dust is captured and compacted into pellets, convenient for recycling at the steel mill.



1,200 tonnes go into the actual knife blades and other finished products, with the remaining 600 tonnes of cutoffs and 600 tonnes of particles being recycled. Constant improvements of the production, recapturing and reuse of waste streams ensure the high-quality knives are manufactured efficiently and sustainably.

Compact and stylish, with a wide range of features, the Swiss Army Knife is appealing to users everywhere – city dwellers, farmers, intrepid travelers or groundbreaking pioneers. Molybdenum-alloying improves both the manufacture and the performance of this quintessential tool. (ST)



Tapping into stainless steel



Italian design has always been synonymous with style and luxury, with a flair for making the functional beautiful.

Whether Vespa or Ferrari, Benetton or Gucci, furniture or eyewear, Italian style imbues a touch of *bellezza* to all facets of life. Italian bathrooms and kitchens are no different. Sleek, multi-containing stainless steel fittings also contribute to the tradition of combining utility with elegance and glamour.

In a world where the COVID-19 global pandemic has intensified the focus on hygiene, many are spending more time than ever washing their hands. This mundane task, and the humble faucet that enables it, has never been more important. Italian designers increasingly have embraced designing faucets with stainless steel, not only for its unique beauty but also for its innate hygienic properties. The non-porous surface of stainless steel makes it more difficult for bacteria, germs and other deposits to attach and accumulate. Such a smooth surface is also easier to clean, making it a safer and more hygienic choice in both the kitchen and the bathroom. As the world adapts to reduce and prevent the spread of pathogens, it is no wonder these attractive, practical faucets are increasingly popular.

A revolution in the making

Today, most faucet bodies are made from brass. An alloy of copper and zinc, brass's resistance to soft-water corrosion and hard-water calcification makes it a highly popular choice. Brass faucet bodies are generally produced through machining, although some manufacturers use die-casting. Once created, they are usually chrome or nickel-plated.

Using brass to make the faucet body is cost-effective, however, there are drawbacks. The plated finishes required to give brass a clean, modern look wear off over time, slowly exposing the different color of the base material. This unsightly wear often results in a shorter service life compared to more durable materials.

In addition to durability issues, the use of brass faucets raises some health concerns – particularly when used for drinking water. Often, a small amount of lead is added to the brass alloy to improve the casting and machining processes. However, when in contact with water, brass and other lead-containing alloys can release very small amounts of lead into the water and the environment. Although strict regulation drastically reduced the amount of lead allowed in fixtures, in some jurisdictions to less than 0.25% in “lead-free” brass, environmentally and socially conscious companies in Italy are avoiding it altogether. They are turning to molybdenum-containing Type 316 stainless steel to solve these issues while creating beautiful yet functional designs.

A low-maintenance beauty

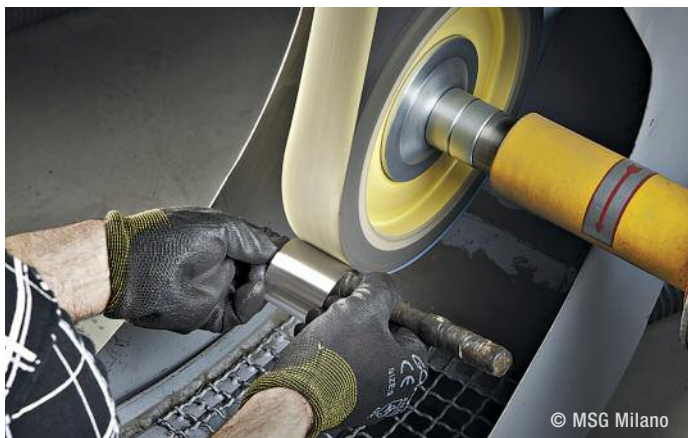
Until recently, stainless steel was predominantly used for industrial valves. More expensive than brass and harder to form and machine, use for kitchen and bathroom fittings was rare. Yet, since the late 1990s more and more Italian manufacturers are using stainless steel for everyday water fixtures. While Type 304 stainless steel is used in much



➤ Outdoor showers in Type 316 stainless steel are resistant to tea staining not only in the desert but also near the sea.

of the mass market, a number of high-end companies have chosen to use Type 316 stainless steel exclusively, or nearly exclusively, for functional, aesthetic and ethical reasons. The first model using Type 316 stainless steel in Italy was created in 1997, and other producers followed suit. Interestingly, many of them advertise their products with “316” in the article or model name, to emphasize high quality.

Type 316 is a more corrosion resistant grade of stainless steel, typically containing 2% or even 2.5% molybdenum. The addition of molybdenum makes the steel extraordinarily resistant to corrosion without additional treatment, even when used in harsh marine environments or for drinking water containing relatively high amounts of chlorides. High corrosion resistance under these conditions makes it well-suited for domestic faucets and shower fittings as well as outdoor spa, shower and pool fittings. Type 316 is not only more durable than Type 304 stainless steel, but it is also more resistant to harsh cleaning agents. If not properly rinsed, Type 304 can stain when cleaned with an aggressive product, while Type 316's superior corrosion resistance avoids many of these problems. For hospitality settings like hotels, where the same powerful detergents used to wash floors and sinks and tubs are often used in the daily cleaning of fittings, this is a significant advantage.



- Hand polishing is a step in the production of this stainless steel fitting.

