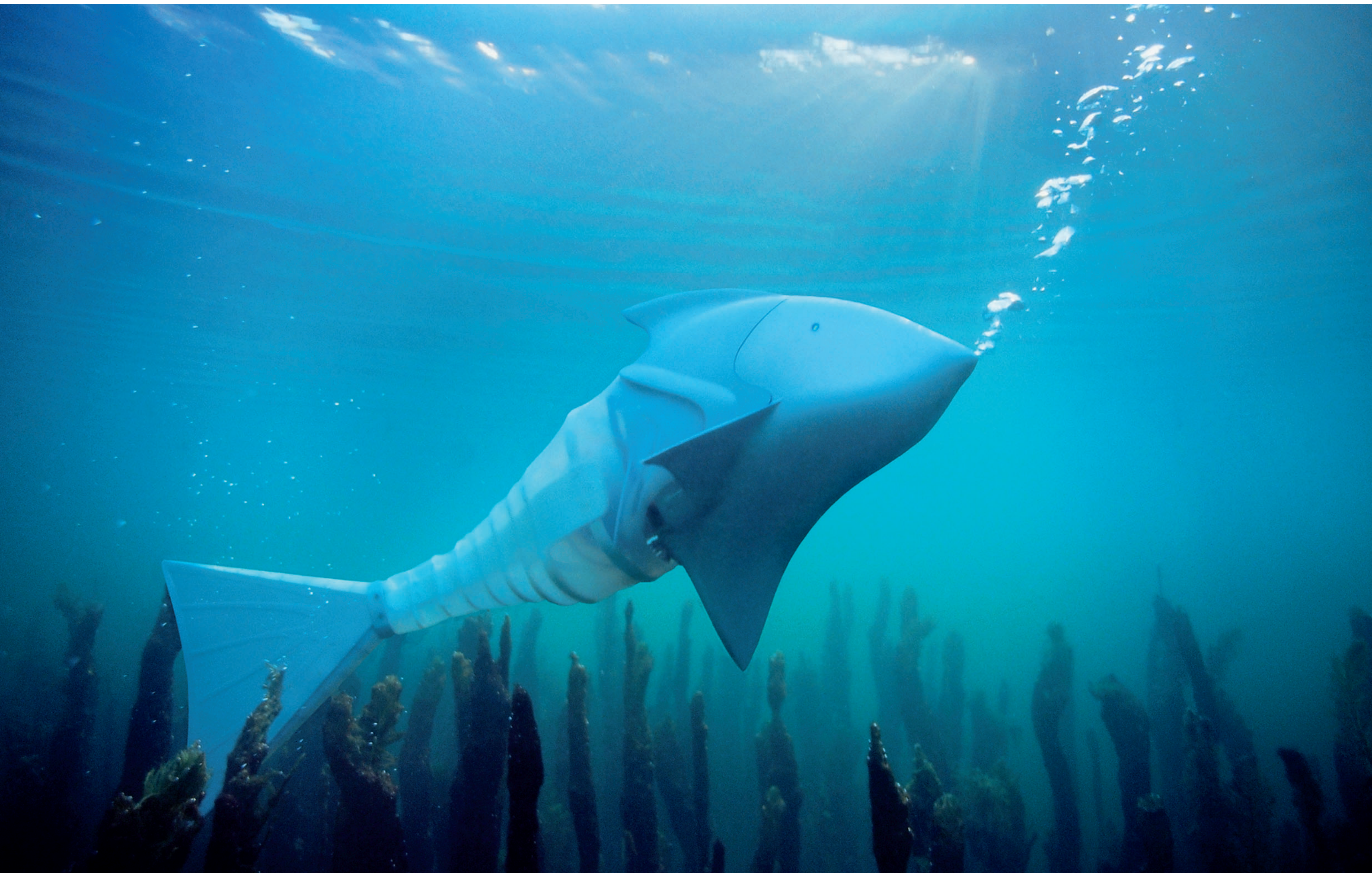
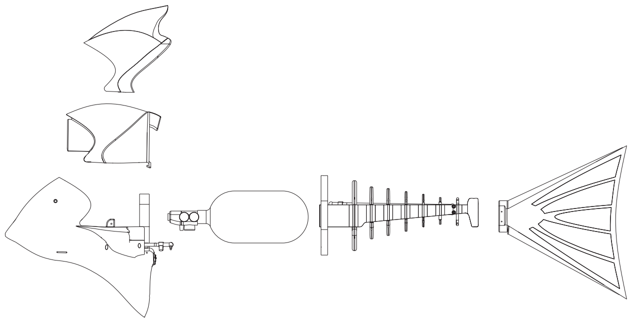
Airacuda

