CABLEWORLD

MAGAZINE FOR LAPP GROUP CUSTOMERS

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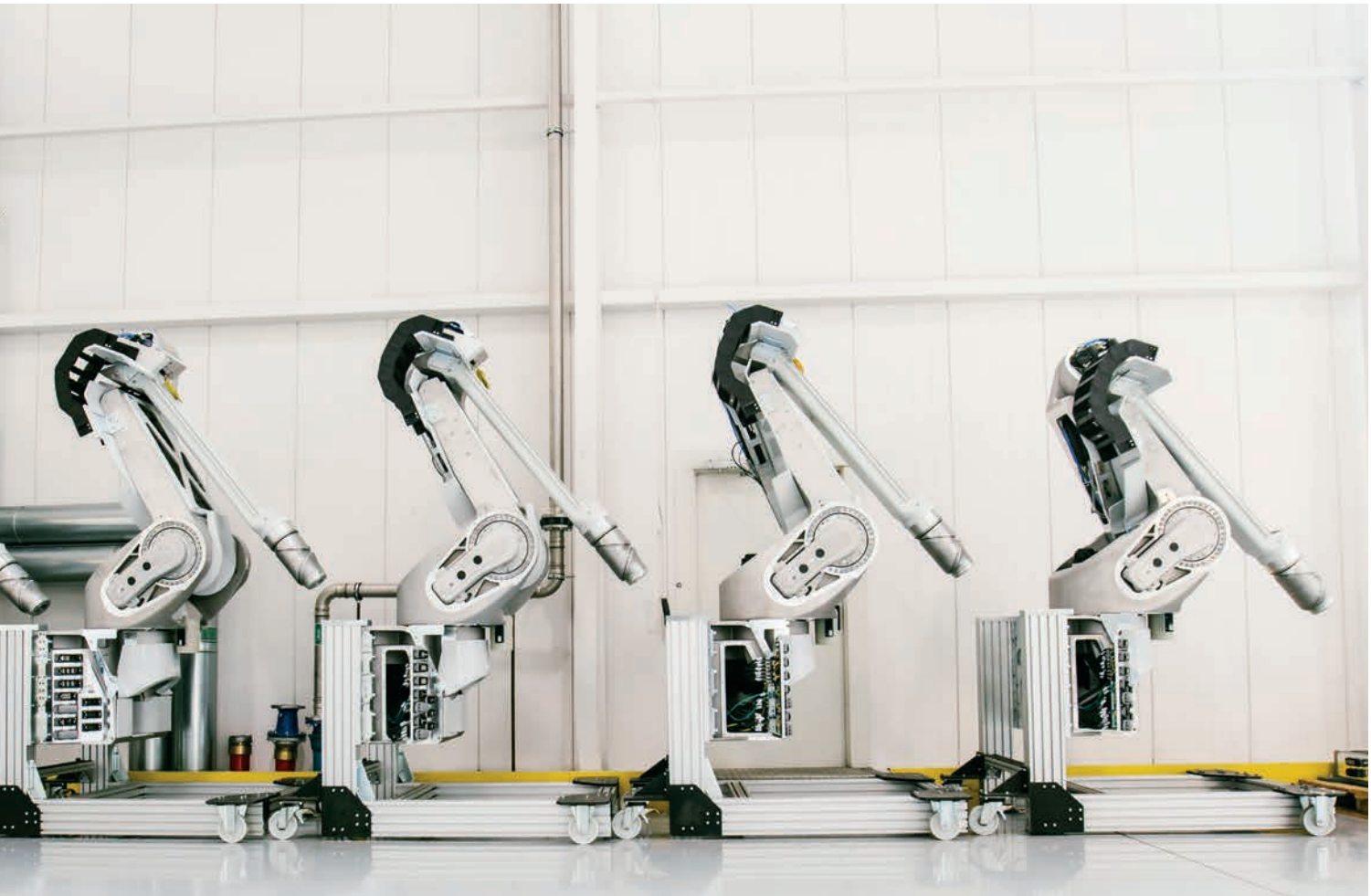


ROBOTICS

TRIUMPH OF ARTIFICIAL INTELLIGENCE

OF MEN AND MACHINES

Dear readers,

Anyone who joins a tour at the Museum of Communication in Berlin will be amazed, not just by the superb exhibits on display there, but particularly by the museum guide. The job is done by a robot. This is just one of many examples of how robots are now firmly established as part of our day-to-day lives. Contrary to most science fiction scenarios, humans and machines live a peaceful and, above all, productive coexistence.

Advances in robotics have not only made many tasks in industrial production much more efficient – they mean that many processes are actually possible for the first time. For us at the Lapp Group, robotics is a thrilling area with huge potential. Naturally, the key question that concerns our customers also concerns us, namely: Where next for robotics?

