FlexShapeGripper

Gripping modelled on a chameleon’s tongue

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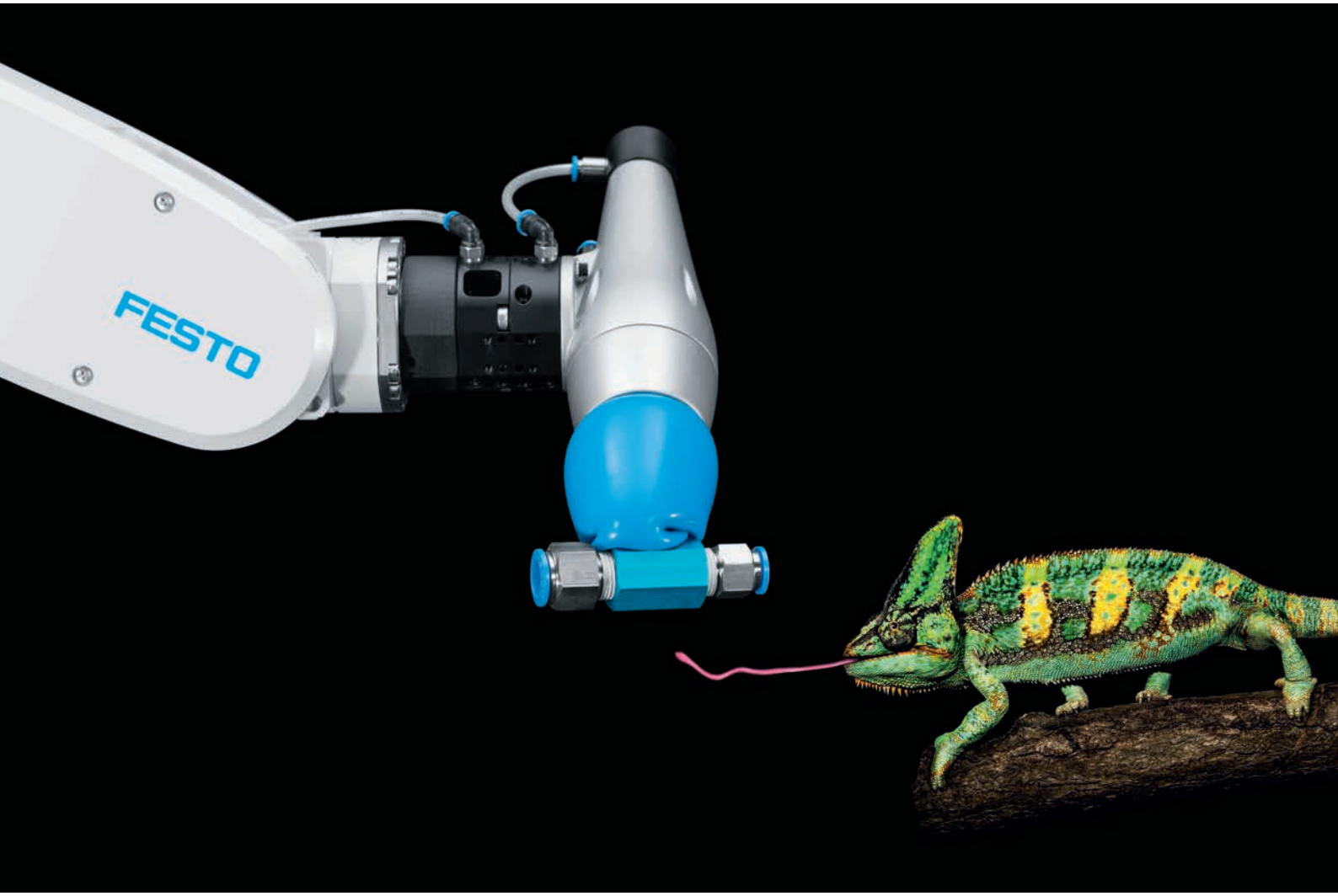

FlexShapeGripper
Soft gripping for various tasks

Picking up, holding and putting down objects – gripping applications have always played a key role in production. At the forefront of industrial automation, Festo is therefore constantly on the lookout for new gripping principles and innovative approaches to solutions for the production systems in the factory of tomorrow. One source of inspiration for new knowledge and future technologies is nature. That is why Festo brought the Bionic Learning Network to life. In an alliance with universities, institutes and development companies, Festo has already studied a range of different grip mechanisms on several occasions using biology as a model.

