

The Irresistible Rise of Commercial Drones

LEMO Engineers at your Service

**Underwater Kites to Harness Ocean Power** 



EDITORIAL

Innovation is a very demanding mission, never acquired and constantly evolving.

To be able to develop innovative products, we have to keep adapting our processes and structures. Above all, we need to adopt a certain way of thinking and be constantly open-minded.

The sense of innovation is at the very heart of LEMO. It made us invent the Push-Pull connector and create solutions that have become global standards. In order to provide the best products and services to our customers, we keep exploring new areas, pushing the limits of miniaturization, experimenting new materials and surface treatments and rethinking our production methods.

This new issue of CONNECTED is dedicated to innovation and innovators. Its contents, from Europe, Asia and the United States, bring news about innovative products and markets. They give voice to the CEO of a start-up and to a young engineer. They present technologies that can film the invisible, capture the energy of ocean currents or fly to your rescue in less than a minute.

The past was about choosing solutions, the future is about generating options.

Alexandre Pesci Corporate CEO LEMO SHEHZAAD CALLACHAND CEO. AERACCESS

"The revolution is already here. With widespread technology moving at a fast rate, commercial UAVs have a promising future."

-Starting

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#### IMPRESSUM

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### TECH-BITS FROM AROUND THE WORLD



### THIS LED BULB WILL SHINE FOR FORTY YEARS

LEDs last an average of 50,000 hours, which is much better than the 2,000 hours of conventional bulbs, but not enough for Jake Dyson, inventor and entrepreneur. Sir James Dyson's son has designed a light bulb that maintains its brightness for 180,000 hours, which is 40 years, if the light was on 12 hours a day. The inventor has realized that the heat emitted by a LED is a crucial factor in determining its lifetime. He designed a LED bulb incorporating six pipes and several fins that quickly remove heat from the light's core. The lamp is called Ariel and it will be released in May, retailing at around 2,300 euros.

© Jake Dyson LLP



Bloodhound has four wheels and is under full control of its human driver, so it is a car. Otherwise, it is a technological monster: over 13m long, 7.5 tons and 135,000 horsepower... The British car's mission for next summer is to break the world land speed record, established in 1997 at 1,227.99km/h. This technological feat, planned in the South-African desert, is only a test. Next year, with two more rockets, Bloodhound should be able to reach 1,609km/h. The engineers designed it to have a neutral lift, at this speed it should neither take off, nor crash. A technological lab on four wheels, Bloodhound is sponsored by Jaguar, Rolls Royce and **LEMO** connectors amongst others.





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#### GOOGLE GLASS IS DEAD, BUT THE PROJECT LIVES ON

At the end of last January, Google announced the withdrawal of the company's glasses from the market. A big surprise, after the high-profile launching in 2012. Their futuristic and rather intrusive look divided opinions. Their capacity to film surreptitiously had banned them from a number of public areas. However, the story of Google Glass is not over yet: they have been withdrawn from sales to the public, but continue to be developed for professional applications (medical, search and rescue, industry...). Now they have their own division at Google, under the responsibility of Tony Fadell, "the father of iPod" and founder of Nest (acquired for 3.2 billion by Google early 2014). The future will tell, whether they were simply launched too hastily for public use.

© Google

### AT CES 2015 ELECTRONICS GO BEYOND THEIR OWN BOUNDARIES

Held every year in January, in Las Vegas, CES is THE electronics show for the general public, where trends are set and confirmed. The usual televisions and PCs were exhibited alongside more recent technologies: virtual reality, wearable technologies (smartwatches, intelligent sportswear, health sensors...), 3D printing, the Internet of things and home automation. Exhibitors from the automobile industry (see hereunder) or drones (see our special feature p.10) were also major attractions of the show. A total number of 170,000 visitors have strolled around 3,600 exhibitor stands.





© International CES

#### AUTONOMOUS LOUNGE IN MOTION DESIGNED BY MERCEDES

Mercedes took the opportunity to prove their interest in autonomous cars at CES 2015. Dieter Zetche, CEO, unveiled the F015 luxury concept car in Las Vegas. 5.20m long and 1.5m high, this rolling lounge can be used as an autonomous vehicle or driven manually. The seats automatically swivel outward to make it easier for passengers to get in and out. Six HD screens in the doors keep passengers connected to the virtual world (browsing) or to the real world outside. In driver-less mode the F015 uses LEDs in the air vents to tell pedestrians to go ahead. Google, Ford, Tesla, Audi and Nissan also develop autonomous vehicles. There are rumours that even Apple is working on such a project.

