

BOLTED

THE MAKING OF BOLTS

FROM RAW STEEL
TO TAILOR-MADE APPLICATIONS

HIGH FLYERS
UNMANNED
HELICOPTERS
TO THE RESCUE

SUPERSONIC
FAST-TRACKING
TOMORROW'S
TRANSPORTS

DOWN UNDER
DIVERS FIX
CRITICAL
ASSEMBLY

GREASED UP
THE BASICS
OF PROPER
LUBRICATION

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Bolted magazine is published by the Nord-Lock Group and strives to increase knowledge about bolt assemblies. The Nord-Lock Group is a world leader in bolting technologies and offers a wide product portfolio, including Nord-Lock wedge-locking solutions, Superbolt tensioners, Boltight hydraulic tensioning and Expander System. For further information visit www.nord-lock.com

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NORD-LOCK
GROUP

How it all comes together

Many industrial companies are producing videos to show what they do and how they do it. I myself follow several forums where there are great videos explaining new mechanical designs and interesting technical solutions.

Recently, I came across a video showing how offshore wind turbines, with rotor blades bigger than a double-decker bus, are assembled and ready to produce electricity for thousands of households in just one day! All fasteners are pre-assembled for faster installation and minimal maintenance at site, of course.

At Nord-Lock Group, we are increasingly focusing on videos and digitalization in order to spread our knowledge and make life easier for our customers – our YouTube channel is one good example. Another exciting new thing is the 'Torquelator', which is a torque calculator app for when you use Nord-Lock washers. Just enter your fastener information, lubricant and the calculating method, and you'll have our recommended torque value on the spot. You can

read more about the app, and install it easily, on torquelator.nord-lock.com.

Speaking of exciting, in this issue of *Bolted*, Filemon Schöffner talks about 3D printing (aka additive manufacturing). What is the real potential of this technology, and what can manufacturing industries learn from it?

We also take a closer look at what goes into the manufacturing process of traditional bolts. After all, the most amazing mechanical engineering designs come together so nicely thanks to... well, you guessed it, bolted joints.

Thank you for reading!


CARIN LAGERSTEDT
MARKETING MANAGER



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Easily overlooked, bolts can make or break a joint. And producing high quality bolts is a more complex task than you might think.

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Using divers to assemble propeller caps underwater saves time and potentially lots of money.

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WORDS: ISABELLE KLIGER PHOTO: CYBAERO

MISSION POSSIBLE

CUSTOMER: CYBAERO AB, SWEDEN	ESTABLISHED: 2003	PROJECT: APID ONE, UNMANNED HELICOPTER FOR MILITARY AND CIVILIAN USE
APPLICATION: REMOETLY PILOATED AIRCRAFT SYSTEMS	NORD-LOCK PRODUCTS: NORD-LOCK WASHERS FOR M3 TO M12	

PRODUCED TO OPERATE in some of the world's most challenging environments, Swedish company CybAero's state-of-the-art, unmanned APID One helicopters can easily be adapted to the unique needs of its clients.

The concept is based on four main components: the helicopter platform, payload, data link, and ground station. The helicopter can be fitted with various sensors, and the design makes it easy to quickly change the sensor system. Sensors include video cameras, loudspeakers, floodlights, infrared cameras, electro-optical cameras as

well as light detection and ranging/synthetic aperture radar.

This modularity makes these UAVs (unmanned aerial vehicles) suitable for a variety of applications, such as inspecting power lines, carrying out search and rescue efforts where time is of the essence, as well as border-control missions.

These are the kinds of application where you can't afford to take any safety shortcuts. To ensure that critical flight missions go off without a hitch, CybAero relies on the wedge-locking technology from Nord-Lock Group.

Since 2009, Nord-Lock Group has

supplied wedge-locking washers for the tail boom, exhaust system and main rotor hub on the APID One helicopter. These are applications where parts suffer high exposure to vibration, heat and extreme forces, which are known to be the main causes of locks and bolts coming loose.

"We chose Nord-Lock's technology due to its unique vibration-proof characteristics," explains CybAero's CEO, Mikael Smith. "A robust bolted joint results in less wear and tear, which, in turn, extends service life and reduces the likelihood of faults and failure, as well as the need for maintenance." ■

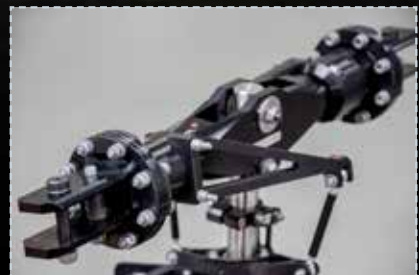




EASY HANDLING

Targeting time-critical applications, often in inaccessible areas, easy handling is an essential feature of the unmanned APID One helicopter. The canopies, airframes and avionics have been designed for simple packaging and transport, but also for simple maintenance and service.

Using Nord-Lock products, CybAero extended the service life even more, reduced the likelihood of faults and failure as well as the need of maintenance. To the right is a rotor head, secured by Nord-Lock washers.



TRAINING TOP GUNS

CUSTOMER: AMST-SYSTEMTECHNIK GMBH, AUSTRIA	APPLICATION: HUMAN TRAINING CENTRIFUGE (HTC)	ARM LENGTH: 8 M	ACCELERATION: UP TO 15 G	SPEED: 42 RPM
NORD-LOCK PRODUCTS: SUPERBOLT TENSIONERS; SUPERBOLT EZFIT EXPANSION BOLTS AND NORD-LOCK WASHERS				

MODERN FIGHTER JETS are so powerful that standard manoeuvres push the pilots down in their seats with up to 9 g – nine times the force of gravity. This would cause unconsciousness if pilots didn't wear special suits and performed high-G training.

