DURABLE TORQUE SENSORS KEY TO COBOT SUCCESS

Producing and working with collaborative robots (cobots) is a relatively new phenomenon — the first cobot was introduced in 1996. Yet, cobots are now considered to be one of the fastest growing segments in industrial automation.

Over a 4-year span, cobot installation increased by

DOUBLED

(11K to 22K)

Robot installations decreased by

7%

World Robotics 2021 industrial Robots Report, International Federation of Robotics, Oct. 2021

But why cobots instead of full automation? Efficiency.

In some applications, a human working alongside a robot is much more efficient than a fully automated or manual solution. Not only do cobots take on the repetitive, restrictive tasks that could cause a human operator harm, but they can increase the speed and accuracy of these tasks. In addition, cobots exert stronger force and/or torque than a human could, which is especially useful in applications where the operator would be prone to muscle fatigue. Plus, using cobots lets, human employees tackle more complex tasks.

Co-manipulation, a process by which humans operate the cobot to perform various tasks, also provides significant benefits. It allows plant managers and operators to leverage the efficiency and precision of a robot with the human ability to process contextual cues. Examples of this include soldering, illumination, drilling, sanding, and much more.

Another reason why cobots are growing in popularity is a lower threshold for adoption. Cobots do not require as much upfront engineering time when compared to a fully autonomous system, as they are typically not intended for more complex tasks. Therefore, cobots provide the benefits of automated functions at a lower cost.

SITUATION: Cobots for a major robotics company

TE Connectivity (TE) partnered with a major robotics company to optimize its next generation of cobots. As a market leader, this company needed a cobot that met industry-leading requirements — including high levels of functional safety, a high load-bearing capacity with increased arm speed, and a lightweight design.

Essentially, this cobot design had to be compact, accurate and extremely safe while also capable of complex functionality in a small space in an environment with high torque and thermal fluctuations.

CHALLENGE: Maximum functionality within minimal space

One of the most challenging areas in almost any robotic application is the joint. Not only is the space extremely limited, but the components have to be durable enough to withstand the high repetition and high torque produced as the robot is working.

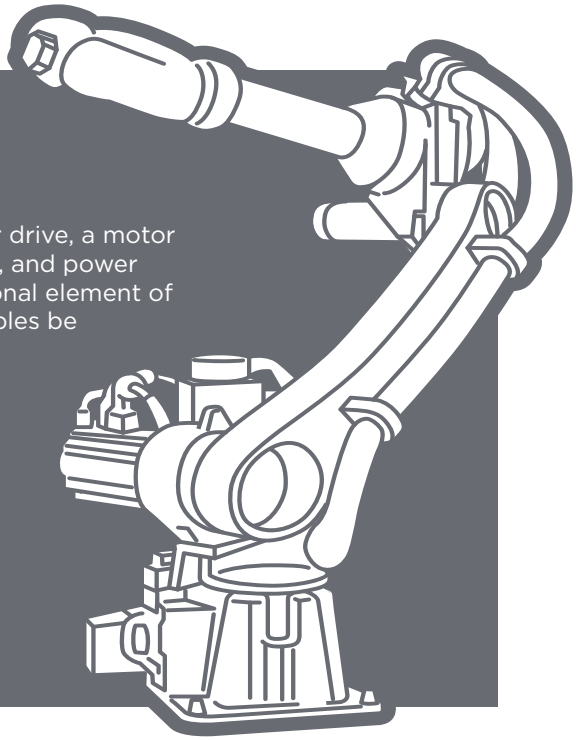
Due to the functionality of the OEM's application, the arm joint was subject to extreme axial loading as well as tilting movement. Even the location of the joint itself made it more susceptible to experiencing force. Through it all, however, the OEM needed the sensors to maintain accurate measurements without becoming subject to torque. Thus a durable torque sensor was an essential requirement for this project.

Temperature stability was an additional challenge. Due to the overall design, the joint was located near a motor, subjecting it to additional fluctuations in temperature. The engineers needed to reduce thermal sensitivity in the joint to maintain the highest levels of accuracy.

