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Illustration ABB

Human touch goes robotic

A special solution for producing torque converters for automatic transmission provides precision that saves time and money – and workers' health.

> Ever wonder how an automatic transmission in your car shifts gears without a clutch? This is made possible through an important device in transmission called a torque converter, which essentially keeps the engine running independent of the transmission.

The production of torque converters is no easy task, however. Heavy fluid coupling – above 18 kg – typically requires carrying by one or two workers. During assembly, workers must align three stages of gears and splines by "feeling" for a proper fit.

The heavy and repetitive assembly of automatic transmissions has caused elbow and wrist tendon injuries at several automakers. In the year 2000, a United Auto Workers (UAW) union's ergonomic safety officer contacted Ford Advanced Engineering in search of an automated process alternative.

At that time no feasible method existed to automate the torque converter assembly process due to several random uncontrolled positions of parts that are assembled by "human feeling for force" and the trail-and-error nature of the assembly process.

Research teams from Ford and ABB worked together to automate the torque converter assembly. Robot handling of the part wasn't the problem, it was replacing the important "human feeling for force."

This led to the development of Force Control, which makes the robot path adaptable to sensing 3D forces and torques at the end of its arm. Using a force and torque sensor on the gripper, the robot is programmed to imitate human processes. The robot controller accommodates the force feedback, with programming to control and guide its path.

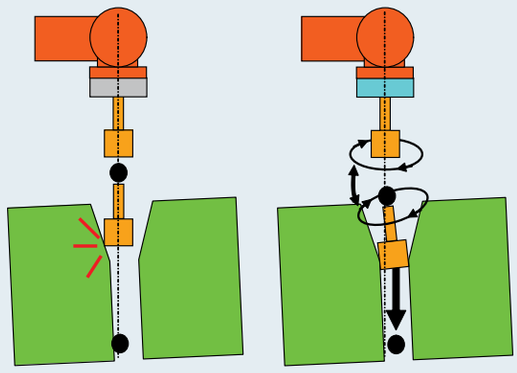
In a typical position control, the assembly path is fixed according to pre-determined geometrical coordinates. The variations in parts manufacturing and tolerances inevitably led to uncontrolled forces in assembly. In the case of Ford, the manual torque converter assembly caused a 3-percent reject rate due to high contact forces.

In a force-controlled robot assembly, the robot instead adapts its path, keeping the contact force to its limit as programmed, preventing such waste.

Automotive torque converters typically have three distinct sub-assembly stages required to complete the overall assembly: a turbine spline hub over the splined turbine shaft, a stator spline hub over the splined stator shaft, and the pump impeller feature that drives the transmission pump as the engine turns.

ABB has developed a programming tool to monitor and optimize assembly parameters, such as force and position, so that both contact forces and cycle times are minimized in all these three stages of assembly. This monitoring and control of forces enable built-in quality during the assembly process. The built-in quality was a very important factor to control the force during the assembly rather than finding out the part was assembled wrong at the end of the line.

In addition to the achieved safety and ergonomics, and cost savings from automation, the Force Control automation also achieved higher throughput and zero rejects, thereby lowering unit product costs. And Force Control can be applied to several other assembly applications, most notably for powertrain assembly automation. The end result was a successful installation of torque converter assembly that made both Ford and UAW happy. Today Ford recognizes this process as "Replication Ready" – that is, a tested, proven and repeatable process, and applies it at all new torque converter assemblies.



Position Control
- – Fixed path
- – Fixed speed
- – Uncontrolled contact force
- – Potential part damage
- – Potential assembly failure
- – Potential tool failure

Force Control
- + Adaptive path
- + Adaptive speed
- + Controlled contact force
- + Built-in-quality
- + Eliminate part damage
- + Reduce assembly failure
- + Extend tool life

>FACTS

Better with Force Control

The new solution for torque converters and powertrain assembly provides a wide range of benefits for Ford:

- Number of rejects reduced from 3 percent to zero
- Product unit costs lowered
- Workers no longer subjected carrying a heavy and repetitive job, thus lessening elbow and wrist tendon injuries
- Robot controller handles the difficult job of monitoring force and position