For this training, the world's top air forces turn to simulation expert AMST. The company recreates every aspect of the cockpit, training pilots for the most dangerous situations, such

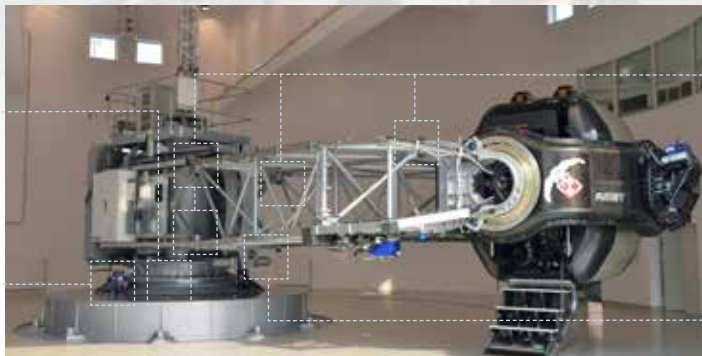
as spatial disorientation, g-force induced loss of consciousness (G-LOC) and hypoxia.

A few months ago, AMST installed its most sophisticated simulator ever, a 20-ton human training centrifuge (HTC), and one of few simulators worldwide able to produce 15 g – close to the human limit.

These are all extreme machines, built with a 30-year lifespan. During that time, regular service requires bolted joints to be loosened.

Previously, this always led to damage, and the use of specialised and expensive tools. For nearly 10 years AMST has only installed Superbolt tensioners and expansion bolts where bolted joints are exposed to the flux of force. These give excellent vibration resistance during the simulations and allow important adjustments without harming the constructions. ■

LINDA KARLSSON



Nord-Lock Group provided Superbolt tensioners, Superbolt Expansion bolts and Nord-Lock washers for the human training centrifuge.

FINDING AN ELEVATED SOLUTION

CUSTOMER: ALL ENERGY MANAGEMENT LLC	INDUSTRY: WIND ENERGY	LOCATION: WISCONSIN, USA
APPLICATION: 1,000 WIND TURBINES	PRODUCT/SOLUTION: OVERSIZED SLEEVES FROM EXPANDER	

NEARLY TWO YEARS AGO, US company All Energy Management (AEM) began developing retrofits and training companies that service a fleet of 1,000 wind turbines in the UK, the US, Canada and Italy. When embarking on repair work, it was found that the pins attaching the turbine blades to the rotor were wearing prematurely, along with the rotor holes. Line boring and welding when up on the turbine tower was not possible due to weight and space constraints. The only solution was to replace the rotor and pins, which took roughly 10 working days and cost USD 15,000.

Subsequently, AEM began discussions with Expander about developing a solution that would increase speed, improve efficiency and maintenance safety, and ultimately reduce costs. AEM developed a system to bore the holes out before

installing the pins to ensure a reliable connection.

Sets of three pivot pins and three different oversized sleeve options were supplied by Expander, which fitted perfectly into the holes depending on the degree of wear. Fewer parts meant faster and simpler installation, while the Expander System also provided a perfect fit into the borehole, eliminating further movement causing wear.

AEM has now been using the solution for over a year and is delighted with the results. "Instead of taking three days with four workers onsite to repair a turbine, it now takes us less than a day with only two workers required," says Ian Slegler, Operations Manager. "The guys at Expander are really accommodating and the solution has freed us up to concentrate on other matters." ■

ALASTAIR MACDUFF





ZOUHAIR CHAIB
SENIOR TECHNICAL EXPERT



SONNY HALBERG
APPLICATION ENGINEER

Email your questions about bolting technologies to experts@nord-lock.com



ASK THE EXPERTS

Do you have a question about bolting technologies? Put the Nord-Lock Group experts to the test.

Running smoothly

Q: What are the key factors when choosing lubrication?

A: There are a lot of different lubricants to choose from, and they have different properties, serving different purposes. This can potentially make choosing the right lubrication for your bolted application very difficult.

When working with bolted joints and lubrication, the most important consideration is that it should provide a uniform result. Experience has shown that a paste lubricant gives a much more uniform result than an oil-like lubricant.

BELOW ARE SOME KEY FACTORS that you should consider when choosing a lubricant:

- High temperatures.
 - The materials you are working with.
 - If specific certification is required, such as in the food industry or in a nuclear power plant.
 - The need to be waterproof.
 - The need to have a sealing effect.
- Before choosing a lubricant, consult an



expert who can guide you to the most suitable lubricant. That could be your local dealer, or a lubricant manufacturer.

To ensure that the right preload is achieved, a torque-tension test can be conducted to

determine the correct tightening torque for your application.

Follow Nord-Lock Group on social media, or look for more lubrication tips in upcoming issues of Bolted. **SH**

All stressed out

Q: Are there any hidden dangers of torsion?