© Mercedes-Benz

# **BIOCOMPATIC: A GREAT** SOLUTION FOR MEDICAL **CABLES** By Alexis Malalan

Northwire has just launched a brand new cable with unprecedented specifications. Flexible, resilient, supple and biocompatible, it is a great alternative to silicone cables. This is a small revolution in the medical sector which could also be interesting for other demanding environments.

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Until now, silicone was the undisputed leader among cable jackets adapted to medical applications. Extremely flexible, highly resistant and smooth, its unique features make a real difference compared to other materials with similar elasticity and robustness. Northwire's latest innovation may very well change silicone's leadership.

Compliant to REACH and RoHS2, BioCompatic is a cable newly designed by Northwire's research and development laboratories. Made of TPR (Thermoplastic rubber), its performance makes this cable a great multi-ways type will be available to the market early spring. alternative to silicone for the medical industry.

Just as flexible and soft to the touch as silicone cables, BioCompatic's jacket material is much more chemical, sterilization, abrasion, cut and crush resistant. For crush testing, Northwire's engineers have subjected it to extremes that exceed real-world conditions. In order to evaluate its performance in hospitals, a test was designed to simulate a 200 pound medical gurney (wheeled stretcher) device that repeatedly rolled over the cable. The silicone cable failed after less than 9300 cycles, whereas BioCompatic lasted over 186,000 cycles (twenty times more). BioCompatic can be rolled over, pulled or bent with no danger when handled. It also showed resistance equal or superior to silicone for all sterilization types, such as steam and gamma radiation. Its resistance to extreme temperatures has been tested with steam sterilization, preserving physical properties through over 500 autoclave cycles. BioCompatic has also perfectly resisted the most aggressive

exposure to hospital-grade disinfectants, retaining 100% of original material performance after 24-hour total immersion in a variety of chemicals including Betadine, alcohols or hydrochloric acid.

The new cable features more than just technical advantages. "Compared to the long and costly curing requirements of silicone, the industrial processes are much shorter and price-competitive at Northwire. It takes 10 to 12 weeks to deliver a silicone solution, whereas BioCompatic is available in 5 to 15 days.", explains Krista Lindquist, Materials and Manufacturing Engineer.

BioCompatic meets the strictest specifications in its main application field, such as ISO 10993-5 for cytotoxicity, or USP Class VI certification, guaranteeing compliance with United States Pharmacopea (USP) for health care technologies. Containing no halogens, latex or phthalates, it could also become the ideal material for the food industry. Environment friendly, its composition is free from products derived from animal origin.

BioCompatic is the first product launched by Northwire since its acquisition by LEMO in 2014. Fitted with LEMO connectors, it is a perfect example of fully integrated end-to-end solutions that the LEMO Group is now capable of supplying to its customers. Proving LEMO's strong interest for innovation, this cable was developed in record time, thanks to the Wisconsin company's expertise and technical network. A 41-year industry veteran, Kevin DePratter, Northwire's Director of R&D remembers: "We worked around the clock, seven days a week. In four months, the new cable was finished and had obtained all the certifications."

BioCompatic was officially presented at the 2015 Pacific Design and Manufacturing show, held in February in Anaheim, California. The SPECIAL FEATURE

# THE RISE Prices Huber OF DRONDES

From military-only to geek's gadget, UAVs have become ubiquitous. Last year saw a significant take-off of consumer drones. This year they will fly everywhere – despite privacy and security issues. Get ready for this technological and social revolution.



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### THE MARKET TAKES OFF

"DRONES IN OUR SKIES, BUT NOT IN OUR EVERYDAY LIVES" **19** A DRONE MAY SAVE YOUR LIFE ONE DAY **20** 

DRONES ARE ALL AROUND!





Remember the 1989 movie "Back to the future Part II"? Hero Marty McFly (Michael J. Fox) travels forward in time and lands in 2015. His first glimpse of the future: a drone walking a dog. Well, it seems that we may very well see this actually happen in our 2015.

Until recently, drones or UAVs (unmanned aerial vehicles), RPAS (remotely piloted aircraft systems) or UAS (unmanned aerial systems) were restricted to the military vocabulary. Valuable allies in reconnaissance missions, they have also made it possible to hit the enemy without risking the soldiers' lives. The Obama administration have turned them into major tools in its asymmetrical warfare against terrorism.

Recreational drones have arrived more recently, thanks to model aircraft fans. Lightweight and affordable, they benefit from ever improving technology. The boom in the smartphone market, using similar miniature technologies – optical elements, batteries, gyroscopes, compasses, pressure sensors and accelerometers – as well as more and more powerful processors have also accelerated their uptake.

Recreational drones have rapidly appealed to professionals – first of all to image and surveillance professionals. However, these users require higher specifications, in terms of weight load, reliability and security. The commercial drone market was born to meet these requirements (interview on page 15). According to specialists, this market may very well exceed the military or recreational markets. In any case, as far as legally permitted.