Wherever the road leads, despite all their artificial intelligence there are some things that even future robots will not be able to do. Things like carefully turning over this page, or sincerely wishing you an enjoyable read. Only a person can do that!

With best regards,

Andreas Lapp

COVER STORY

IN FOCUS

ROBOTICS – TRIUMPH OF ARTIFICIAL INTELLIGENCE

FROM THE ROBOT THAT SEARCHED THE RUINS OF THE WORLD TRADE CENTRE FOR SURVIVORS TO THE FLYING DRONES THAT WILL DELIVER OUR ONLINE PURCHASES TO OUR HOMES IN THE FUTURE, ROBOTS WILL SOON BE AS INTEGRAL A PART OF OUR EVERYDAY LIVES AS THEY ARE TODAY IN MAJOR INDUSTRIAL SECTORS. IT IS NO WONDER THAT SCIENTISTS AND JOURNALISTS ALIKE ARE ALREADY DUBBING THE 21ST CENTURY THE "AGE OF ARTIFICIAL INTELLIGENCE".

One figure illustrates how rapidly robotics is advancing: Forecasts suggest that in 2015 annual sales of industrial robots will exceed 200,000 units. This boom is due to the fact that robotics has developed in giant steps. Today's intelligent helpers are much easier to program and teach than just a few years ago, and they can be flexibly and individually used for a huge variety of different tasks with extremely short setup times. These high-tech descendants have little in common with their "great grandfathers", who packed bottles into boxes back in the 1960s.

Robots are not only used in production, logistics and storage these days. Wherever there are jobs that are too dirty, too dangerous, too strenuous or simply impossible for humans, smart companies are relying on artificial intelligence. The best example of this: service robots. These include remote controlled vehicles that inspect or weld underwater oil and gas pipelines, robots that ensure drinking water quality in hot regions, or even tiny robots that are sent into sewage systems to clear and repair them.

ROBOTICS IS THE SUPREME DISCIPLINE FOR CABLES

As demanding as the tasks performed by robots are, the requirements for the cabling are equally stringent. That is why the issue of robotics is a major focus in the Lapp Group. Building on a wealth of manufacturing expertise within the company, while the French subsidiary Lapp Muller in Grimaud has specialists with more than 25 years' experience in robot and drag chain applications.

This know-how creates competence. Ultimately, competence is exactly what it takes to be successful in robotics, with its countless range of applications and individual designs. It is an area where practically no two applications are the same. This means that every cable solution also has to be unique, whether it is to provide a specific power supply for robots or high-performance data transmission, for example when building robots with high resolution camera systems.

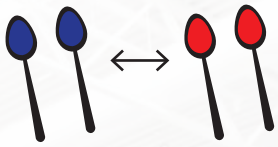
However, for many robot applications the outer material of a cable is just as crucial as what is inside. The cable may need to be able to withstand mechanical abrasion and chemicals, or requirements might include resistance to harsh working environments, or extreme tensile strength. Whatever people demand from a robot as an indefatigable worker, they demand exactly the same from the cables.

INDUSTRIAL ROBOTS

- Articulated robots with 4 to 6 axes are flexible to use and can handle everything from handling and assembly tasks to welding, loading and unloading. Painting and coating robots are a special form, providing efficient and precise bonding, dusting and painting.
- Swivel arm robots carry out "pick and place" tasks, moving materials in a limited radius at high speed.
- Parallel kinematic robots with opposing arm systems are primarily used in the food & beverage sector.
- Linear robots are frequently used for loading pallets in the packaging industry.

FROM MOONLIGHT BLUE TO MISANO RED IN UNDER 10 ML

A painting robot can switch from one paint colour to another in 10 seconds with minimal material wastage. Dürr has managed to reduce the inevitable paint loss to around 10 ml per colour change – just 2 teaspoons or a half-full shot glass.



THE EFFICIENCY QUOTIENT

INDIANA RED, MISANO RED, TORNADO RED – ALL AUTOMOTIVE MANUFACTURERS HAVE THEIR OWN SPECIFIC COLOURS. MANY OF THESE HAVE SOMETHING IN COMMON, NAMELY THAT THE VEHICLES ARE OFTEN PAINTED BY ROBOTS SUPPLIED BY THE SOUTHERN GERMAN COMPANY DÜRR. WE VISITED DÜRR HEADQUARTERS IN BIETIGHEIM-BISSINGEN TO FIND OUT HOW ARTIFICIAL INTELLIGENCE CAN BE DEPLOYED TO INCREASE EFFICIENCY.

Long bright corridors, well lit manufacturing halls and a noticeably high number of young employees – the laboratory of the future certainly looks futuristic. Dürr is a system provider supplying cleaning systems for production of engine and gearbox components, as well as balancing systems and products for final assembly. However, Dürr's main role is in planning and building paint shops for the automotive industry. In other words, this means workstations for robots.