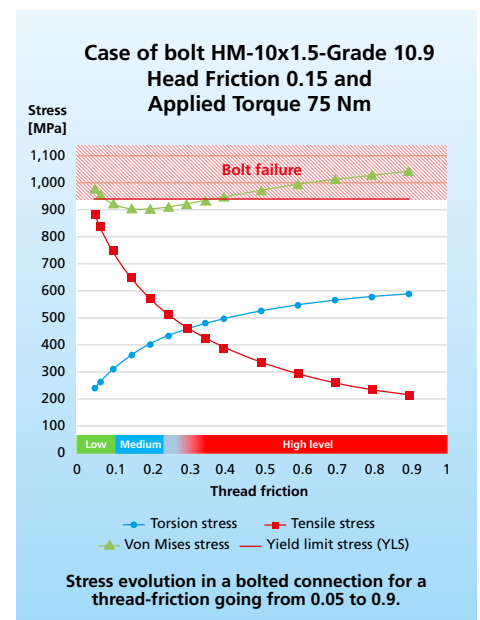
A: Torsion in bolt connections is mainly introduced during a torque-tightening operation. For an applied torque, 35–45 percent will be dissipated by friction under the head (or nut), zero – in the case of thread-galling – to 10 percent will be transformed to an axial load. The rest will be absorbed by friction at the threads. This means that 55–65 percent of the torque introduce a residual torsion in the bolt; in the case of thread-galling – stainless steel joints without lubricant/specific coating – this could reach 100 percent!

The graph to the right illustrates the evolution of stress in an HM10-10.9 (Hex head, Metric Thread, diameter = 10, grade 10.9) bolt with thread friction varying between 0.05 (excellent lubrication) to 0.9 (dry). It shows that under-estimation of torsion – bad estimation of friction coefficients – was the main source of bolt failure during tightening.

To avoid failure, designers must take torsion into account in their preload calculations. There are three ways:

- Selecting tightening methods that prevent torsion, such as the use of hydraulic or mechanical tensioners (no residual torsion).
- Using lubricant or suitable coating to reduce friction at threads, and to prevent galling.
- Reducing the preload level by using some practical rules: 50–62 percent YLS (Yield Limit Stress) in the case of tightening in dry conditions and 65–80 percent YLS for a suitable lubricant/coating.

In many cases, this residual torsion decreases progressively due to relaxation, a small rotation of head/nut, or a self-unscrewing phenomenon. The technical rules VDI2230-03 estimate the torsion relaxation to be 50 percent after tightening. **zc**



THE MAKING OF BOLTS

Bolts are one of the most basic components of engineering and construction, yet their production has become an advanced, high-tech process with multiple steps. Find out how raw steel is transformed into highly specified and exact metal implements.

WORDS:
NIC TOWNSEND

PHOTO:
RF 123

ILLUSTRATIONS:
DAN HAMBE



Bolts can come in a wide range of different sizes and shapes, but the basic production process generally remains the same. It starts by cold forging steel wire into the right shape, followed by heat treating to improve strength and surface treating

to improve durability, before being packed for shipment. However, for more advanced bolt designs, the production process can expand by a number of additional steps.

As one of the leading suppliers of fasteners to the automotive industry, Swedish manufacturer Bulten is highly proficient in every step and facet of bolt production. “We do not produce catalogue parts – everything we produce

is custom-designed, according to the customer’s specifications,” says Henrik Oscarson, Technical Manager at Bulten’s production plant in Hallstahammar, Sweden. “Depending on where the fastener will be used, there are a number of different options for producing exactly the right bolt.”

COLD FORGING STARTS with large steel wire rods, which are uncoiled and cut to length. The grade of steel is standardised across the industry, according to the requirements of ISO 898-1. Using special tooling, the wire is then cold forged into the right shape. This is basically where the steel is moulded, while at room temperature, by forcing it through a series of dies at high pressure. The tooling itself can be quite →

1

2

3

4



The production process

1. WIRE

Uncoiled, straightened and cut to length.

2. COLD FORGING

Moulding the steel into the right shape at room temperature.

3. BOLT HEAD

Progressively formed by forcing the steel into various dies at high pressure.

4. THREADING

Threads are formed by rolling or cutting. See side article.

5. HEAT TREATMENT

The bolt is exposed to extreme heat to harden steel.

6. SURFACE TREATMENT

Depends on the application. Zinc-plating is common to increase corrosion resistance.

7. PACKING/STOCKING

After quality control to ensure uniformity and consistency, the bolts are packaged.

5

6

7

→ complex, containing up to 200 different parts with tolerances of hundredths of a millimetre. Once perfected, cold forging ensures bolts can be produced quickly, in large volumes, and with high uniformity.

For more complex bolt designs, which cannot be contoured through cold forging alone, some additional turning or drilling may be needed. Turning involves spinning the bolt at high speed, while steel is cut away to achieve the desired shape and design. Drilling can be used to make holes through the bolt. If required, some bolts may also have washers attached at this stage of the process.

HEAT TREATMENT IS a standard process for all bolts, which involves exposing the bolt to extreme temperatures in order to harden the steel. Threading is usually applied before heat treatment, either by rolling or cutting (see side article for a comparison between the two methods), when the steel is softer. Rolling works much like cold forging, and involves running the bolt through a die to shape and mould the steel into threads. Cutting involves forming threads by cutting and removing steel.

Since heat treatment will change the properties of the steel to make it harder, it is easier and more cost-effective to apply threading beforehand. However, threading after heat treatment will mean better fatigue performance.

“The heat treatment can cause heat marks and minor damage to the bolt,” explains Henrik Oscarson. “For this reason, some customers demand threading after heat treatment, especially for applications like engine and cylinder head bolts. It’s a more expensive process since you need to form hardened steel, but the threads will maintain their shape better.”