THE ANATOMY OF AN ARM JOINT

The arm joint is comprised of a torque sensor, a gear unit or gear drive, a motor drive or position sensor, a power converter for the electric motor, and power supplies. The sheer number of components introduces an additional element of complexity. The OEM on this project required the component cables be fed through one hole 8 – 10 mm in diameter.

Each time a hole is drilled through a piece of metal for those cables to run through, the stress performance of the overall design changes. Therefore, the input and output for the joint torque and safety torque sensors had to be customized for each cobot application — introducing yet another hurdle. Each design is unique to optimize the particular stress conditions for that particular torque range, thickness, and mass.



SOLUTION: Rugged torque sensors for added durability

TE leveraged cross-industry expertise in aerospace, rail, manufacturing, and more — as well as a wide product portfolio — to design a custom solution for this client. To meet the client's particular specifications, torque sensors, additional connectors, and cable assemblies were especially critical to the project's success.

Microfused sensor technology increases reliability

TE's torque sensor measures the deformation of a diaphragm under external pressure using highly sensitive silicon strain gauges in a bridge configuration. The silicon is bonded onto stainless steel using glass through TE's Microfused sensor technology, creating a stable, reliable bond that is well suited for the application's thermoregulatory requirements. This bond also helps transfer strain from the steel into the silicon, allowing for accurate torque measurements over long-term use.

Plus, the Microfused sensor technology offers excellent overload capabilities, meeting the OEM's need for high load-bearing capacity in the cobot arm. The design and use of Microfused sensor technology produced repeatable survivability rates at 200% and structural failure rates at 500% of rated load.

In addition, TE's torque sensors feature gauging with electrically segregated channels. This allows two data channels to be fed into a single chip which also has segregated channels, preserving the integrity of independent data outputs. This enables two truly separate measurements from different locations on a single physical structure, providing the dual redundancy needed for the increased accuracy, confidence, and safety that the OEM required.

Preserving functional safety through redundancy

Dual redundancy in the segregated channel design also allows for cross-checking. As the cobot works, the machine compares the independent measurements and stops operating in case of failure, in accordance with the OEM's required safety standards. TE worked with the customer so the cobot would trigger an error message if the two measurements were not within a small window of variability.

Torque sensor

In addition to providing additional reliability and safety, TE specifically engineered the torque sensor to reduce cross-load errors. This was achieved through controlling the steel geometry and its location, and fine-tuning the dimensions of the sensing region to meet the customer's specific measurements and requirements — which included compatibility with a full-scale range of sensors from 20 to 900 newton meters.

A full portfolio provides additional reliability

To help increase safety, the OEM required low deflection (or a high level of stiffness) in the cables as the torque is measured by the sensor. TE used connectors and cable assemblies throughout the cobot arm to reinforce the customer's functional safety standards.

TE assembled all the components together on each sub-functional unit of the cobot. Working with the same manufacturer for these components helped make sure that the internal connections and communications system from joint to joint were engineered to work together, which added an additional level of reliability in this project.

TE components were also used as a base connector in the end-of-arm tool interface, where the DC power, ethernet, sensor element, and brake unit are connected. Each component is shielded to withstand changes in vibration, shock, temperature, and more.

CONCLUSION: Global resources, cross-functional expertise, custom solutions

Designing robotics solutions with accuracy, reliability, thermal resistance, and safety, within very specific measurements from an OEM requires a feat of engineering. Each individual project must be optimized within the given parameters to provide the best possible performance.

Fortunately, TE has been fine-tuning this craft for more than a decade. With cross-industry experience, including designing torque sensors for the aerospace industry, engineers applied those same learnings to this customer's cobot applications, translating to increased reliability and durability for the OEM.

TE's global footprint also played a role in the success of this cobot project. TE established a team that spanned different functions and business units to develop a comprehensive, custom solution in a short time frame. Given the expected growth rate for cobots in the coming years, TE's ability to scale along with the market to help its customers grow makes the company a strategic partner.

Reliable connectors, durable torque sensors, and global and cross-functional expertise all play a role in creating the machine-human hybrid workforce of tomorrow.

Are you interested in learning more about TE's components and expertise suited for cobot applications? **Connect with us today.**

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