In fact, in many countries, commercial drones are forbidden, with a few exceptions. This is the case in the US, where regulation should have come into force this year, but was postponed until 2017. In other countries, like in France, these commercial flights are authorized to a much greater extent, but law enforcement and legal training are still rather unclear. The international trend is to integrate drones into civil aviation law, which promises to be a lengthy and complex process.

These restrictions have not prevented an explosion of commercial and recreational projects (see page 20). The drones that Amazon is hoping to use for parcel delivery are the most publicized examples.

The will of authorities to keep control is legitimate. It also brings up the issue of privacy, in case they are equipped with cameras: "Are UAVs nothing more than flying Google Glasses?" some ask. Drones also represent a risk to physical safety: this is recent technology, operated by people without extensive training. Crashes are quite common, even in the streets of New York. The question is not whether, but when a serious accident will happen.



Military Surveillance



### IN JANUARY, A DRONE CRASHED ON THE WHITE HOUSE TURF...



The FAA (Federal Aviation Administration) has recorded hundreds of incidents involving drones and commercial airplanes. Even some close calls have been recorded at La Guardia Airport, New York. In

England, last summer, a drone passed just 7m from the wing of an Airbus during the landing approach at London Heathrow Airport.

Other extremely sensitive areas have also been visited by drones. French nuclear power stations have been flown over, without any pilots being identified. Also in France, the operators of a drone have been given a four-month suspended prison sentence for causing danger to life, impeding air transport, operating an aircraft not conforming to safety rules and violation of air navigation rules: they flew their drone above a sinking boat, delaying helicopter rescue operations.

At the end of January, a new incident became the most emblematic case of potential threat: a quadcopter crashed on the lawn of the White House. It could have carried explosives.

The risk of accidents, indiscretion and even attacks have induced public skepticism. According to a recent Associated Press survey, only 21% of Americans support the use of commercial drones.

Obviously, all new technologies generate such queries, which rarely prevent them from becoming accepted. Commercial drones provide useful services, cost savings and open highly lucrative business opportunities. There is little doubt that regulations will be implemented and the market will take off – 2015 is just the beginning.

Soon these drones will benefit from "detect and avoid" systems that will secure flights. They will be equipped with better batteries and become more intelligent. In short, more reliable.

Tomorrow drones will be assembled to transfer digital data before dispersing. "Paparazzi" drones will stalk everything that television channels want to film. Tomorrow your drone will accompany your children to school. A drone ambulance may even save your life (see page 19).

In the meantime, if you want to use a UAV to walk your dog, finding a model shouldn't be a problem. But it may work better if your dog is a Chihuahua.

During the CES 2015 show in Las Vegas early January, the Consumer Electronics Association have estimated that the global market for consumer drones will approach \$130 million in revenue this year increasing by 55% from 2014 and that it is expected to exceed \$1 billion in just three years.

In the exhibition area for UAVs at CES (for the first time) about a hundred new models were exhibited.

Startups and small companies have market launched. Their innovative solutions have been carefully followed by well-established companies (e.g. by Parrot) and even by military suppliers. Powerful technological companies (Facebook, Google...) have been developing their own devices. Even GoPro whose cameras are often fitted to drones, have decided to get their share of the pie by launching their own drones.

UAVs now have their dedicated magazines. They also have their international shows. The first Commercial UAV Show was held in London in October 2014 and its organizers expect over 3000 visitors for the 2015 event.

### THE MARKET TAKES OFF 1 BILLION \$ EXPECTED BY 2018

# "DRONES IN OUR SKIES, BUT NOT IN OUR EVERYDAY LIVES"

Somewhere between military drones and recreational drones, commercial drones – for professional applications – is an emerging market with enormous potential. Aeraccess is one of the few French manufacturers in this field. Interview with CEO Shehzaad Callachand, 32, an aerospace engineer.

#### Miniature or giant, autonomous or radio-controlled, military, commercial or recreational: what does the term "drone" cover?

Shehzaad Callachand: the word has become commonplace in recent years and it designates more or less anything that flies without a pilot! Today, there is a drive to make a distinction between the different types. For example, in Europe, they would like to restrict the use of the term "drone" to military applications only. For consumer applications, they prefer RPAS (Remotely Piloted Aircraft Systems). In the USA, they also talk about UAVs (Unmanned Aerial Vehicles) or UAS (Unmanned Aerial Systems)......

COMMERCIAL

OPERATORS:

DRONE



Photo: Aeraccess

Aeraccess CEO Shehzaad Callachand.