For long bolts, where the length is more than ten times the bolt’s diameter, the heat treatment can have the effect of making the steel revert to the round shape of the original steel wire. Therefore, a process of straightening often needs to be applied.

THE CHOICE OF surface treatment is determined by the bolt’s application and the requirements of the customer. Often, the main concern for fasteners is corrosion resistance, and therefore a zinc-plated coating applied through electrolytic treatment is a common solution. This is a process whereby the bolt is submerged in

a liquid containing zinc, and an electric current is applied so that the zinc forms a coating over the bolt. However, electrolytic treatment does come with an increased risk of hydrogen embrittlement. Another option is zinc flakes, which offers even higher corrosion resistance, albeit at a higher price.

WHEN CORROSION RESISTANCE is not an issue – such as inside an engine or an application that is regularly exposed to oil – using phosphate is a more cost-effective option.

Once the surface treatment has been applied, standard bolts are typically ready to be

A brief history of:

BOLT MANUFACTURING

WHILE THERE ARE several theories, little is known about the origin of threaded bolts. Some single out Archimedes of 3rd century BC Greece, others ancient Egypt or Assyria. In the 1st century BC, wooden bolts were widespread in the Mediterranean area. For ages, the threads had to be painstakingly cut, filed or sawed by hand. Until the early 1800s, the head was square-shaped.

The Industrial Revolution, especially in Great Britain, saw the breakthrough of fasteners. Still, the making of nuts and bolts was cumbersome and the quality totally dependent on the craftsman’s skills. Lathes had been around for a long time, but adapting them for screw-cutting came relatively late. This breakthrough in the mid-18th century made another problem evident: the lack of standards.

15th century Threaded metal screws are used as fasteners, e.g. in armour.

15th to early 16th century Leonardo da Vinci draws designs for screw-cutting lathes and machines.

1568 Jacques Beson makes the first machine for cutting bolts and screws. He later introduces a screw-cutting gauge or plate for lathes.

1739 HENRY HINDLEY designs a gear-equipped lathe that cuts screws with different pitch – even left-handed threads.

1760 JOB AND WILLIAM WYATT introduce an automatic screw-cutting device enabling mass production of screw threads – a major breakthrough.

1775 JESSE RAMSDEN constructs what may be the first modern screw-cutting lathe – a precursor to the modern lathe (non-CNC).

“Depending on where the fastener will be used, there are a number of different options for producing exactly the right bolt.”

HENRIK OSCARSON, TECHNICAL MANAGER
AT BULTEN'S PRODUCTION PLANT IN HALLSTAHAMMAR

packaged. However, more advanced designs may require some additional assembly, such as brackets. Other bolts will also require some form of patching, either a locking patch or a liquid patch. A locking patch consists of a thick nylon layer over the threads, which helps improve grip. A liquid patch will help improve thread-forming torque.

ONCE THESE STEPS are complete, the bolt is finished. Now all that remains is some form of quality control to ensure uniformity and consistency, before the bolts can be packaged and shipped. ■

1800 HENRY MAUDSLAY launches the first power-driven lathe for cutting screws – the ancestor of modern screw-cutting – which turbo-charges the Industrial Revolution.

1841 JOSEPH WHITWORTH devises his standard for screw threads, and screw and bolt manufacturing take a giant leap into the future.

TIME →

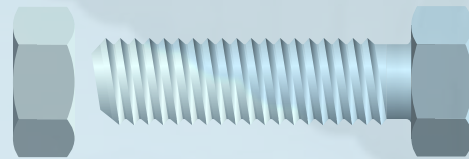
STEEL OR STAINLESS?

THE MAIN ADVANTAGE of using stainless steel fasteners is their non-corrosive, anti-rusting properties, which are the result of its high content of chromium. It also has high aesthetic value – which is important in many applications – as well as hygienic properties, which are vital in food and health care industries. However, stainless steel is also a lot more expensive than steel, and, because of its low carbon content, it cannot be hardened.

STEEL, ON THE OTHER HAND, if unprotected and exposed to moisture, will rust and, over time, this rust will cor-

rode the steel to the point of failure. There are a number of surface treatment options available that will protect steel from corroding, though these tend to be less aesthetically appealing compared to stainless steel.

Once again, the choice comes down to the application. If function is more important than form, for example, if the application is hidden or if appearances are not important, then steel is generally the most cost-efficient option. For use in highly corrosive or harsh environments, other materials, such as SMO high-alloy austenitic stainless steel is often recommended. ■



ROLLED THREADS VS CUT THREADS

There are essentially two main methods for producing threads on a bolt: rolling and threading. Rolled threads are made by running a bolt through a set of threading dies, which mould and shape the steel into threads. Cut threads mean that steel has been cut away and physically removed from the bolt to form threads.

Overall, the rolling process is much faster and simpler than cutting, and uses less material, which means less labour and lower costs. It also ensures consistency and uniformity, which are important for producing large volumes.

In addition, the rolling process has a burnishing effect on the threads, which produces a superior finish. This can improve strength, since there are no tears and chatter, which can often lead to fatigue failure later.

With cutting, the natural grain flows within the steel are interrupted, which can undermine structural integrity. Rolling on the other hand, moulds the grain flows to follow the contours of the threads.

However, rolling also has its limitations; it is not very cost-effective for producing small volumes due to the cost of tooling, cannot be used for producing very deep threads, and does not permit the angles needed for multiple threads, which has to be done through cutting.