A whole football team of 6-axis robots is lined up, ready for their functional test and nearly ready for use. The robots' destinations are already decided – Melfi, Dingolfing, Shanghai. Many of them are going on a world trip, as Dürr has a significant international focus. One of them is marked RPL: Robot Paint Low. Its taller colleague has the code RPE. The E stands for elevated, as some painting robots are built higher. Dürr robots not only paint cars throughout the world, but also their big brothers – commercial vehicles.

HIGH-TECH-HELPERS

When it comes to painting vehicles, both drivers and car manufacturers alike have very specific expectations. Frequent changes of model, innovative vehicle designs and new paint systems demand a high level of flexibility and innovation from Dürr. These days, painting is very much a high-tech sector.

A painting robot has the job of moving the nozzle during painting, at a constant vertical distance from the body surface, thus ensuring an even application of paint. To achieve this, Dürr constructs and programs not only moving and stationary painting robots for exterior and interior painting, but also so-called handling robots, which are small, intelligent helpers that can open, hold and close car doors and bonnets.

PAGE 6 – 7 In the fast lane: In the last 3 years alone, the number of Dürr robots installed worldwide has risen from 4,400 to 7,300.

THE ART OF REDUCTION

Under Dürr's logo you will find the phrase "Leading in production efficiency", while their flag shows a simple formula: less is more. Less time and distance, less material required and less energy consumption. Wherever Dürr can reduce colour changeover times or minimise paint and solvent losses, the global market leader is increasing its customers' production efficiency. This is their claim, but is also the reality.

Dürr is experiencing significant growth, as there is always a high demand for efficiency. To ensure that things stay that way, systems and products are continuously being developed, including their internal components.

"Our robots use cables that are subjected to huge loads. There are torsional movements that the cable simply has to be able to cope with", says Heiko Kamp from Dürr control engineering product development. "Not just twice, but millions of times. We know we can rely on Lapp to deliver this".

"Coping with" in this case means that the cable needs to have a dynamic bending radius equivalent to 10 times its outer diameter, capable of ± 180°/m of torsion. Ultimately, Dürr can rely on Lapp because our cables are all tested for 10 million bending and torsion cycles.

THE IDEAS FACTORY NEVER STOPS

The extreme mechanical and chemical loads or even the demanding technical requirements are not the only challenges. Because no two robot applications are ever the same, every cable is a special solution to a certain extent.

"We rely on Lapp's expertise to produce special cables for us for these applications", says Heiko Kamp. This is true even when it comes to breaking new ground, as the Dürr ideas factory never stops. "We are always coming up with new ideas. Putting them into practice often calls for special solutions, cables and connectors that are simply not available off the shelf. But we're always confident that Lapp can come up with the goods."

PAGE 8 – 9 High tech in tiny spaces The technical requirements in terms of bending radius and torsion demand a great deal of know-how and design skill from Lapp.

DÜRR PROFILE

Dürr is a global system partner to the automotive and supplier industry, and is the global market leader in painting, balancing and cleaning technology. The company has 8,200 employees at its 52 locations in 23 countries. In the last 3 years alone, the number of Dürr robots installed worldwide has risen from 4,400 to 7,300.

MISTER ROBOTO

"THE FUTURE IS NOT FAR AWAY" SAYS SOMEONE WHO SEES IT EVERY DAY. AN INTERVIEW WITH WOLFRAM BURGARD, PROFESSOR AT THE INSTITUTE OF INFORMATICS AT THE UNIVERSITY OF FREIBURG, HEAD OF THE RESEARCH LABORATORY FOR AUTONOMOUS INTELLIGENT SYSTEMS AND WINNER OF THE GOTTFRIED WILHELM LEIBNIZ PRIZE – THE MOST IMPORTANT RESEARCH PRIZE IN GERMANY.

Professor Burgard – You specialise in research into intelligent systems and mobile robots. Is the future already here?
To be honest, we are not far away from it. There are already autonomous mobile robots, for example for cleaning floors, vacuuming or mowing the lawns. In industry, we have transport robots that can move objects autonomously. Autonomous driving is also a result of research in the field of mobile robotics. In the future, vehicles will take on more functions, making driving significantly safer.

How do you actually develop a robot? Is it more science than fiction?
Typically, we start with a specific problem, for instance the question of whether a robot can navigate autonomously through city centres. We ask ourselves what mechanical properties the robot will need to have and which sensors will be the best suited. Then we build the robot and equip it with sensors and computers. Then we start adapting the process for the robot system. In some cases we have to create totally new processes.

Robots in the home, robots in health care, robots that support operations – what will be next?
Cars will carry out an increasing number of tasks autonomously, reducing our workload when driving. I have great expectations of autonomous systems in an industrial context for performing transportation tasks more effectively. But in the future we will also see more robust systems for simple manipulation tasks, starting in an industrial environment. As soon as they have established themselves there, it will not be long before there are handling robots for the home.