#### The topic of drones keeps cropping up in the media. Why such a take-off?

Miniature drones have existed for about a decade already and have been flying around research laboratories. So "small non-military drones" are nothing new. The boom began when drones started to be used as toys. They were boosted by model aircraft fans. Miniaturization, improving guality and decreasing prices of technologies such as GPS, gyroscopes, sensors and processors, as well as open source software have then sped up progress. They have become much more than simple toys...

Their excellent performance has opened the way to a wide range of more serious, professional applications, such as photography and surveillance.

This is how "commercial drones" were born. They bring solutions that could only be provided by helicopters and military drones until now. The costs are much lower too!

### > 1,000 IN FRANCE > 5.000 IN USA > 10.000 IN CHINA

#### Does that mean that the development of drones has come from below?

Exactly: commercial drones are upscaled recreational drones and not downscaled military drones! It's easy to see that "consumer drones" are closer to the world of "geeks" than that of aeronautics.

#### It sounds rather scary as far as reliability and safety are concerned!

Yes, it is certainly a major concern! Today in France 90% of drones are designed and assembled by people with no background in aeronautics, who lack sensitivity, knowledge and comprehension of maintenance requirements, etc. Unlike aircraft or cars, drones were not subjected to years of R&D, tests, certification, or first limited to high-range models prior to general release. There is the same concern about training: whilst extensive training is reguired for professional aircraft pilots or drivers, piloting commercial drones requires none.

#### And yet, they fly ...

Absolutely! In France, in 2013, a year after the introduction of regulations on commercial drones, there were already 1,000 operators. In China, there are an estimated 10,000. In the USA, allegedly 5,000 active commercial drones, although their use is officially forbidden! Some exceptions are made for instance for Hollywood shooting.



#### Is it all about to change?

Yes, for sure. The sector is very young, it has begun to structure itself. Europe has been working on harmonizing the rules. The U.S. Federal Aviation Administration has recently announced a Notice of Proposed Rulemaking for small UAS, but it will probably take 12-18 months to turn them into laws. This is an international movement: countries cooperate on solid regulations. Commercial drones will be integrated into civil aviation legislation. It will be rather complex and it will certainly take time, but the sector will then grow on a firm basis.

#### Simultaneously, commercial drones are becoming more professional...

For commercial applications - implying for instance flying over residential areas - we cannot accept technologies from the world of "geeks". We need more in terms of reliability, safety and performance. So we go for drones equipped

with industrial technology and professional servicing. Such as those that Aeraccess and Aerialtronics manufacture, to give a couple of European examples.

#### The market is still young, how is it structured?

Three sectors - military, recreational and commercial - are still rather distinct, but it is already changing. Some military players, such as Aeryon, Cassidian or Novadem have started showing interest in the civilian market.

Parrot, a major recreational drone provider, has just invested in a company specializing in agricultural sensors and another one developing long-haul drones.

Governments and armies have started using civilian drones for some applications. Obviously, the boundaries are becoming increasingly blurred. ▶

"COMMERCIAL DRONES



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professionnal drone in the world (see article on the next page).

WILL BE INTEGRATED INTO CIVIL AVIATION LEGISLATION. IT WILL BE RATHER COMPLEX AND IT WILL CERTAINLY TAKE TIME."



### Apart from legislation, what prevents commercial drones from establishing themselves on a major scale?

What they are most lacking at this point in time is a "detect and avoid" technology. If we want to make thousands of drones coexist, they need to be able to avoid each other, birds, electric lines or any other obstacle. This requires highly efficient sensors that are not yet available, but soon technology will make drones extremely reliable. They will be used efficiently – at reduced cost – in a wide variety of surveillance, reconnaissance and broadcasting applications.

#### How about our everyday lives?

As disappointing as it may sound, I do not see drones enter our daily lives yet. Delivering parcels, for instance, like Amazon and Google would like to. They are not ready for it. You see, autonomous cars have been developed for years, using proven technologies. However, they are still not on the road. With drones, everything is new. We probably still need another decade before technology is proven enough and commercial applications can be used by the general public. Also, our society needs to accept drones in our daily lives. |

Aeraccess's HAWKER Q800X in flight.

Photo: Aeraccess

#### AERACCESS LAUNCHES THE FIRST ALL-WEATHER DRONE

Drones, even more than helicopters, are weather-dependent, which represents a major constraint for certain military, paramilitary or police interventions and some search and rescue operations with these devices. Aeraccess has invented the first "all-weather" drone.

Q800XE is the only IP67 rated professional drone. Perfectly watertight, it can fly in heavy rain, in a blizzard and 70-80km/h winds. Its turret, also designed by Aeraccess, is naturally also watertight. Only three or four manufacturers in the world are able to provide them.