Stainless steel fittings create an elegant accent in any bathroom thanks to the different surface finishes available. They include mirror, brushed and satin finishes and even a range of colors. The basic finishes are obtained through polishing of solid stainless steel, unlike the plating added on top of the surfaces of brass faucet bodies. Polished stainless steel is extremely scratch-resistant, and if scratching ever occurs, it can be polished out. Considering the average family uses a faucet 70 times a day, durable materials help maintain the beauty and the value of a bathroom renovation. The long-lasting performance of Type 316 and its low carbon cousin, Type 316L, means less frequent replacement, essentially offsetting the higher initial cost of the material.

- Type 316 stainless steel faucets are available in different finishes and even different colors.



- A stainless steel tap is made of solid metal. The smooth finish on the inside reduces the formation of biofilms and adherence of pathogens.

Responsible elegance

Product quality and excellence aside, socially responsible consumers and manufacturers have additional reasons for a growing interest in molybdenum-containing stainless steel faucets and bathroom fittings. Made completely of stainless steel, these fittings are 100% recyclable. Thanks to its high intrinsic value and its predominantly industrial applications, Type 316 stainless steel has an especially high end-of-life recycling rate. It is probably one of the most recycled materials in the world. Additionally, according to a Yale University study (2015), the average recycled content of new stainless steel was 44% globally, but in the USA and Europe, the recycled content of new stainless steel is 70% or more. It is noteworthy that global demand for stainless steel outpaces the amount of scrap available for recycling. Therefore, virgin material is used to a greater extent in more recently industrialized countries, that do not yet have as much older stainless steel in service.

Then there are the health benefits. In addition to inhibiting bacterial growth, Type 316 stainless steel is also 100% lead-free. This mitigates toxicity concerns and simplifies compliance with rigorous Health and Safety requirements around lead content, such as NSF61 Annex G, and the low lead requirements of the U.S. Safe Drinking Water Act. The high corrosion resistance of molybdenum-containing stainless steel also means it does not release any other harmful components into the drinking water.

Kitchen and bathroom fittings made of sanitary and sustainable materials are becoming more sought after globally, as consumers demand safer, greener and more durable, yet stylish water fixtures. Italian manufacturers were among the first to set these trends. And by using molybdenum-containing stainless steel, they have found the perfect way to continue the age-old Italian tradition of making the functional beautiful. (ST)

IMOA news

Continued progress during global pandemic

Last September, IMOA held its first-ever virtual AGM. The successful event offered members the opportunity to hear two experts speak about the molybdenum market. Markus Moll from Steel Market Research (SMR) summarized the demand side dynamics of the molybdenum markets in 2019 and provided an updated 10-year forecast. Jim Lennon, from Red Door Research, reviewed the short and medium-term outlook for molybdenum supply and demand considering the COVID-19 pandemic and resulting economic uncertainty.

Speaking after IMOA's 32nd AGM, Tim Outteridge, IMOA's Secretary General, said: "2020 will be remembered as the year when the coronavirus swept the globe. Like other industries the molybdenum industry has had to respond and adapt to the health, social and economic challenges of a world impacted by COVID-19. Against this backdrop I am pleased to report that IMOA has continued to advance its Market Development, HSE and other programs with many notable successes."



Webinar announcement in China.

Over the last year, IMOA's peer-reviewed datasets informed policymaking across the globe. Tim commented "these developments continue to highlight the importance of our work in providing robust science to help inform regulatory decisions."

IMOA's market development programs that demonstrate the value of molybdenum in our modern world remain as important as ever. Tim explained that "education is a cornerstone of IMOA's market development work. This year alone, despite the pandemic, we have succeeded together with the Nickel Institute in delivering an extensive program of educational workshops and webinars to around 2,500 engineers, architects and specifiers. Outcomes of IMOA research projects have also triggered the development of new advanced flat steels as well as production trials of high-strength 'super-HSLA' steels and modified cast iron. In time, these developments will result in lighter, safer and cleaner vehicles."

Further information is available in the IMOA Annual Review. The Association looks forward to welcoming members in person to the AGM in Geneva, September 8–9, 2021, should the pandemic situation allow.

Practical Guidelines for the Fabrication of Austenitic Stainless Steels reissued

One of the most frequently downloaded IMOA brochures, *Practical Guidelines for the Fabrication of High Performance Austenitic Stainless Steels*, has been updated and renamed *Practical Guidelines for the Fabrication of Austenitic Stainless Steels*, to better reflect its broader content. It is now available for download from the IMOA website.

The publication provides information on the properties, performance and fabrication of the whole range of austenitic stainless steels, from the standard grades all the way up to the High Performance Austenitic Stainless Steels (HPASS). HPASS are highly corrosion resistant and obtain their improved performance through alloying with higher amounts of molybdenum, chromium, nickel and nitrogen. More complex in their metallurgy than standard stainless steels, engineers and fabricators need a thorough knowledge of

their characteristics in order to specify and fabricate HPASS successfully, so they perform well in the field.

Stainless steels were introduced at the beginning of the twentieth century, with modern era stainless steels developed in the 1970s. The increasing need for cost-effective, high-performance alloys in chemical processing, as well as in emerging environmental and energy sectors, pushed suppliers over time to develop new HPASS grades with the required corrosion performance. Continued innovation and development led to a range of stainless steels with ever greater corrosion resistance, combined with good fabrication properties, which are now commercially available.

The updated brochure includes information on all recent developments and offers detailed information on the metallurgy of the full range of austenitic stainless steels, as well as the mechanical and physical properties of these sustainable materials. It offers clear and practical guidelines on cutting, machining, joining and finishing to ensure fabricators produce high quality installations and equipment, and engineers have the information to effectively use these materials. The brochure is co-produced with the Nickel Institute and the International Chromium Development Association.



➤ The brochure is available to download in both English and Chinese.

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