Which other fields will robots conquer in industry?
At the moment, there are mobile transport systems and static manipulation robots. In the near future, these two areas will be combined by developing mobile manipulation robots. These will be robots that can assemble components while moving, a major advantage over conventional conveyor belts.

Should we be be scared of robots? Or all worried about our jobs?
No. I'm a fan of systems that can carry out tasks independently. But we are so much better than robots when it comes to manipulation tasks combined with perception that there will still be enough work options for us in the future.

Is there anything that robotics cannot construct?
Of course there are limits, both mechanically, in electrical engineering and in software engineering. Currently, there are not yet any robots that can move quickly while simultaneously going up or down a kerb. When it comes to developing grippers and hands, we are lagging way behind nature, to say nothing of the issue of batteries, which are still too heavy for the capacity we require. There are also shortcomings in sensor technology, for example in robust three-dimensional perception. Finally, we lack reliable software solutions for detection of objects.

What will a robot never be able to do?
Be like a person.

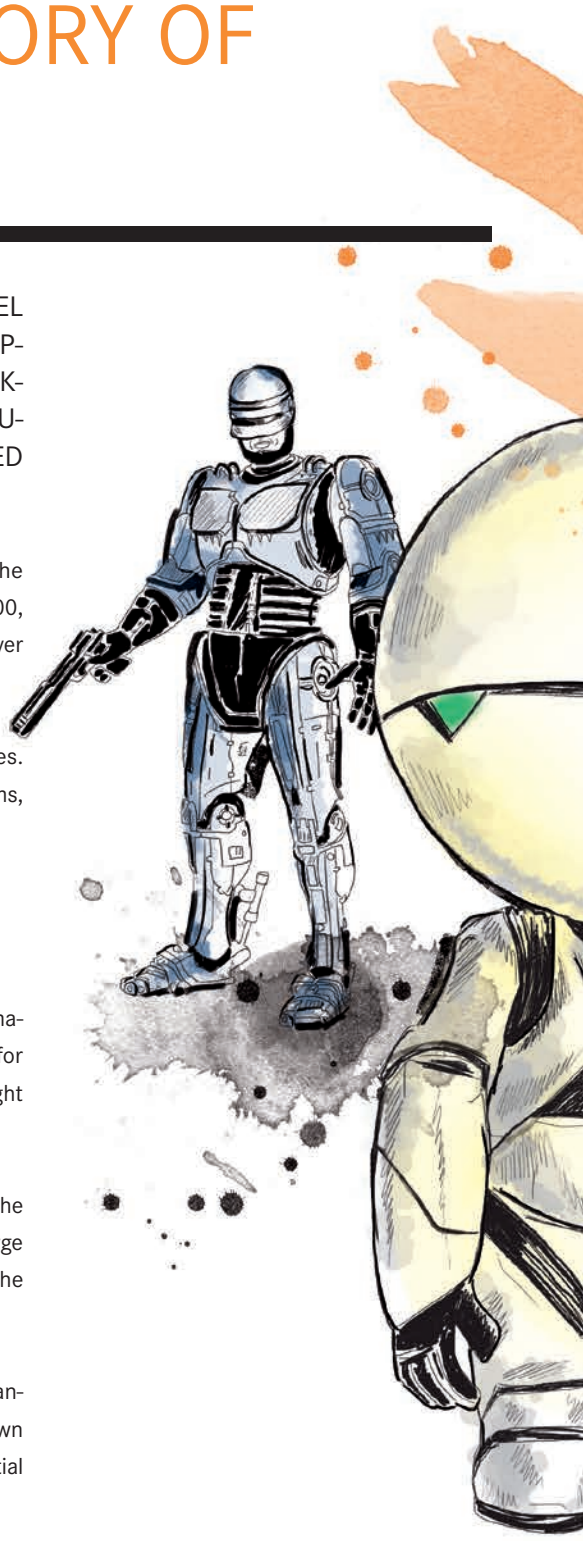
"WE HUMANS ARE SO MUCH BETTER THAN ROBOTS WHEN IT COMES TO PERCEPTION."

ABOUT WOLFRAM BURGARD

Wolfram Burgard studied Computer Science at Dortmund Technical University, completed his doctorate at the University of Bonn and, in 1999, was appointed to the University of Freiburg. There, he holds the professorship in autonomous intelligent systems and mainly works in the area of robotics.

Wolfram Burgard has published more than 300 academic papers and has received numerous awards. In 2009, he was awarded the Leibniz Prize by the "Deutsche Forschungsgemeinschaft" ("German research association"), the most sought-after academic prize in Germany.