In order to protect the drone and all its elements (including the removable parts), Aeraccess had to be doubly ingenious. They had to reduce weight, redesign architecture. The antennas are for instance hidden in the fibreglass landing legs.

The startup company has also developed an innovative method of fitting the arms. Thanks to a **LEMO** custom-designed solution, they can be plugged in within a few seconds. It is ideally designed to be able to equip a drone with more powerful motors and carry a bigger payload. Aeraccess has patented this global innovation.

The startup is one of the few French manufacturers of professional commercial drones. It's characterized by the modular design of its turrets, which makes it possible for the clients to use the same drone in a wide variety of applications. Furthermore, Aeraccess uses only specifically adapted high-end industrial technologies.

The Q800XE is the third model designed by the startup. The Hawker Q800X another multi-motor, ultraportable drone, which is easy to assemble and ideal for surveillance of a targeted zone (industrial plant, a building on fire...). The Goshawk W200 is a fixed-wing drone, capable of flying at an altitude of up to 1000m and with a longer range. It has been designed for surveillance missions and reconnaissance of larger areas.

Launched 4 months ago, after two years' developing their first models, Aeraccess have just delivered their first drones in England. |

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### A DRONE MAY SAVE YOUR LIFF ONF DAY



The "ambulance drone" working prototype delivers an automated defibrillator.

Photo: Samy Andary

The year is 2020. Imagine that you are having a heart attack. You or the nearest person calls the emergency number. Within a minute a drone lands next to you with a defibrillator; you have just been saved. This was the scenario imagined by Alec Momont, graduate student from Delft Technical University's Faculty of Industrial Design Engineering.

"Because of their military history, drones do not yet have a positive image, explains the young engineer, although they can be used for extremely valuable applications. My first idea was to prove it." Amongst potential applications presented in his graduate work, aptly named "Drones for good", Alec Momont focused on the "drone ambulance". He has designed a ambulance arrives. working prototype capable of delivering an automated defibrillator.

The drone could potentially carry any essential medical equipment weighing under 4 kg: oropharyngeal mask in case of acute respiratory distress or an inflatable life jacket to prevent drowning.

The emergency system would be based on a network of drones. "Strategically positioned, approximately one every 12km<sup>2</sup>, the ambulance drones would be activated via an emergency call centre." The caller would be located by his telephone signal and his data transmitted to the drone which would take off and rush at 100km/h towards the scene of the emergency. It could even alert passers-by upon arrival.

"On the spot, through two-way audio and video communication, an emergency rescue specialist would instruct the patient or the nearest person on how to use the emergency *kit.*" The patient would then receive appropriate - often life-saving - care long before the

"By providing help in less than a minute, the system can improve cardiac arrest survival rates from 8% today to 80%", estimates Alec Momont. Some 800,000 people suffer a cardiac arrest in an insulin kit in case of a diabetic attack, an the EU every year, entailing estimated health care costs of 200 billion euros.

Alec Momont's drone ambulance prototypes are now being field tested for 6 months. The system's reliability (safety, precision, speed) is being studied. It is also important to test human reactions upon seeing a drone arrive and upon hearing instructions transmitted through the device. The drone's design aims at optimizing this interaction: small size, soft lines, local emergency service colours. The drone should be a reassuring presence to be taken seriously.

Provided that legal regulations keep going in the right direction, a drone ambulance could possibly save your life in five years' time.

For the time being, Alec Momont's project has had major success. He has had good media coverage and his video has had nearly 2 million viewings on YouTube. In any case, society seems to be fairly interested in the idea of drones doing good.

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## DRONES ARE ALL AROUND!

New emerging technologies and restrictive regulations have not prevented drones from taking off. Here is a small glimpse into many already existing applications.



#### MAPPING

Guided by their GPS, drones can cover and prepare detailed maps of a territory. Sensefly a Swiss company acquired by Parrot, used their drones for 3D mapping the Matterhorn with an average resolution of 20cm.



#### DELIVERY

In 2013, Amazon declared their intention to use drones for delivering their goods. This news – a first among major companies – was met with disbelief. Since then, Google have revealed their own project, tested in Australia. DHL have also presented their "parcelcopter" delivering medicine and other urgent goods to Juist, a small German island in the North Sea. Other existing or projected applications from all around the world deliver food (pizza, sushi, beer...), medicine and documents.



#### CRIME

Mesa County (Colorado) police use a drone to take photos of crime scenes – it delivers aerial views without altering the crime indices. In Switzerland, last November a drone used by border guards located and helped arrest burglars. Criminals also use drones: in January a drone transporting drug crashed in Tijuana (Mexico).



#### MOVIES

Shooting a vast battle scene has never been as spectacular and easy to perform. Hollywood studios are among the companies pushing US legislators to loosen current regulations on commercial drones.

