



Capstone Design Project Abstract

Project Title: ZF Tractor Assembly Drive Line Ergonomic and Process Improvement

Sponsor: ZF North America, Inc.

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This project focuses on enhancing the efficiency, safety, and consistency of the current assembly process for a heavy machinery parts manufacturer, ZF. The existing method, implemented in 2018, is labor-intensive, requiring a single operator to manually secure over 40 heavy-load bolts on a Caterpillar tractor's final drive. Currently, an operator must secure these bolts using industrial power tools. This process presents ergonomic risks and extended assembly times, leading to potential safety hazards and increased labor costs. Several operators at ZF have recently developed musculoskeletal disorders, such as Carpal Tunnel Syndrome, due to the long-term operation of the torque gun. These employee injuries have impacted ZF financially and highlighted the need to redesign the process.

Our project aims to develop an improved assembly system that integrates automation and ergonomic enhancements while maintaining process reliability and scalability. Key design opportunities include reusing existing parts and integrated safety features such as Human-Machine Interfaces (HMIs) and emergency stop mechanisms. The primary challenges involve ensuring precise torque control, minimizing operator fatigue, and validating the system through performance testing and safety compliance. Lastly, the drive line has two different sizes which must be accommodated by our design.

To address these challenges, our team has designed a semi-automated torque application system that mimics some of ZF's current workstations. Our designed workstation will incorporate bolt torquing, sensor-integrated torque verification, and an operator-friendly control interface. We have incorporated several safety features such as a two-hand start button and a light curtain to address operator safety. As for prototyping, we produced CAD visualizations and process efficiency timelines to showcase our design.