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Inductive linear position sensors in the Flying Fish roundabout ride now ensure reliable position sensing of the gondola arms



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Flying Fish

Zierer uses Turck's linear inductive position sensors with IO-Link interface

Amusement parks today are a crisis-proof sector of the economy all over the world, both for the owners and for their equipment suppliers. "Particularly in the difficult times, the visitor numbers to amusement parks have increased considerably – and continue to do so," explains Wolfgang Brück, managing

director of the amusement ride manufacturer, Zierer Karussell- und Spezialmaschinenbau GmbH, Germany. "In the amusement sector, the owners need to make regular investments in order to offer new attractions. Zierer is therefore in a good position even in times of economic crisis. We were and continue to be well in demand."



The company was founded in 1930 in Deggendorf, Lower Bavaria, and is one of the leading suppliers of family amusement park rides. Amusement parks and fair operators all over the world know and value Zierer amusement rides on account of their high quality workmanship, their safety standards and their low maintenance requirements. As a result, Disneyland, Universal Orlando, Tivoli Copenhagen, Busch Entertainment Corporation, Movie Park, Everland Korea and many other amusement parks worldwide are customers of the company.

From planning to design, continuing through to production and after-sales services, Zierer is the single

Quick Read

In its Flying Fish roundabout ride, Zierer Karussell- und Spezialmaschinenbau GmbH previously measured the horizontal position of the gondola arms using individual proximity switches. However, with five sensors for each of the twelve hydraulic cylinders, mounting, calibration and integration in the ride control system were really complicated, especially as the height measurement could only be approximated. For the first time, Zierer is now using inductive linear position sensors from Turck, that supply an analog signal and can be parameterized from the PLC via IO-Link.



“The LI sensor not only saves investment costs but increases the availability of the ride and helps to increase operational safety.”

**Wolfgang Brück,
Zierer**

source for a full range of services for the construction of fairground machinery. All amusement rides are manufactured to order and designed to customer requirements. Only the technical design is largely pre-determined.

Fun with optimum safety ensured

Amusement rides must not only be enjoyable to their guests, but must also be safe. In this sector, the requirements are often higher than conventional industrial plants. “After all, this ultimately involves passenger transport,” Brück points out. A classic in the Zierer offering is the Flying Fish roundabout ride. With this ride, passengers sit in twelve fish-shaped gondolas. Affixed to metal arms, the gondolas turn around the center of the ride. The twelve fish arranged in a star can be moved up and down hydraulically on their arm. The ride passengers particularly enjoy the fact that they can control the horizontal movement of the fish with a joystick.

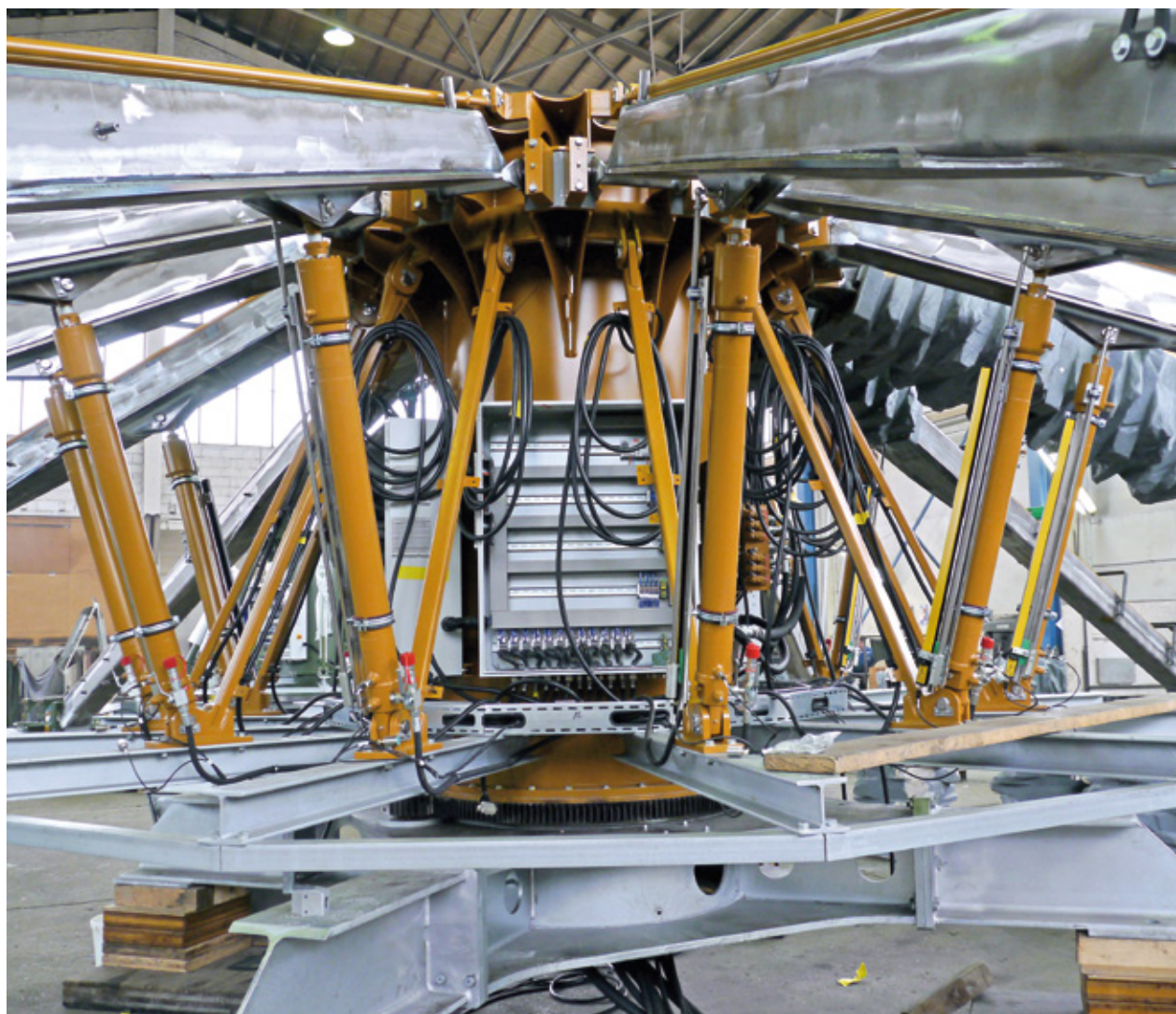
Zierer also offers the option with the Flying Fish ride of spraying fish, so that passengers have to dodge water jets if they want to stay dry during the ride. As safety should not suffer on account of the control options