A BRIEF CULTURAL HISTORY OF ROBOTS



THE WORD "ROBOT" FIRST APPEARED IN 1921. THE CZECH AUTHOR KAREL ČAPEK USED THE WORD – WHICH WAS BASED ON **ROBOTA**, MEANING APPROXIMATELY FORCED LABOUR – TO DESCRIBE ARTIFICIAL PEOPLE WORKING IN FACTORIES. SINCE THEN, ROBOTS HAVE BEEN THE HEROES OF NUMEROUS SCIENCE FICTION STORIES AND SOME OF THEM HAVE ACHIEVED CULT STATUS. HERE IS OUR HALL OF FAME:

ROBBY THE ROBOT. Became a cult figure after appearing alongside Leslie Nielsen in the film "Forbidden Planet". At the time, Robby was the most expensive effect ever at $ 125,000, including a lighting console in the head that flashed when Robby spoke. There have been over 300 toy models of the great grandfather of all film robots.

ISAAC ASIMOV. The science fiction author published almost 500 books and 200 short stories. Asimov formulated the three fundamental rules of robotics, which are still quoted today in films, books and TV series:

1. Robots may not cause any damage to human beings.
2. Robots must obey commands given by humans.
3. Robots must protect their own existence.

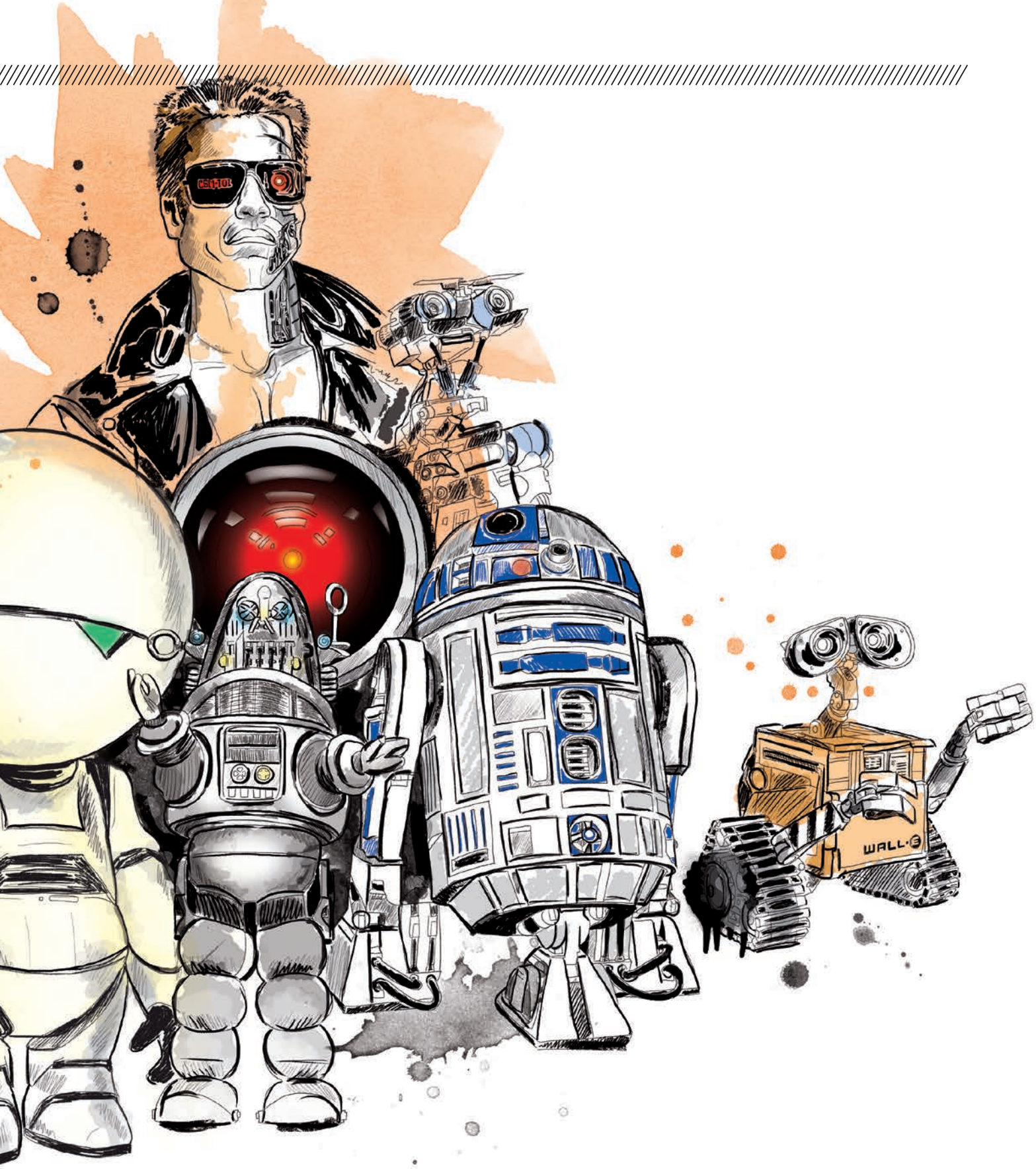
HAL 9000. The red camera eye from Stanley Kubrick's "2001: A Space Odyssey". A machine that understands language, and with which you can play chess, a kind of prototype for artificial intelligence. Is it coincidence or some kind of in-joke that the letters H-A-L are right next to the letters I-B-M in the alphabet?