Pick and place of all kinds of shapes

In cooperation with the Oslo and Akershus University College of Applied Sciences, Festo now presents a gripper whose working principle is derived from the tongue of a chameleon. The FlexShapeGripper can pick up, gather and set back down several objects with the widest range of shapes in one procedure – without the need for a manual conversion. This is made possible by its water-filled silicone cap, which wraps itself around the items being gripped in a flexible and form-fitting manner.

Nature as a model

The unique inherent ability to adapt to different shapes gives the FlexShapeGripper its name. In nature, the unique combination of force and form fit demonstrated by the tongue can be observed when the chameleon is on the hunt for insects.

Once the chameleon has its prey in its sights, it lets its tongue shoot out like a rubber band. Just before the tip of the tongue reaches the insect, it retracts in the middle, whilst the edges continue to move forwards. This allows the tongue to adapt to the shape and size of the respective prey and firmly enclose it. The prey sticks to the tongue and is pulled in like a fishing line.

New impetus from open innovation

The aims of the Bionic Learning Network not only include learning from nature, however, but also identifying good ideas at an early stage, and fostering as well as implementing them jointly beyond company borders. The gripper is an outstanding example of the close collaboration by Festo with international universities as part of the network.

01: **Universal use:** flexible gripping of all types of objects

02: **Energy-free holding:** even when collecting more than one object in a single procedure

03: **Natural role model:** the form-fitting slingshot tongue of the chameleon

04: **Controlled gathering:** picking up and setting down according to the last-in-first-out-principle

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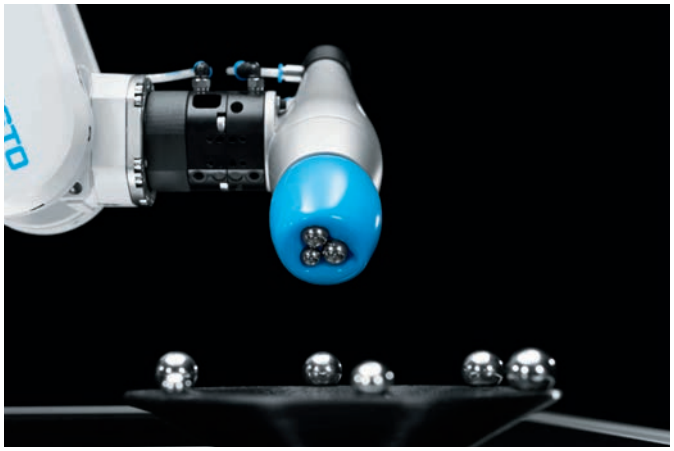

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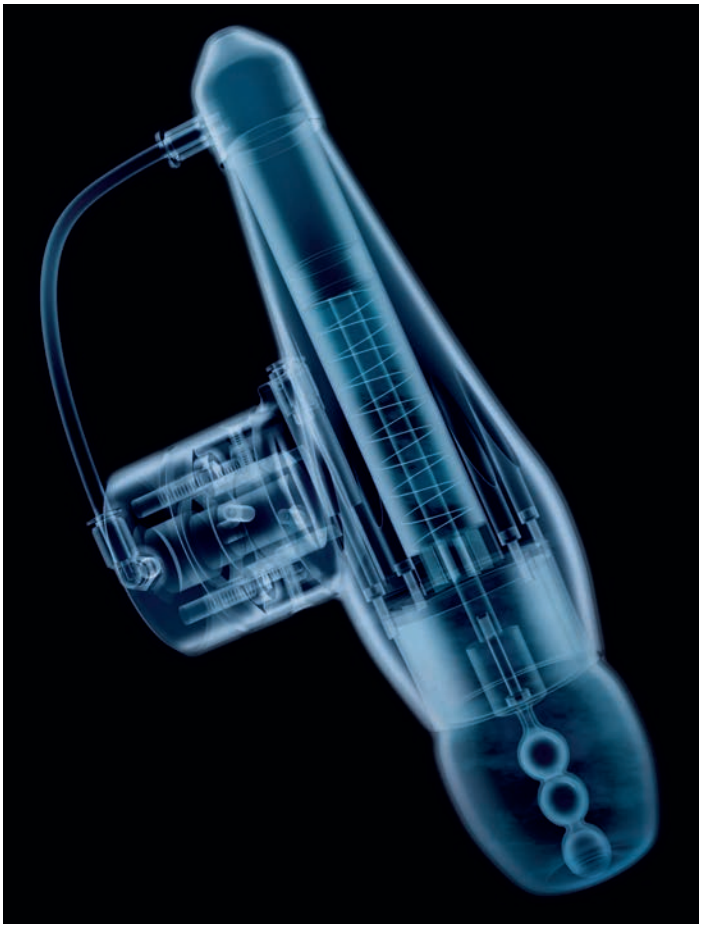