The material used can also be a defining factor for deciding which method is best. For example, rolling is recommended for materials with good plasticity – an elongation factor of 12 per cent or more – otherwise cutting is better. ■

MOVING MEGASHIPS FORWARD



Before the financial downturn in 2009, MMG delivered 180 propellers per year – mainly to new ships. Today, the company's most important business is the Retrofit programme, redesigning old propellers, with about 120 orders per year.



“The shipping industry is very conservative. But we’ve convinced them of the diver solution’s merits.”

JÖRN KLÜSS,
HEAD OF DESIGN AND CONSTRUCTION AT MMG

During the worst shipping crisis in history, Mecklenburger Metallguss reinvented the ship propeller to help the world’s largest container ships sail through the storm.

WORDS:
LINDA KARLSSON

PHOTO:
MMG & DR. KARL-HEINZ HOCHHAUS

IT’S LATE in the evening and heavily loaded lorries escorted by police cars, blue lights flashing, move through the sleepy town of Waren, north-eastern Germany. Yet the residents of the quaint little houses aren’t worried; they know it’s just another ship propeller about to leave town.

Waren, with some 20,000 inhabitants, is home to Mecklenburger Metallguss GmbH (MMG) – a world leader in the design and production of propellers for large container ships. One of its creations, a 131-ton, huge six-blade propeller for Maersk, holds the world record for the largest ship propeller.

It’s a tricky transport challenge. Hamburg, Germany’s largest seaport, is more than 200 kilometres away and stopping on the autobahn is time-consuming for the convoy of long and heavy vehicles. Some years ago, a whole A-road, along with two railway tracks, had to be moved as the company grew and propeller transports kept jamming the traffic. So, what is an XXL ship supplier like MMG doing this far from the sea?

“We started manufacturing propellers 70 years ago, as the area was a Soviet occupation zone and the East German ship building industry had to be rebuilt after the war,” explains Jörn Klüss, Head of Design and Construction at MMG and a Waren native. “Back then, ship propellers were a lot smaller. Today, the know-how in the region is what makes us stay.”

CARGO CAPACITY has grown 1,200 percent over the past 40 years. Fifteen years ago, ships moved 5,000 TEU (twenty-foot equivalent unit, a standard 6.1-metre shipping container). Today, ultra-large container ships load 22,000 TEU.

However, container demand collapsed during the financial crisis in 2009, and orders for new propellers stopped. “What saved us was our ‘Retrofit’ programme,” says Klüss, “a new generation of propellers that optimises efficiency in old ships.”

UNTIL THEN, propellers were built for ships operating at the highest possible speed. After the crisis, ships started slow steaming with engines running below capacity to cut fuel consumption. Ships that used to cross the oceans at 25 knots (46.3 km/h) slowed down to 18 knots (33.3 km/h) or less.

“The slower an engine runs, the larger you can go on the propeller,” explains Klüss. “By analysing individual operating profiles, we adapt the number of blades and the diameter to determine the most efficient individual propeller.”

The company also analysed the propeller cap – the part of the propeller behind the blades that protects the steel components of the propeller shaft from seawater corrosion. It created a new energy- →

→ saving cap (MMG-escap) with a new fin design that straightens the hub vortex, reducing the required torque and preventing wear on the rudder.

These innovations made it possible to increase efficiency by up to 10 percent, saving roughly EUR 200,000 for an Asia-Europe voyage.

MANY SHIPPING COMPANIES showed interest in upgrading old propellers with the MMG-escap, which alone increases propulsion system efficiency by up to 3 percent. Conventionally, propeller caps are fitted to the propeller with bolts secured by a chemical locking adhesive. But this requires the ship to dock for at least three days, incurring docking fees of about USD 15,000 per day, plus the cost of removing the ship from its sailing schedule.

“We started thinking about attaching the new cap underwater, using divers,” says Klüss. “But that excludes the use of adhesives, which need oxygen to harden. That is how we found out about wedge-locking washers and the inventor of this technology – Nord-Lock.”

HOWEVER, the strictly regulated shipping industry relies on classification societies to ensure safety at sea and define technical standards for ship construction and operation. A ship cannot operate without classification, as it won’t get insurance or freight orders. The Nord-Lock washers hadn’t been tested and approved for use with the special copper alloy used in the propeller cap, so a certification that the washers efficiently secured the propeller cap was urgently needed. Every ship building country has its own classification organisation, and MMG works with all of them. In this case, they contacted DNV GL, one of the largest.

“If the shipping company and classification society agree, you may implement an application and perform a subsequent verification,” explains Klüss. “The Nord-Lock washers already had multiple certifications and DNV GL was motivated to test for another one due to our innovative steel-copper alloy combination.”

THE FIRST UNDERWATER ASSEMBLY of a propeller cap with Nord-Lock washers was carried out in 2014 on a large European container ship. Three divers only needed 1.5 days to do it during regular port time and without docking fees – a success.

MMG, DNV GL and Nord-Lock met in September 2016. Less than a year later, the washers had been tested and approved.

“The shipping industry is very conservative,” says Klüss. “But we’ve convinced them of the diver solution’s merits, and Nord-Lock is now our new standard for all bolted joint applications.” ■



Using wedge-locking washers, it is possible to assemble propeller caps under water, saving significant amounts of money.

FACTS:

THE SOLUTION

CUSTOMER:

Mecklenburger Metallguss GmbH.

END CUSTOMERS:

Shipping companies across the globe, ship yards mainly in Asia.