R2D2. Standing just 96 centimetres tall, this droid is probably the real star in Star Wars. The shape of his body is based on half a washing machine drum from the 1930s. Director George Lucas came up with the name because R2-D2's first appearance was intended to be on the second roll of film (Reel 2) in the second dialogue (Dialogue 2).

TERMINATOR. Referred to in the film as a cyborg, strictly speaking the Terminator is an android. Arnold Schwarzenegger's legendary "I'll be back" made the list of the 100 best known film lines. The movie, made on a relatively moderate budget, became one of the most influential science fiction films of the 1980s.

WALL-E. Computer animated joint production by Pixar and Walt Disney. The name is an acronym for "Waste Allocation Load Lifter, Earth-Class". It's a waste disposal robot, but a brilliant one. With off-road capability, WALL-E moves around on two tracks, has scoops for hands, two cameras – and falls in love at the end.

ROBOCOP. A hugely successful classic 1987 film that had a bad start. Initially, Producer Jon Davison could not find a director, as everybody baulked at the title. Then, the final 15 kg latex Robocop costume did not arrive on set until the first day of filming – for a trial that lasted 11 hours.



NUMBER 5. The moving story of a military robot who develops a consciousness after he is struck by lightning. He outwits his pursuers by making a copy of himself from spare parts and achieves a happy ending with the film's famous line: "It's not a malfunction – Number 5 is alive."

MARVIN. Probably the most depressive robot in history. The secret star of Douglas Adams' science fiction parody "The Hitch-Hiker's Guide to the Galaxy". With a brain the size of a planet, he is constantly bored on the space ship "Heart of Gold", being hopelessly over-qualified for all the jobs on board.

"THE MAGIC WORD IS LISTENING."

FRANK ROTHERMUND, MARKET MANAGER FOR THE ROBOTICS SECTOR AT LAPP ON ROBOT KNOW-HOW IN THE COMPANY AND THE SECRET OF GOOD CUSTOMER RELATIONSHIPS.

When we spoke to Frank Rothermund, he was pleasantly focused. He knows what he's saying and what he's talking about. He is not only an attentive listener, but also a good raconteur. His eyes light up and you can feel his enthusiasm when he talks about the collective robot know-how in the Lapp Group, and the manufacturing expertise within the company. And the fact that Lapp is not just a supplier, but a developer and producer.

He outlines the fact that Lapp supplies complete systems in the area of robot cabling, from a flexible cable solution for the drag chain through to the connectors. This includes power cables, data cables, servo cables, sensor cables and hose systems for the entire electrical, pneumatic and hydraulic systems.

Rothermund's job is to work with various Lapp production sites to develop solutions for customers. This can only happen by understanding the customers and their individual requirements. "The magic word is listening", he says. "It's all about knowing what the customer really needs and how we can support them". This is the key to innovation for Lapp.

Even as a young lad, Frank Rothermund was a huge fan of Transformers. Now he's the one who transforms things, from ideas to realisation, from a customer need to a workable solution.

THE TRUST FACTOR

We want to know what the Robotics sector means for Lapp. "It's a major global future market", he replies without hesitation and immediately goes on to explain that the advancing automation in production, in the food industry, in the automotive sector and in industrial machinery makes robotics a strong growth market. It's a market that Lapp wants to help shape.

Then we ask a question from the other side, what role does Frank Rothermund, who has been with the company for 15 years, think customers believe Lapp can play in the area of robotics. Once again, his reply is overflowing with enthusiasm.

The most important aspect in robotics is the trust factor. Not just in Lapp products, but in Lapp as a partner. He is proud that he can promise his customers quality that they can depend on, quality in the products, but also in communication, delivery times and after sales support. Service cannot just stop when a transaction is complete. Ultimately the key is continuous improvement.

"To some extent, we are constantly working on the future" Frank Rothermund says. "Lapp carries out fundamental research like almost no other supplier. We are always on the lookout for new solutions to deliver an optimum package to our customers."

QUANTUM LEAP IN PRODUCTION

FULLY AUTOMATIC, RELIABLE PROCESSES BASED ON ROBOTS – WITH ITS NEW METAL PROCESSING CENTRE, THE LAPP GROUP HAS ONE OF EUROPE'S MOST MODERN PLANTS FOR MANUFACTURING RECTANGULAR INDUSTRIAL CONNECTORS.