The stimulus for the project was a workshop on the subject of bionics at the Oslo and Akershus University College of Applied Sciences, where Festo presented its current research approaches from the Bionic Learning Network. Two of the students were inspired firstly by the presentation and then by nature itself: as part of their master's thesis, they presented the bionic grip principle modelled on the tongue of a chameleon. Together with the Festo engineers, the gripper's material, design and pneumatic components were subsequently optimised and the design concept for the FlexShapeGripper was developed further.

Technical configuration of the gripper

The gripper consists of a double-acting cylinder, of which one chamber is filled with compressed air whilst the second one is permanently filled with water. This second chamber is fitted with elastic silicone moulding, which equates to the chameleon's tongue. The volume of the two chambers is designed so that the deformation of the silicone part is compensated. The piston, which closely separates the two chambers from each other, is fastened with a thin rod on the inside of the silicone cap.

Form-fitting gripping thanks to inversion

During the gripping procedure, a handling system guides the gripper across the object so that it touches the article with its silicone cap. The top pressurised chamber is then vented. The piston moves upwards by means of a spring support and the water-filled silicone part pulls itself inwards. Simultaneously, the handling system guides the gripper further across the object. In doing so, the silicone cap wraps itself around the object to be gripped, which can be of any shape, resulting in a tight form fit. The elastic silicone allows a precise adaptation to a wide range of different geometries. The high static friction of the material generates a strong holding force.

Both the holding and the release mechanism are triggered pneumatically. No additional energy is necessary for the holding process. The yielding quality of the compressible compressed air simplifies the coordination between the handling system and gripper during the grip stage. The force and the deformation of the silicone part can be set very precisely with the aid of a proportional valve. This allows several parts to be gripped at once in a single procedure.