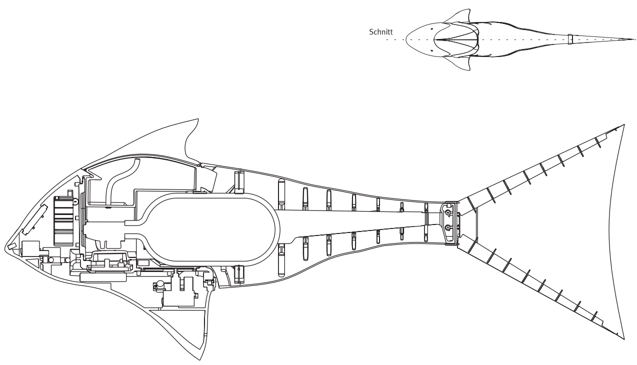


Info

Bionic object with fin drive



Structural design



Longitudinal section

Airacuda is a remote controlled and pneumatically driven fish that consistently harnesses bionic principles. Bionic, as we define it, is about translating biological operating modes into technical applications as closely as possible. Nature serves as a source of inspiration – it strikes us with an unlimited number of solutions showing uncompromisingly optimized features developed over the course of the evolutionary process. Various innovations can be derived from nature – and visions come true.

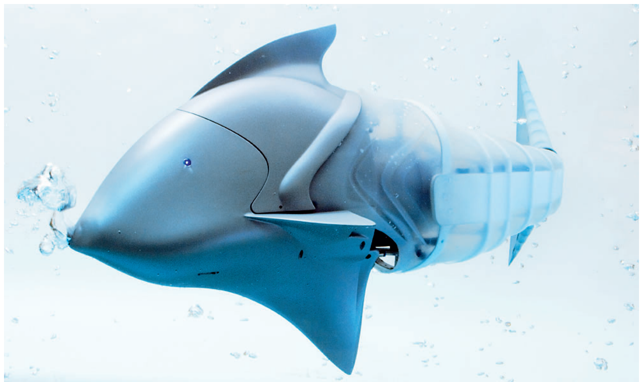
The Airacuda mimics a fish concerning its function, structural design, as well as shape. Airacuda's kinematical concept closely resembles the one deployed in its biological role model – propulsion is achieved through a mechanical fin drive.

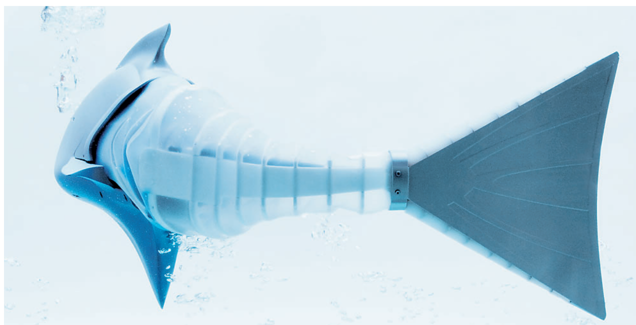
In terms of structural design the fin drive is modelled based on tail fins found in many fish; also, it applies a Fluidic Muscle showing qualities very similar to real muscles. The structure itself consists of two alternating pressure and tension flanks connected by a vertical frame. If one flank is put under pressure the structure automatically bends in the opposite direction of the actual force. What sounds complicated at first is a rather simple principle allowing the fish to fully convey the power generated by its fin stroke onto the water. This concept is called Fin Ray Effect® and was originally developed by Leif Kniese. In the case of Airacuda, the concept is harnessed twice, first within a passive structural element in the tail fin, and second for an active structural component inside the fish's hull. Concerning the latter, the diagonal dimensions of the structure are shortened alternately by means of two Fluidic Muscle.