For the Lapp Group, robots are not just on the customer list, they can be found in the building. Since mid-2013, some tasks that were previously carried out by hand on a lathe are now being performed by autonomous machines in the new metal processing centre. As well as ensuring effective process flows and quality at Lapp, this is helping to safeguard Germany's future as an industrial location.

Thanks to the new metal processing centre, Lapp has managed to bring production from the Czech Republic back to Germany. This is a good example of how industrial production of high grade components can help the country remain competitive internationally in this age of globalisation.

The new plant not only achieves higher volumes, it can also manufacture all variations in the product range flexibly and with short lead times. Four Fanuc robots, two metal processing machines, a fully automatic riveting station with loading and unloading station and a washing system are in use around the clock.

They turn 54 housings blanks into around 580 industrial versions of EPIC® rectangular and circular connectors. Production of the inserts for the connectors is also automated.

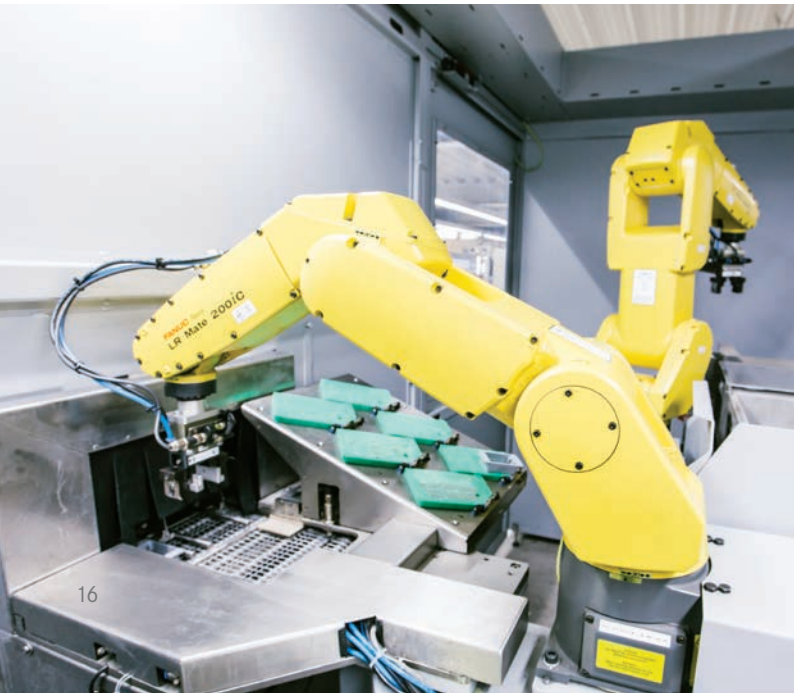
FULLY AUTOMATIC QUALITY CONTROL

While quality control for the EPIC® connectors was previously performed manually, the entire process is now fully automatic. Robots use a scanner to measure each individual part, then calculate any dimensional variation and tolerance and resolve any discrepancies immediately. They find the new zero point for the hole automatically or separate out a part if its tolerance variation is too high.

Everything runs fully automatically in the subsequent riveting station too. Here, the bolts are individually fed to the riveting unit according to their type and position, then positioned and riveted. The riveting point is corrected automatically where necessary. At the same time, the riveting pressure is monitored, and the values are documented and stored. This guarantees traceability at all times.

Jürgen Sielaff, production manager in connector production at Lapp, is proud of his new plant: "By combining fully automation with digital quality control, we have managed to achieve optimum repeat accuracy while maintaining the same high quality."

Translated into added value for the customer, this means a high, dependable quality level and, thanks to increased flexibility in production and faster processing times, also shorter delivery times.