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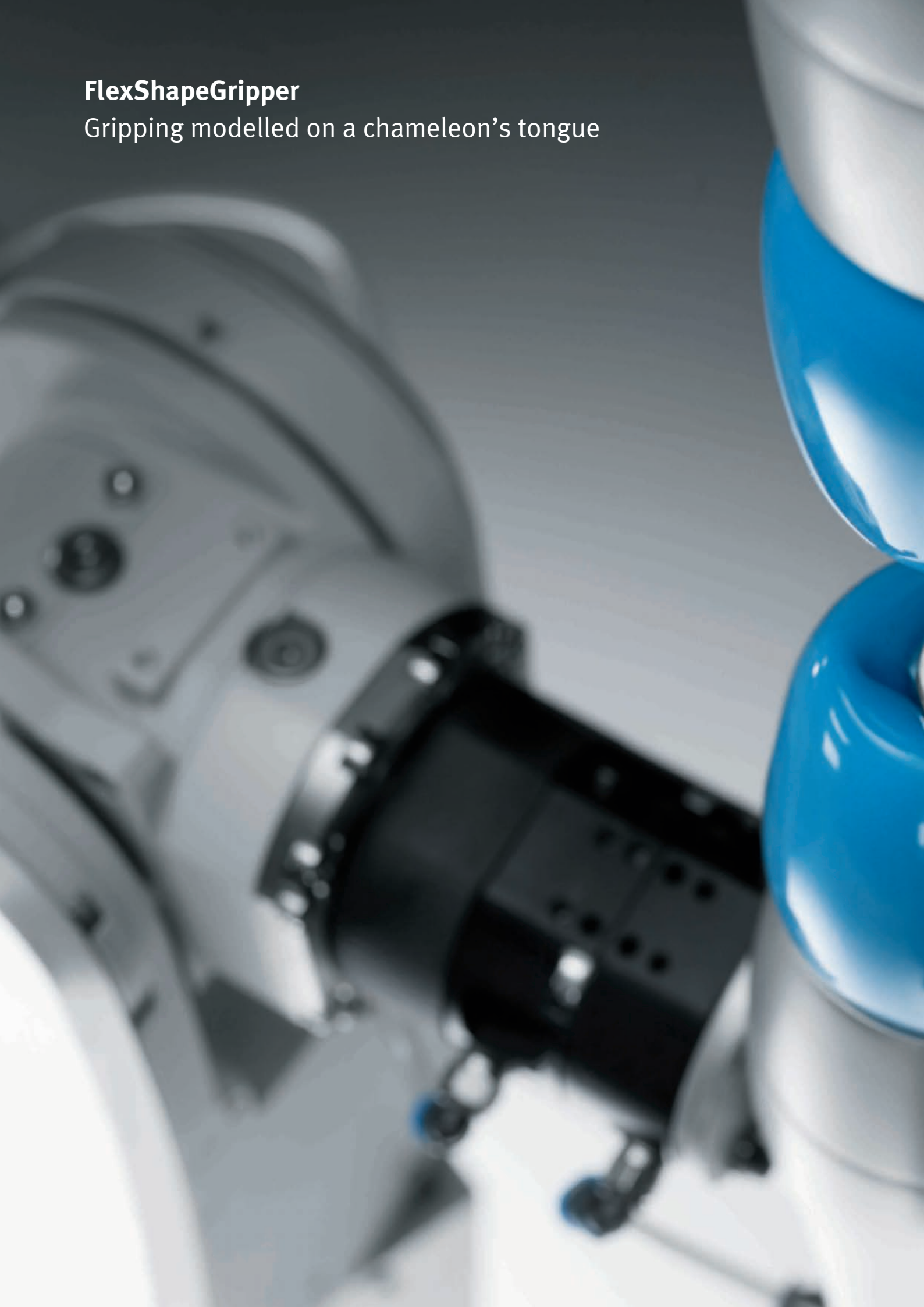

Special features of the chameleon
Chameleons are fascinating creatures. They can move their eyes independently of each other and change their colour depending on their mood and temperature. Another special feature is their hunting strategy. With the unique way they shoot out their tongue, they can attack as quick as lightning and securely fetch back their prey.

Technical benefits for Festo
A chameleon can catch all kinds of insects by putting its tongue over the respective prey and securely enclosing it. The FlexShapeGripper uses this principle to grip all kinds of objects in a form-fitting manner. With its elastic silicone cap, it can even pick up several objects in a single gripping action and set them down together.

Flexible installations and adaptive components
New solutions for the production of the future

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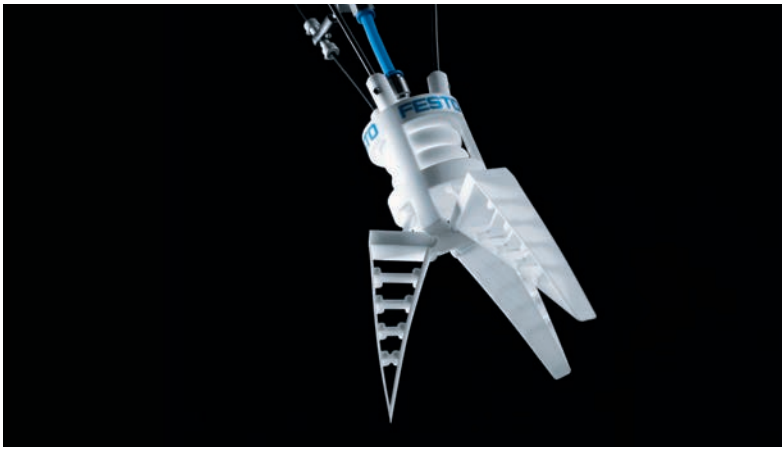