of the passengers, the movement of the arms must be measured exactly and must be dampened at the top and bottom of the hydraulic system. Otherwise the gondolas could move to the end stop with a jerk, which would not be a pleasant experience for riders.

In order to determine the horizontal position of the arms, Zierer previously used five sensors on each hydraulic lift cylinder. Although this ensured safe operation, the installation of the sensors and their adjustment was relatively complex. There was also another reason why the designers searched for an alternative sensing method: the position of the gondolas could not be determined exactly at any time, but only at the five critical points where the sensors were mounted. “The range in between was a no-man’s-land,” says Klaus Gäck, project manager. “The controller didn’t know whether a fast upward or downward movement was possible, because it wasn’t known if the gondola was five or 150 centimeters away from an end point.”

Alternative linear position sensor

A solution using linear position sensing was considered in October 2011. Zierer looked for a linear position



Instead of having to use five proximity switches for each hydraulic cylinder, a 1,000 mm linear position sensor from Turck now supplies the exact position of the arm

sensor that measures the travel of the hydraulic cylinder up to its total length of 1,000 millimeters. Besides testing the sensors of other manufacturers, the Zierer project team also tested the LI-Q25 inductive linear position sensor from Turck. This sensor operates on the resonant circuit measuring principle which offers a high level of precision and interference immunity. Unlike magnetostrictive sensors, position sensing is not implemented via a magnetic positioning element, but with an inductive resonant circuit, i.e. an oscillating system consisting of a capacitor and a coil. Magnetic or metal environments, offset or vibrations can not impair the precise measuring function of these linear position sensors.

The LI-Q25 has very short blind zones because the sensing electronics are integrated over the entire length of the sensor. The system is currently the only one of its kind on the market. Zierer was suitably impressed by the test results of the Turck sensor. Even with rapid movements and the resulting centrifugal forces, the sensor reliably supplies the exact position of the positioning element via the 4...20 mA analog signal. The controller can determine from this the exact position of the arm at any time. Project manager Klaus Gäck was completely satisfied with the test result and summed up as follows: "For us the quality and reliability of all components in the operation is very important. The Turck linear position sensor seems to be exactly the right choice here."

Parameterization via IO-Link

Despite the positive test, two other requirements had to be clarified afterwards: for safety reasons, Zierer also wanted the possibility to indicate any failure of the positioning element. Although an LED on the sensor indicates if the positioning element is outside of the measuring range, Matthias Niedermeier, in charge of the electrical design, wanted to output this signal on the controller. Here the LI sensor was able to impress thanks to its ability to be parameterized via IO-Link. The IO-Link interface allows the user from the controller to define the measuring ranges, invert the output signal or simply output special signals like the failure signal. Niedermeier parameterized the sensor so that the "positioning element missing" signal was output separately via the IO-Link channel, just like all other error messages. The controller recognizes this special condition and shuts down the ride according to a stored safety routine.

Zierer had another requirement with regard to the MTBF (Mean Time Between Failures) values, which provide information about the probability of a device failure. The calculation of the value is based on operation at 40 °C. An analysis in accordance with directive SN 29500 (Ed. 99) has determined that the LI sensor can be operated for 138 years without failure. This probability of failure impressed everyone involved in the project. Managing director Brück was also impressed by the quality: "The sensor not only saves on investment costs but also increases the availability of the ride and contributes to greater operational safety."



With its short blind zones, IP67 and contact-free inductive positioning element, the LI sensor is ideal for the rugged use required in fair-ground machinery



Zierer electrical engineering specialist Matthias Niedermeier, parameterizes the LI sensor conveniently via the IO-Link interface, which also supplies all error signals to the PLC

Ultimate test

Zierer is currently building the first Flying Fish version with a total of twelve LI sensors for an amusement park on Lake Neusiedl near Vienna. "This is where Turck can demonstrate the robustness and reliability of its sensor technology," says Brück. If the sensor proves itself in continuous operation, Zierer will make it a standard product for other installations. ■