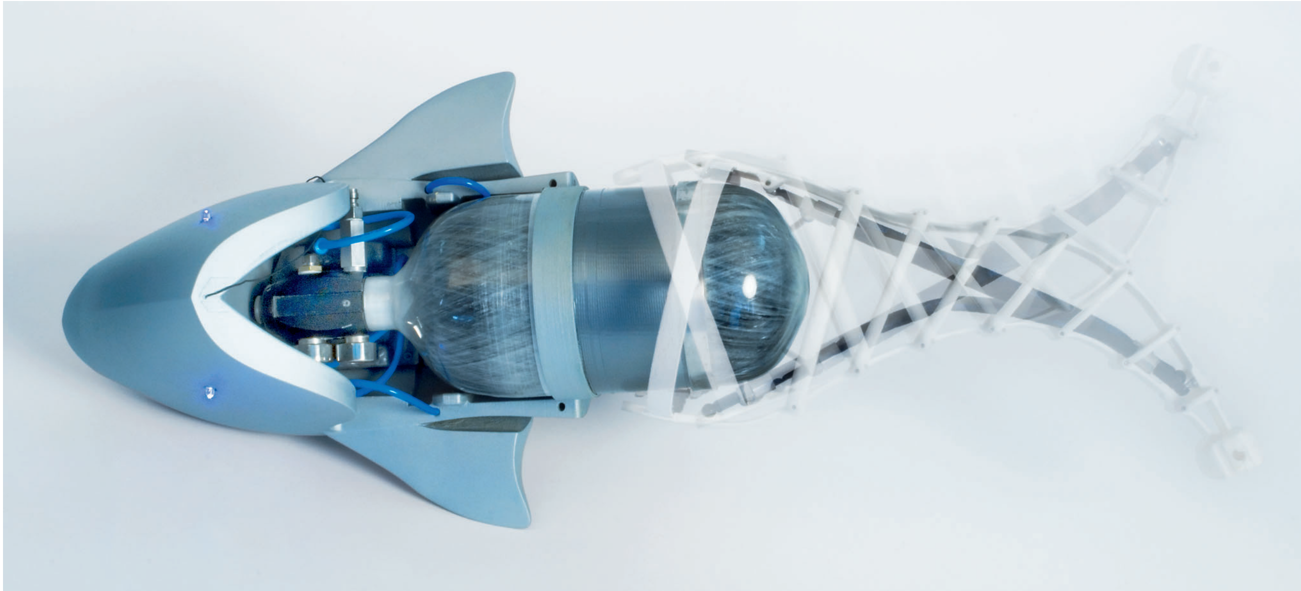
The Fluidic Muscle is a Festo product basically consisting of a flexible hose made from rubber and embedded aramid fibres. When inflated with pressurized air, the Fluidic Muscle expands in diameter and at the same time contracts longitudinally. The artificial muscle releases an initial force of high magnitude and shows dynamic qualities similar to human muscles. Being light-weight, and combined with its high flexibility and functional versatility, the Fluidic Muscle is the ideal actuator for bionic applications such as the one described here. Accordingly, two muscles are sufficient to actuate the tail fin in an S-shaped pattern. Two additional muscles allow for steering, which makes the Airacuda fully manoeuvrable using a total of only four actuators.

As a matter of fact, balancing the Airacuda when waterborne is also modelled after its natural archetype – That is, using an air bladder. To do so, the hull has an internal cavity, which can be flooded with water or filled with air, respectively. A pressure sensor evaluates depth and sends a corresponding signal to the electronic components, which then regulates the valves for either vacuum or compressed air to enter the air chamber.

To provide for a light but powerful energy supply, pressurized air is stored in a bottle at 300 bar. Operating Airacuda for approximately 35 minutes requires roughly 400 litres of compressed air. The air is distributed to the Fluidic Muscles in a controlled manner by means of the electronically steered valves. When inflated with compressed air at 6 bar the muscles contract by about 20 %, and thus, set off the structural motion.

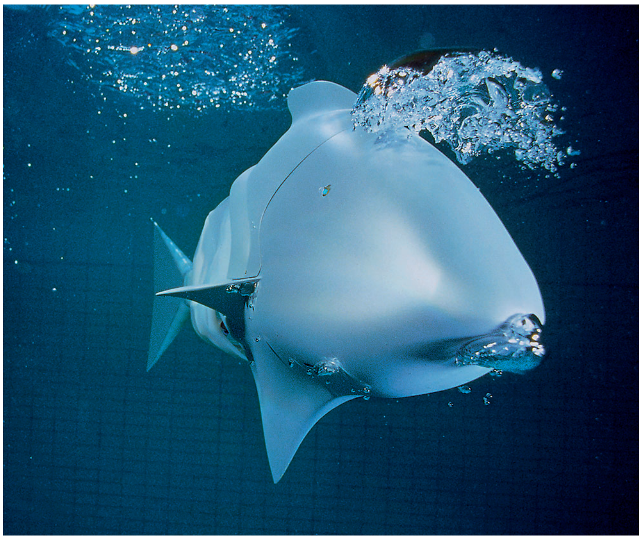






Structure moving

All electronic as well as pneumatic components are housed waterproof inside the head. The entire structure is coated with silicon film. Both, tail fin and head are designed and manufactured using the latest technology, which is CAD and related numeric controlled equipment. The complex form was generated without any manual labour using highly sophisticated laser-sintering technology only. It may very well be that future challenges lie mainly in exploring and learning from nature's amazingly versatile designs by harnessing cutting-edge technologies. However, while self-evident in many cases, nature's solutions aren't yet easy to imitate.



By engaging in bionic matter, Festo wants to reach beyond its core expertise bringing to you the excitement for both, nature and technology. Moreover, this study provides an idea about the diversity of applications Festo components can be used in.

Specifications

Length:	100 cm
Width:	28 cm
Height:	45 cm
Weight:	approx. 4 kg
Material used for head, structure and tail fin:	laser-sintered polyamide
Material used for skin:	silicone
Propulsion system:	4 Fluidic Muscle, ø 5 mm (prototype, not commercially available yet)
Compressed air storage:	1.5 litre bottle, 300 bar

Project partners

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