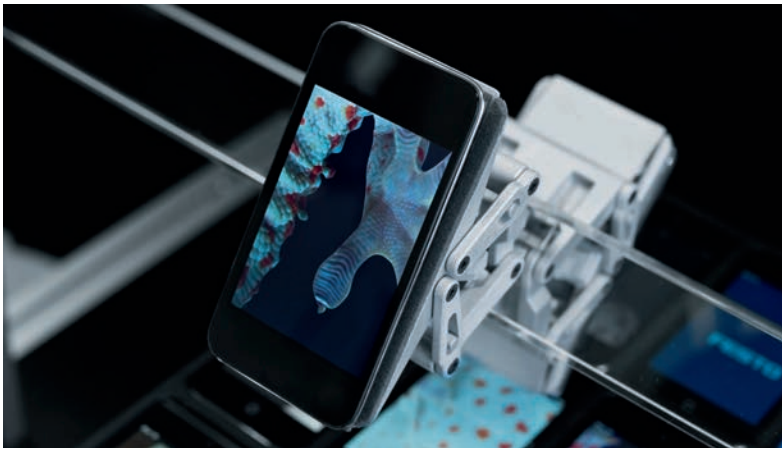

As an innovation leader in its industry segment, Festo has set itself the task of helping to shape the production of the future. An important part of this is making production processes simpler and developing new production systems.

Grippers in today's automation
There are already a number of different grippers in the industrial automation sector today, and each of them has been developed for a special task. If the shape of a workpiece changes, the corresponding gripper must be replaced on the machine or converted, which requires a great deal of effort. In facilities that make various products, changeover systems are therefore frequently used, which are fitted with different grippers.

Requirements of tomorrow's factory
In the production of the future, however, there will be a need for more flexible installations and components, which are independently adjusted to the respective product being made in line with the plug-and-produce method. Adaptable grippers like the FlexShapeGripper can assume a significant role in this respect.

Potential future uses
In future, the FlexShapeGripper could be used in any facility where multiple objects with a range of different shapes are handled at the same time – for example in the service robotics sector, for assembly tasks or when handling small parts.

In flexible production plants, it would be possible to handle all kinds of products in one procedure, without having to change the gripper. The job of sorting fruit and vegetables or other objects with irregular shapes would also present a possible task for a universal gripper such as the FlexShapeGripper.

Once it has been put into operation, the gripper is able to do various tasks. This functional integration is a good example of how systems and components themselves can be adapted in future to a variety of production scenarios.

The project also shows how Festo acquires new findings from nature for its core business of automation and how important the interdisciplinary exchange of information is beyond company borders.

01: **FlexShapeGripper 2015:** form fit of the chameleon's tongue

02: **BionicTripod with FinGripper 2009:** according to the principle of a fish fin

03: **NanoForceGripper 2012:** gripping modelled on a gecko's foot

04: **PowerGripper 2012:** inspired by the kinematics of a bird's beak

05: **ExoHand 2012:** power boost for human–technical cooperation

06: **LearningGripper 2013:** gripping and learning – working together

07: **MultiChoiceGripper 2014:** variable gripping of different shapes

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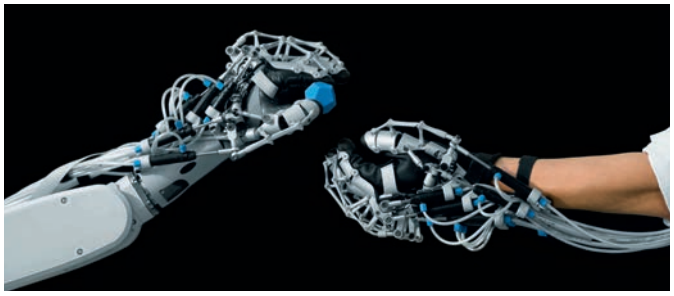