LOCATION:

Waren (Müritzt) in Mecklenburg-Vorpommern, Germany.

APPLICATION:

Securing a ship propeller cap with Nord-Lock washers instead of adhesives.

NORD-LOCK GROUP SOLUTION:

SMO washers for stainless steel bolts.

BENEFITS GAINED:

- Excellent locking reliability.
- Reduction of assembly errors thanks to ease of use.
- Possibility to fix the propeller cap to an existing propeller under water.

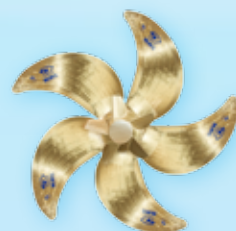
Taking no risks – Nord-Lock Group Technical Centers

DESIGNED TO MEET THE R&D POTENTIAL of Nord-Lock Group technologies and to perform application tests for customers, the Nord-Lock Group has started several Technical Centers around the world.

Utilized globally, the R&D centre near Lyon, France, conducts hundreds of customer-specific vibration, torque and preload tests annually to ensure faultless reliability.

It was here German company MMG turned when it needed tests to document the properties of Nord-Lock wedge-locking washers in combination with copper alloys – the standard material for casting ship propellers because of its corrosion resistance. Aluminium, zinc and iron are added to the alloy to increase the tensile strength. Representatives from registrar and classification society DNV GL, MMG and Nord-Lock met at the Technical Center in Lyon in January 2017 to observe the following properties:

- Tightening process with and without washers.
- Elongation of the bolts during tightening.
- Preload loss over time.



The Junker test put the bolted joints through the most extreme vibrations possible. The tests were successful. Tobias Klanck, Sales Engineer at Nord-Lock Group, who attended the tests, gives one example: “Our plan was to observe any possible loss of preload due to setting issues for 12 hours,” he says.

THERE WAS NO LOSS of preload at all within the critical first half hour after the setting. The waiting time could be reduced to only one hour, so all the tests were finished within two days instead of a week.

“I’m very happy that our washers were approved, and that this helps MMG and its customers,” Klanck adds. “Our work at Nord-Lock is not only about selling products, but also about supporting our customers whenever needed.” Indeed, Nord-Lock Group customers anywhere in the world are welcome to contact their local sales office if they, for example, would like to test their application or torque. The sales office will then pick a suitable laboratory, depending on the task and if the customer wants to observe the testing on-site.

“There’s no stock, no waste, and it can be done locally”

Since its launch in 2013, Dutch 3D printing start-up 3D Hubs has produced over a million parts, making it the world leader in distributed manufacturing. Chief Marketing Officer Filemon Schöffner explains the concept.

WORDS: RICHARD ORANGE	PHOTO: SIMON VAN BOXTEL	
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What is the thinking behind 3D Hubs?

“The current value chain in which goods are manufactured produces a lot of waste. Many products have been produced in very high amounts for economies of scale, but roughly one third never get sold. What distributed manufacturing can bring is ‘on-demand manufacturing’, so goods are only produced the moment they’re sold. There’s no stock, no waste, and it can be done locally.

“3D printing is a new manufacturing technology, and in that it’s doing really well. The scepticism is based on the consumer market, where few people see anything happening. So that would be my message: it’s in the manufacturing sector.”

So, what benefits does 3D printing bring to manufacturing?

“For injection moulding, the most common process used for manufacturing in China, you need to build a mould first, and that means that there are a lot of up-front costs. Without moulds, 3D printing is very price competitive for small-batch production. It’s also on-demand, so if you upload a file now, we can start producing instantly. And because it’s additive, you can do highly complex geometries.”

Are there any specific industries or applications that benefit?

“3D printing is completely conquering the prototyping market. Then industries that need small-batch production of highly complex geometries, such as prosthetics, hearing aids and dental implants. There are already a lot of



“While best suited to small-batch production, 3D printing can also benefit the fastener industry, especially for on-demand replacement parts,” Filemon Schöffner says.

commercial aircraft with 3D printed parts in them. Replacement parts are also a very large business, which really leverages the on-demand aspect of 3D printing.”

What are the benefits for the fastener industry?

That’s an interesting case actually. As fasteners, almost by definition, are standardised parts, they are typically not suitable for 3D printing – simply not price competitive.

However, in a wider context, from a value chain perspective – 3D printing can offer a lot in terms of replacement parts and ‘on-demand’ turn-around. Especially in the technical service branch, we see 3D printing used a lot for these benefits, even for standardised parts. This is where I would see fasteners of any kind benefit as well. ■

FACTS: FILEMON SCHÖFFER

TITLE: Chief Marketing Officer, 3D Hubs, Amsterdam, The Netherlands.

AGE: 32.

BACKGROUND: I’m an industrial design engineer and physicist, so I know a lot about manufacturing, but I’ve always worked in ads and creative campaigning.

LIVES: Near the 3D Hubs office among the start-ups, galleries and hip bars of Amsterdam’s trendy Westerpark district.

PASSION: AFC Ajax.

INTERESTING FACT: Filemon’s ancestor Peter worked with Gutenberg in the 15th century. “3D printing has a lot of potential to localise manufacturing of lots of things, it distributes both skill and know-how, and I think that’s comparable to what the printing press did.”

Doosan Heavy Industries & Construction required a bolt tensioning solution to tighten nuclear reactor pressure vessel stud bolts. Boltight delivered a cost-effective solution for a restrictive, highly loaded joint.