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#### GAMES

Benefitting from ever advancing and lowcost technologies, recreational drones are also easier to handle than model aircraft or helicopters. Some are equipped with streaming cameras enhancing the cockpit sensation. Guaranteed in-flight emotions.



#### **PERFORMING ARTS**

Cirque du Soleil and the Swiss Federal Institute of Technology in Zurich (EPFZ, Switzerland) have created "Sparked"\* a dreamlike short movie, showing an electrician "dancing" with flying lamps. Why is this so original? There is no computer-generated imagery: the lamps are drones driven by EPFZ's algorithms. Cirque du Soleil could very well integrate drones into their shows.



#### SPORTS BROADCASTING

Influenced by video games, sports broadcasting combines aerial shots and close-ups, to create greater impact. Drones followed skiers during the Winter Olympics in Sotchi, others are used for filming golf competitions. Their images are much more dynamic than those shot by fixed cameras.

PROFESSIONAL PHOTOGRAPHY

Photographers were surely the first to use drones for commercial purposes. Their GoPro's or even their heavy reflex cameras are able find unprecedented vantage points.





#### SELF-PORTRAITS

Selfies are no longer limited by the length of your arm. The Hexo+ drone flies around you to film your achievements (mountainbike, motorcycle, mountaineering...) then smoothly flies back to you. Zano, Airdog or the ultraportable Nixie drones fly on the same market.



#### WAR

Mobile and discreet, drones make it possible to spot and attack targets without the risk of losing a pilot. Their presence in modern military arsenal has brought about a counterattack, just as futuristic: US Navy revealed last summer an anti-drone laser canon, the very first directed energy weapons system ever deployed.

#### INSPECTION AND SURVEILLANCE

Major infrastructure operators (electrical lines, power plants, pipelines, engineering structures...) are able to inspect rapidly and safely.

#### ENVIRONMENT AND AGRICULTURE

From coast inspection, to surveillance of poaching or illegal fishing activities, spotting and counting wildlife and cultivated field management: drones are useful to all those who need to see nature from above.

#### SEARCH AND RESCUE

Firemen and rescuers need only a few minutes to activate a drone, assess the scope of a fire, a natural disaster or a wreckage and organize rescue operations accordingly.



LEMO

"Tailor-made" custom solutions make LEMO a special trademark. The engineering department's winning team ensure the company's continued leadership in terms of innovation, performance and responsiveness.

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When used in a nuclear power station, the product must not alter even after several decades, in order to withstand any unexpected event. When fitted into aircraft wings, it must be ultra-lightweight and resistant to extreme temperature variations. When part of medical equipment, it must be fail-proof to guarantee every patient's safety. The LEMO connector, irreplaceable element in a large number of demanding hi-tech applications, conveys electricity, fluids and light... even several of these signals or energy simultaneously.

In order to meet its customers' various requirements, LEMO offers an exceptionally vast catalogue of over 75,000 different product combinations.

What if we can still not find THE ideal solution? Then LEMO invents it: every year, LEMO starts an important number of new product studies with its engineering department.

Located in the company headquarters in Ecublens (Switzerland), the department is under the responsibility of Attilio Vicario. They are at the heart of LEMO's custom-made design and innovation. Other R&D teams located at LEMO's foreign subsidiaries: in USA, UK, Germany and Japan, complete LEMO's special competence.

"Whenever a new study request arrives, my designers are always very enthusiastic, says Attilio Vicario. We are about to create something new!"

Interestingly, the first challenge is to create the least possible number of new parts. "We only design new parts when they are really necessary to open up new possibilities". This is when another quality of LEMO products becomes obvious, their extraordinary modularity. "This is how we are able to propose such a vast number of different combinations, explains the engineer. This modularity makes it possible to design solutions with tried and tested components that are already perfectly under control."

Every new request must be thoroughly reviewed by the engineering team. If the required parts are definitely not included in the catalogue, they proceed to investigate project feasibility. "In many cases, the technical specifications have to be further developed in cooperation with the customer. The deadlines are often extremely demanding, in which case, we try and find a solution, together with the customer."

Thanks to this procedure, the number of studies that are not completed has dropped considerably. Today over 85% of studies result in a complete order.

Careful upstream work can save a lot of time (and increase productivity). Most importantly, it guarantees a successful solution.

*"Whenever a new study request arrives, my can at last start actual development through designers are always very enthusiastic, says creativity and innovative design.* 

Last year the department's engineers created for example connectors conveying fluids and electric signals for a Danish company specialized in dermatology. The team is now working on an "ultraclean" connector that doesn't emit the tiniest particle. This project is for a company manufacturing production equipment in the field of microelectronics. The requirements were extremely high. "If our connector emits a dust particle of even a few microns, the reliability of the overall equipment may be altered – tells Attilio Vicario. The smallest mistake can have important financial consequences for the customer."