THE MATHEMATICS OF ROBOTICS

INCREASING AUTOMATION IN AUTOMOTIVE

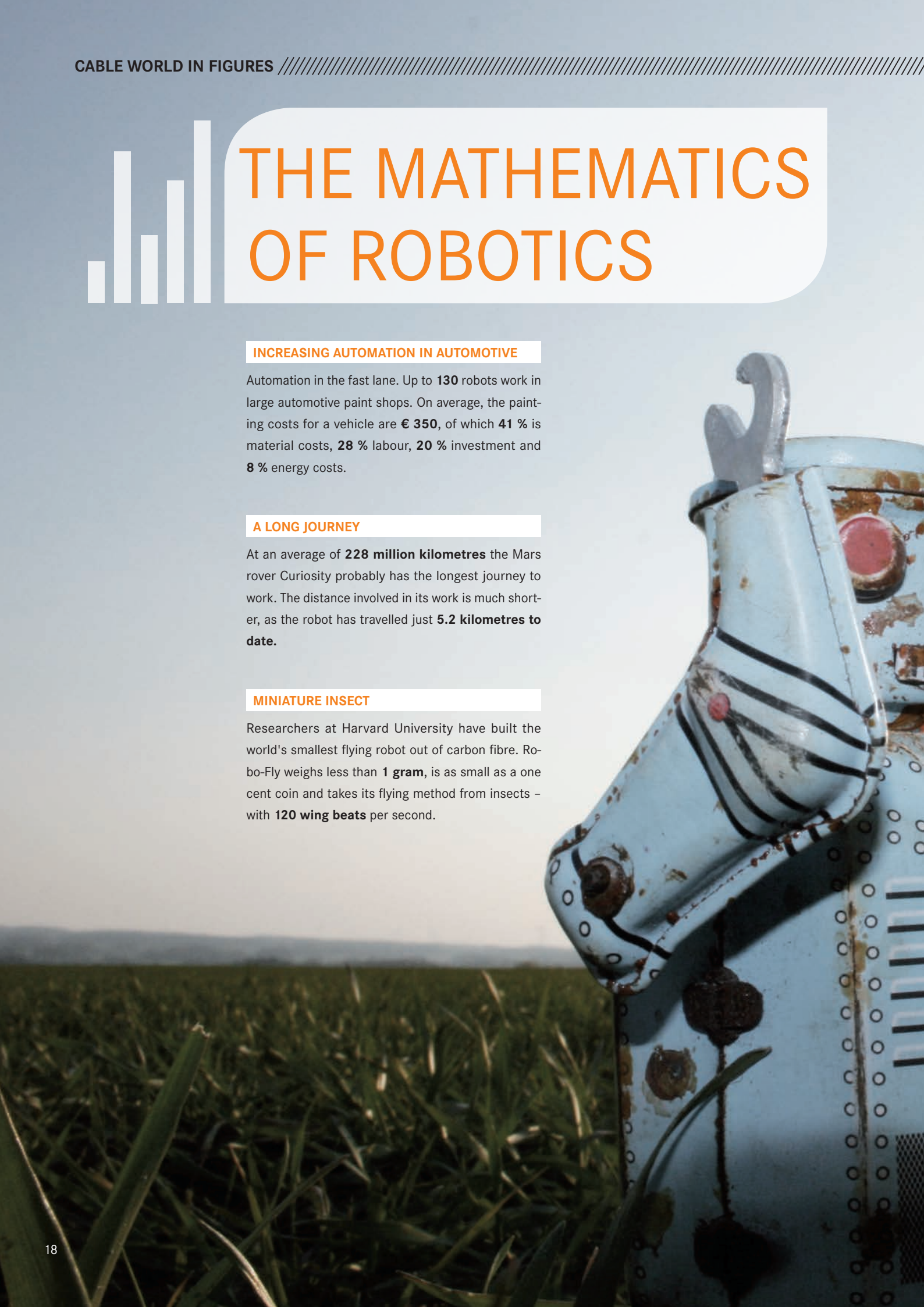
Automation in the fast lane. Up to **130** robots work in large automotive paint shops. On average, the painting costs for a vehicle are **€ 350**, of which **41 %** is material costs, **28 %** labour, **20 %** investment and **8 %** energy costs.

A LONG JOURNEY

At an average of **228 million kilometres** the Mars rover Curiosity probably has the longest journey to work. The distance involved in its work is much shorter, as the robot has travelled just **5.2 kilometres to date.**

MINIATURE INSECT

Researchers at Harvard University have built the world's smallest flying robot out of carbon fibre. Robo-Fly weighs less than **1 gram**, is as small as a one cent coin and takes its flying method from insects – with **120 wing beats** per second.



FASTER THAN BOLT

The "Cheetah" robot developed for the Pentagon is the fastest. The four-legged machine has set a world record at **45 km/h** – even faster than Jamaican sprinter Usain Bolt, who "only" managed **44.7 km/h** when setting his own world record.

GIANT MADE IN GERMANY

The largest walking robot is **15.72 metres long, 5 metres tall, has a span of 12.33 metres, weighs in at 11 tons** – and is a dragon. Produced by Zollner Elektronik AG for Germany's oldest folk play, it is powered by a 1**40 BHP diesel motor** and is remotely controlled by **4 people.**

OFFICIAL YEAR OF BIRTH

The word **"robot"** appeared for the first time in 1**921**. The Czech author Karel Čapek used the word – based on the Czech word **robota**, which means something like forced labour – to refer to artificial humans working in factories.

ROBOTS SEEKING EMPLOYMENT

The Japanese company NEC has developed the first babysitting robot – with **2 stereoscopic camera eyes, 8 microphones and a vocabulary of 3,000 words** – as well as the **first robot sommelier.** The "wine bot" analyses the quality of a vintage using infra-red rays.

ROBOT EMPIRE IN ASIA

Japan is the world's largest robot market and is set to retain that position, with **28,700 units sold in 2012.** However, Korea has the highest robot density: per **10,000 workers** they use **396 industrial robots.**

PUBLISHING DETAILS

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