Meeting a tight specification

WORDS:
ALASTAIR MACDUFF

PHOTO:
THIERRY VIALARD & BOLTIGHT

THE CHALLENGE Doosan Heavy Industries & Construction is a South Korean conglomerate company active in many industries, including nuclear power generation. In 2016, it required a bolt tensioning solution to tighten nuclear reactor pressure vessel stud bolts. After reviewing proposals from several companies, Doosan approached Boltight via a third party.

The challenge for Boltight was to design a tool to achieve a predetermined bolt elongation, without exceeding the reactor head's maximum allowable bearing stress. The required bolt load was critically high (14,500 kN), and the space envelope very small. The radial space available to install and operate the tensioner was particularly tight. These tensioning tools also had to compensate for dynamic joint behaviour.

THE SOLUTION In November 2016, Boltight delivered a bespoke solution to Doosan – a tensioning system that could accommodate the particularly high preload capacity within the



Doosan representatives were present at Boltight's facility in Walsall in the UK to witness the factory acceptance test, and are thus far very happy with the solution that has now been put into service.

space available. Boltight engineers also incorporated a hydraulic piston retraction function into the design, to enable the equipment to be reset quickly. A spherical reaction nut and piston interface were integrated to accommodate any bending effects in the event of flange rotation.

Various safety mechanisms were

incorporated to protect both the tools and the operators. The installation of pressure relief valves prevented the hydraulic return system from over-pressurising. In addition, a floating gearbox design was engineered, to avert drivetrain damage should nut misalignment occur.

THE RESULT In bolt tensioning terms, several key technical benefits have been realised by the project. The gearbox now directly interfaces the geared nut, which negates the need for a costly, heavy socket and provides the necessary torque to rotate the nut. The body rotates independently of the bridge, which differs from the previous tooling Doosan was using. The configuration also dramatically reduces the tilt angle when lifted.

Doosan was extremely engaged throughout the entire project. Boltight was able to deliver a cost-effective solution for a restrictive, highly loaded joint within a tight delivery period. A large bolt diameter, as well as a large number of bolts and high bolt loads were all required. ■

Speeding towards tomorrow's transportation

IN 2015, ELON MUSK, the billionaire behind the futuristic transport technology companies Tesla and SpaceX, launched the Hyperloop Pod Competition. It challenges university students to design the best transport pods for the Hyperloop – Musk's dream where people will travel inside a pod that levitates on its tracks and races at almost supersonic speeds through a giant tunnel network, which connects the major cities of the world.

During the 2017 competition, the WARR Hyperloop team from the Technical University of Munich was the one that finally raised the laser-sintered titanium trophy. During the competition, they broke a world-speed record for hyperloop pod travel, using Nord-Lock wedge-locking washers to secure each bolt of their pod.

THE 30-STRONG WARR Hyperloop team was divided into several sub-teams to manage areas ranging from CAD design and structure to procurement, finance and marketing. Sub-team leader for CAD design and structure, Florian Janke, says he was inspired by Musk's vision for a superfast futuristic transport system, and especially the idea that people could one day travel from Munich to Berlin in just 30 minutes.

He says that, "When Musk launched his 'SpaceX competitions', I just had to be part of it. We did well in all the stages of the Hyperloop Pod Competition. In the last one, which focused on maximum speed, we achieved 324 km/h (210 mph)."

The WARR Hyperloop team's lightweight pod smashed the previous 310 km/h (192 mph) record speed set by California-based Hyperloop One, whose pod reached this speed in a 500-metre tube. "There is obviously lots of ac-



Made of carbon fibre reinforced plastic, the WARR Hyperloop measures 400 x 2,400 millimetres, with a combined weight of 20 kg. The 50kW motor, powered by a lithium-polymer system, provides 40 Nm of torque. Acceleration is 0-350 km/h in 12 seconds. The pneumatic friction brakes bring it to a standstill within 5 seconds.

"When Musk launched his 'SpaceX competitions', I just had to be part of it."

celeration and vibration when testing at such high speeds in a relatively short tube – 1.2 km (0.8 miles)," Janke explains. "It was essential that we had secure bolts, so we used Nord-Lock wedge-locking washers, which held the bolts firmly in place. They were perfect."

The WARR team has registered for the next, third Hyperloop competition, and has already passed the first selection round. While some team members are active in the new, 2018 team, albeit in new roles and positions, most of them are carrying on with their studies. A few are travelling from trade fair to trade fair showing the 2017 winning pod.

AS THE TEAM WORKED very closely with a lot of manufacturers in order to get financial backing and various parts, some team members have since had interviews with these companies, and are now considering working there. ■

ROB HYDE





Tested and approved

IN LIFE, AS IN INDUSTRY, time is the most precious of resources. With more and more industrial applications employing a mass of bolts and fasteners, the ability to quickly measure bolt stress, load and elongation is a major asset for many companies.

ULTRASONIC TECHNOLOGY has existed since the middle of the last century, and constant development has naturally heralded a wealth of more complex capabilities, and it is now a preferred method for determining elongation in fasteners. "Using ultrasonics as opposed to Dial Test Indicators means quicker results," says Joseph Vernam, Engineering Manager at Boltight. "It allows for in-service monitoring and means that bolting equipment does not

have to be taken apart and replaced when measuring."