Requirements keep changing, technologies never stop evolving. The engineering department has to face ever more sophisticated challenges to propose custom solutions. How does the team know whether they managed to create something both innovative and conform to LEMO's standards? "Simply when they see the new product appear in the catalogue!" answers the manager.

Every new product is a small victory over the impossible, such as the creation of the 3K.93C model (see also article on page 28), which has become a standard in HDTV equipment. It is such a successful connector, that it can be found at the end of almost every single cable that broadcasts the images of the Olympic games, the football world cup and most other televised events where the slightest disconnection would cause worldwide grumbling.



## PHOTRON: CAMERAS THAT CAN SEE THE INVISION BURGES HERE

Some movements are so rapid that they are invisible to the naked eye. Photron cameras can nevertheless solve this problem, by capturing up to 800,000 images per second. Welcome to the world of high-speed cameras, where a blink lasts an eternity.



The Fastcam Multi, Photron's latest solution.







Photo: Photron

For thousands of years the human eye was quite sufficient to see the movements that man wanted to observe: his environment, the arrival of danger, the flight of prey. However, the eye is incapable of capturing what researchers would like to see today: the details of an explosion, the impact of a bullet, a car crash, molten metal and the reaction of material to constraint... this is where Photron comes into the picture.

Founded in 1974, the Japanese company designs hi-tech imaging solutions (cameras, equipment, software) for use in manufacturing, scientific research or broadcasting. Photron and its staff of 233 has specialized in high-speed cameras, becoming a global leader in the field.

High-speed imaging enables extraordinary scientific progress. For example filming and studying combustion phenomena in the cylinder of an engine, leading to the reduction of exhaust fume emission. R&D, design and quality control engineers, as well as medicine, biology and aerospace scientists, among others, can benefit from these drastically enhanced eyes.

Obviously, high-speed imaging progresses almost as fast as the subject being filmed. Today, the general public can capture 250fps and a definition of 720dpi, with a high quality smartphone. Photron keeps pushing back the limits of frame rate, but that is not enough to meet customer requirements.

Solutions must provide ever higher resolutions as well as high reliability. Physical resistance is another prerequisite – explosions, combustion, crash tests are particularly hostile environments for any technology. Moreover, camera housing dimensions need to be reduced all the time.

Fastcam Multi, launched at the end of 2014, is the latest Photron product. It is a good example of the multiple specifications that Photron's engineers manage to unite in the same system.

Fastcam Multi features one or two compact camera heads tethered to a remote processor. The camera heads provide for image capture at up to 6,000 frames per second (fps) at megapixel resolution. They are so small in size – 15cm long and 7cm wide – that they can slip into spaces that are inaccessible for standard high-speed stand-alone cameras. The camera heads being separated from the processor is also a safety factor: whatever happens to them during shooting, the images are safely stored. **LEMO** connectors are used to connect the camera heads to the processor.

The Fastcam Mini UX100, Photron's most successful model, is another example. This camera system provides 1,280 by 1,024 pixel resolution to 4,800 frames per second and reduced resolution operation up to 800,000 fps. Yes, 800,000 fps, meaning you can film a one-second sequence and watch it stretching out over more than 9 days. Compared to the HD 720 resolution of a smartphone, it would be 6,000 instead of 250 images captured per second. These are ultra-sharp images: a global shutter provides blur-free imagery with a minimum shutter speed of 1 $\mu$ s. Small and lightweight, this camera is suited for applications as varied as fluidics, life sciences or ballistic testing.

Photron sales and profits have increased over the last few years, beating new records in 2014. The Tokyo-based company with subsidiaries in China, England and the USA, is about to launch new camera systems. Namely, the Fastcam Mini WX, second model in the Mini series, capable of capturing 2000fps in "Full HD" (1920x1080).

It is not only speed that makes things invisible to the human eye. Photron is considering the development of further new technologies. UV high-speed cameras? Ultra high-sensitivity cameras? Anything that would help the company to reach its vision: to capture the images seemingly impossible to film.



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## 20,000 WATTS UNDER THE SEA By Alexis Malalan

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MINESTO

Man has been harnessing the tidal forces for a long time. However, the Swedish company Minesto has come up with a highly innovative solution to this technological challenge. They design lightweight, invisible, non-polluting and highly efficient devices. Power of the future?

> Back in 2001 Magnus Landberg, working in Saab's aeronautics department, was charged with studying the design of carbon fibre wind turbines. After some efficiency calculation, he had another idea: what if, instead of using wind energy, we designed an underwater kite attached to a turbine capable of making use of the currents?