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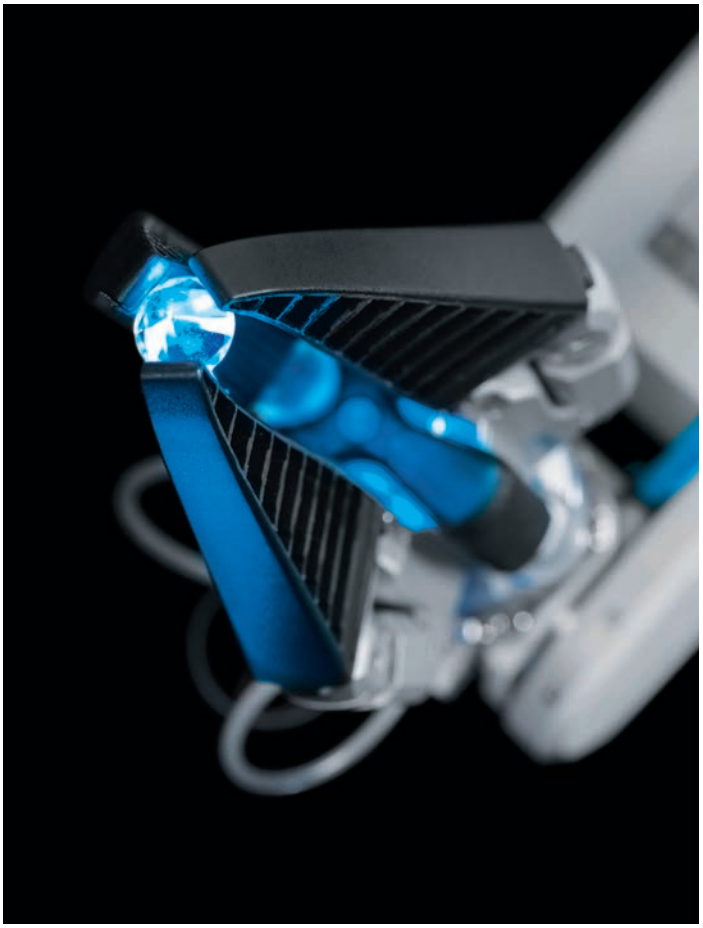

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Widest range of grippers based on a biological archetype
The FlexShapeGripper is added to a series of grippers, which have already emerged from the interdisciplinary research work of the Bionic Learning Network.

The developers were inspired by the animal world for the first time in 2009 when it came to the adaptive gripper fingers on the BionicTripod. Like a fish fin, the structure with Fin Ray Effect® does not give way under lateral pressure, but instead bends around the pressure point. The fingers therefore close softly around the items being gripped, which enables fragile and irregularly shaped objects to be safely gripped. Festo is currently developing the gripper finger into a serial product under the name DHAS.

Another gripper project from the Bionic Learning Network is the NanoForceGripper from 2012, whose gripping area imitates a gecko's foot. It is used to grip especially sensitive objects with smooth surfaces without leaving any residue and almost energy-free. The developers implemented the complex kinematics of a bird's beak in the PowerGripper.

The ExoHand is an exoskeleton that can be put on like a glove. It is used to actively move fingers, boost the power in the fingers and detect movements of the hand and transfer them in real time to robot hands. By means of force feedback, the person feels what the robot is gripping.

In 2013, Festo used the LearningGripper to develop a research platform, which is able to learn and can adopt complex actions by itself. One year later, the opposable thumb of the human hand served as an inspiration for the MultiChoiceGripper: like its natural role model, the gripper is able to change its fingers over so that they grip either in a parallel or centric direction, without requiring any conversion.

All grippers in a joint exhibit
The developers have now managed to take the next step with the FlexShapeGripper: a gripper that can collect several objects with different shapes and put them down together. Festo presents it together with the previous grippers and thus demonstrates the variety of grippers from the Bionic Learning Network.

Project participants

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Fin Ray Effect® is a brand of Evologics GmbH, Berlin

Film

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