THE BOLTIGHT ECHOMETER has been part of Boltight's product range since the company's inception. Updated ultrasound technology now means it can provide fast and accurate information on the status of fasteners during the tightening process, using built-in data recording and reporting. The actual process involves measuring the time of flight of a shockwave as it travels through a fastener. A measurement is taken before and after the bolt is tightened and appears on the Echometer display. The difference between the readings is the bolt elongation.

Establishing how much or how little a bolt

has stretched is vital in the interests of safety and performance. A number of industries are currently using the Boltight Echometer, according to Vernam.

"WE HAVE BEEN WORKING with E.ON (one of the UK's top energy suppliers). They have been using the Echometer during the service monitoring of the towers on their offshore wind farms," Vernam says. "Another industry utilizing torque verification is the oil and gas sector. In the automotive industry, it is utilized as a standalone solution. Its functionality means that it doesn't take extensive training to be able to put it into action." ■

ALASTAIR MACDUFF

Seeing is believing

WHILE A PICTURE IS WORTH a thousand words, moving pictures are worth even more. At Nord-Lock Group, we are increasing our production of helpful bolting videos. Follow our YouTube channel (www.youtube.com/user/nordlockgroup) for videos that can potentially make your work easier and more successful.

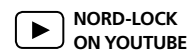
SEVERAL VIDEOS from the Nord-Lock Group have received large interest on YouTube and other social media channels as they present inventions or perform interesting tests on how various bolted joints perform.

A recently added video explains how to easily take your measurements for the Expander System. As the system is adaptable to your requirements, the measurements are all you need to get the right pin for the job. We also have a video which shows you that it is possible to change to an Expander System pin in the field, without getting your vehicle or equipment back to the service hall.

With bolting knowledge that goes well beyond our



own technologies, we also share an increasing number of generic bolting videos. A current example explains the advantages of lubrication. Would you like to see videos covering a particular topic? Send your requests to info@nord-lock.com, and we'll get right to production! ■



Scan the QR code to go to the Nord-Lock Group YouTube channel.



WIFI – advancing women in the fastener industry



Rosa E. Hearn

BEING A WOMAN IN a male-dominated industry doesn't have to get lonely – at least not if it's up to the American organisation Women in the Fastener Industry (WIFI).

"The US fastener industry employs 42,000 people, but women make up only 11 percent," says WIFI President Rosa E. Hearn. "It's hard for women coming in who are new to the industry, so our members unite to educate, mentor and encourage one another."

WIFI WAS STARTED IN 2009 as a LinkedIn forum by Pam Berry, Executive VP of Advanced Components. Berry reached out to other women in the industry for advice when she



With 25 years in the fastener business, Rosa E. Hearn speaks with authority. In her opinion, diversity is a key contributor to success.

unexpectedly inherited a fastener company. Three years later, WIFI had evolved into a non-profit organisation that today boasts 1,500

members (individuals and companies). Four years ago, WIFI introduced two scholarships offering financial assistance to attend the Fastener Training Institute and the International Fastener Expo in Las Vegas.

"A great example of WIFI's purpose, to advance women in the industry," Hearn says, "is a member who would otherwise never have had an opportunity to attend the expo, but who did so well that her employer promoted her from accountant to Vice President of Finance."

INITIAL SCEPTICISM towards the group is long gone and its mission is now spreading among the workforce. "This is not about men versus women," says Hearn. "Great men are also open to mentoring, sharing and helping, and we've created a WIFI brotherhood for that."

Hearn joined the fastener business 25 years ago and has worked both on the distributor and supplier sides. To her, diversity is everything: "Having a diverse workforce of men and women will ensure you have different mindsets focusing on solutions for your organisation." ■

LINDA KARLSSON

Keeping a motor racing veteran on track

WHEN MIKE ROBERTS co-founded TR Fastenings in 1973, he'd already been racing for three years. "I was lying second when crashing on the penultimate lap. My car was totally destroyed, and my pride severely dented," Mike says of his first race at the British circuit Silverstone.

He fared little better in his next race at Castle Coombe in Wiltshire. "On the final lap, my car overturned at around 140 mph, rolled several times and I needed hospital treatment. But eventually I got the hang of it!"

Roberts obtained an international license in 1976 and, when work commitments allowed, raced various sports, GTS and sports prototypes at famous circuits including Le Mans, Spa and Monza.

STILL RACING IN HIS SEVENTIES with an MG Lola EX257, Roberts recently approached his friend and long-term colleague Geoff Budd, Managing Director of TR Fastenings, now under the umbrella of Trifast PLC, to help fix a loose gear shift mechanism. Budd explains: "The car can do up to 200 mph and the gearbox shifts up to 50 times per minute. That's a lot of moving parts

under extreme vibration. It was held on by an M6 socket cap screw, washer and nut."

"I recommended Nord-Lock washers," he continues. "We've worked with them for years because the products are well-engineered. I'd seen tests that proved the joints assembled with Nord-Lock didn't come undone. I'd never have recommended a solution for my friend that I wasn't one hundred percent comfortable with. Since installing the washer, there hasn't been a single problem with the gear shift mechanism!" ■

DAVID NIKEL



Nord-Lock lent a helping hand to keep Mike Roberts on the racetrack at the age of 74.

WHEN SAFETY REALLY MATTERS

The Nord-Lock Group believes that no one should ever have to question the integrity of mechanical solutions so critical to our way of life. We strengthen the public and industrial infrastructures that shape modern living in decades to come.

We are proud to be original innovators and the first bolt-securing partner to offer a full lifecycle warranty across all technologies. We ensure your applications will perform as expected from the first installation to the end of its intended lifecycle.