> Mind you, the ocean is a tremendous source of energy. Every day, the force of gravity of the Moon, the Sun and the Earth's rotation provoke an extraordinary powerful ebb and flow: tides. This extraordinary water movement is being harnessed by Deep Green, the revolutionary solution invented by Magnus Landberg, being now further developed by Minesto, the company born of the project.

> At first sight, Deep Green looks like a toy. Fastened to a foundation on the seabed by a tether, its carbon fibre wing follows the current and, just like a kite flies faster than the wind, it can reach a speed 10 times higher than the water current.

> Carried by the wing, a turbine transforms this mechanical energy into electricity, which continues in sub-sea cables to the shore and the network. The device is fitted with **LEMO**'s underwater connectors for signal control.

> Extremely lightweight, Deep Green is incredibly cheap and hightly efficient. The system can function with velocities as low as 1 to 2.5m/s. Moreover, sea water density being 800 times higher than air density, the device can potentially produce 800 times more energy than a wing used in air. Compared to wind turbines, the numbers are easy to calculate: Deep Green is 16 times more efficient. Since tides are a constant phenomenon, it never stops working.

Minesto also offers key environmental assets. Whereas wind turbines transform the landscape and nuclear plants are criticized because of the danger and waste, Deep Green is particularly eco-friendly. Underwater, it is invisible from the coast. Installed far from fishing zones, it doesn't disturb the fauna and flora that adopt the structure rapidly as artificial reef, once it is "anchored".

Obviously, installation requires a fairly long preparation. You need to identify the ideal geographical area – not too far from the coast, so that electricity can rapidly reach the power network. Since the ocean is a very demanding environment, it is critical to have highly resistant material and components to ensure a 20-year life cycle without frequent replacement.

Despite the challenges, Deep Green has a promising future. Winner of the 2014 "WWL Orcelle Award", rewarding highly innovative solutions in the field of environmental technologies, Minesto is riding on a wave of success and keeps generating interest all over the world. Following a first installation in Northern Ireland, Minesto has been working on projects in Wales, in Japan, in Chili and soon in the USA. 27





HISTORY



By Brigitte Rebetez

In 1985 LEMO launched its first fibre optic connectors. Through continuous development, these products have progressively become leaders in all cuttingedge sectors, featuring more and more impressive characteristics. 4K definition today, 8K very soon.

Exactly 30 years ago, fibre optics were still newcomers to the industrial world, which didn't stop LEMO from taking up the challenge. At that time, René Moreillon was LEMO's R&D manager. He still remembers multifibre or hybrid connectors (2B to 5B series) which were amongst the first fibre optic range. Their production required a highly demanding technology with groundbreaking precision standards. To achieve them, even some production methods had to be reinvented.

What a long way LEMO has come since then! LEMO's ever improving fibre optic connectors have become a must for a large number of various hi-tech applications: television broadcasting for all Olympic Games since winter 2006, the Royal Opera House in London, laser instruments for ophthalmic surgery, Japanese trains or measurement instruments for the Swiss Federal Institute of Technology in Lausanne... These high-performance connectors are so reliable that some (the OB) were fitted to measuring sensors of MIR, the first real space station in history.

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*"It was such a highly specialized application"*, remembers René Moreillon with a touch of pride.

At the end of the 1980s LEMO launched the Optaball® type connectors, adapted to single mode fibre. This was a major first step, generated by a request from the Swiss public post and telecom, aiming at introducing fibre optics into telephone exchanges.

F2 ceramic ferrule contacts, introduced during the 1990s, were one of the major innovations. These contacts, in combination with the modular concept of LEMO connectors, have made it possible to propose many solutions. Among these, a connector requested by Panasonic for its new HD cameras to be used during the Atlanta Olympics in 1996. After a first version, a smaller solution (the 3K.93C) followed shortly, becoming the basis of the global standard for the ARIB, SMPTE and EBU standards for hybrid fibre connectors for the broadcast industry. The high-tech media converters that have been produced by LEMO over the last ten years are the direct successors of this technological innovation.

With the aim of reinforcing its leadership, LEMO created a centre of excellence dedicated to fibre optics (LEMO Fibre Optic Unit of Research or LEMO FOUR). It brings together all that is needed for developing ever improving products and connection solutions: prototype workshop, test & measurement laboratory and above all, high-level researchers.

This research centre has also been working on how to keep pushing the limits of HD technology. For example, LEMO has just tested its fibre connectors for television broadcasting with up to 4K definition (4 times the Full 3G HDTV). The next goal is to reach 8K in the near future which is believed to be more than feasible with the existing technology.



Engineering the standard of fibre optic connectors



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