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| EE495/CME495 |
| Robotic Positioner Problem Definition |
| Revision 1 |

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# Purpose

The purpose of this document is to present the project definition for the EE495/CME495 capstone project which will be taken on by group #5.

## Document Identifier

This document is identified as:

**CD1 – EE495/CME495 Robotic Positioner Problem Definition**

## Applicable Documents

Applicable documents include:

**CD2 – EE495/CME495** **Robotic Positioner Project Plan**

## Revision History

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| --- | --- |
| **Revision** | **Changes** |
| 1 | Initial Revision |
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# Problem Definition

## Problem Description

Doepker Industries is looking into transitioning its rotator units which are currently hydraulic powered or hand cranked to units which operate on electrical power. This would bring many benefits to Doepker Industries, the main benefits being that it will help increase production output while maintaining quality standards and be safer to operate than the current rotators.

Doepker Industries requests a design for a rotator by December 6, 2019 which can be used to rotate equipment for welding, blasting, painting, or finishing that can be mounted to their existing rotator frames. The design is required to be capable of rotating a 1000lb load to any degree, with the ability to automatically rotate the load to pre-defined angled positions. This rotator will help by allowing operators to work with equipment at a comfortable angle. This will also help Doepker Industries save costs by allowing them to produce as many of these units as desired at a lower cost than if bought from a vendor. The client has also requested that the rotator be user-friendly and is operated using physical buttons.

## Background

Rotators are used to reposition work pieces to access different angles. They rotate at very slow speeds, allowing precise placement and reducing angular momentum on heavy work pieces. To achieve rotation on these heavy items, it is often necessary to incorporate gear-boxes to slow down the speed of rotation and reduce fatigue on the prime mover.

Doepker Industries’ current rotators are either hydraulically powered or hand cranked, which then are reduced in speed through a gear-box. They are hoping to update their rotators with an electric drive system to increase accuracy and allow for recallable positioning.

A few possible electric drives exist that can work in this application:

**Servo Drives** are capable of precise motion and provide a closed loop feedback, meaning the position of the rotor is always known. They can run at high RPM, but lose torque at higher RPM. Speed is controlled through a drive controller and a position encoder.

**Brushless DC Motors** provide closed loop feedback which allows the rotor position to be known. They have a consistent torque at low and high RPM. Speed is controlled through a drive controller and a position encoder.

**Three Phase Induction Motors** are a simpler and generally less expensive type of motor. They have a narrow limit of operating speed. Speed control is achieved using a variable frequency drive. They do not have closed loop feedback, meaning that the placement of the rotator would require external sensors.

**Stepper Motors** rotate through programmable microsteps and are capable of high torque for their size. They do not have closed loop feedback and alternative methods to track placement would be needed. Speed is controlled through a drive controller.

A programmable board, such as a microcontroller will be selected based on the drive selection and I/O requirements. It will be used to integrate the motor control, rotator position, position recall and safety features.

## Scope

A rotator is to be designed that will mount to existing stands fabricated by Doepker Industries. It shall be user friendly to operate, provide positional feedback, and shall have the ability to recall locations. Parts selection, circuit design, and programming, system integration, and commissioning shall be completed by the student design team. Doepker Industries will provide assistance in the areas of mechanical integration.

This will be completed in the timeframe from September 2019 to March 2020, with the product design being completed by December 6, 2019, and commissioning to be completed in February 2020. All system testing will be performed at Doepker Industries facilities, where all of the requirements may be tested in the environment of which the system is designed for.

Doepker Industries shall be supplied with enough technical documentation to fabricate the rotator units. Supplied documentation includes a bill of materials (including technical specifications required for the material selection), wiring diagrams, and program code, along with drawings for the physical mounting.

## Objectives

The main objectives of this project are to design and build a rotational welding assembly unit for Doepker Industries that can rotate an attached load to any desired angle to assist operators while welding. The design shall be user-friendly and safe to operate, compared to the rotator units currently used by Doepker Industries.

## Constraints

The following are the constraints of the project:

* The design shall rotate the load using primarily electrical means.
* Design schematics shall be submitted to Doepker Industries for production by December 6, 2019.
* The design shall be able to rotate to predefined angle positions on command.
* The cost to manufacture each unit shall not exceed $10,000.
* The unit shall have an emergency shut off button.
* The unit shall be operated using physical buttons.
* The unit shall be able to operate on a variety of power ratings used in the various facilities of Doepker Industries.

## Safety/Environment/Social Considerations

The only applicable concern would be safety throughout this project. The project design will be both OHS and CEC compliant. In terms of environmental impact, most electronics and motors are RoHS compliant and FCC compliant. The social considerations for this microcontroller and motor will follow the FCC compliance code in terms of the device may not cause harmful interference, and the device must accept any interference received, including interference that may cause undesired operation (add reference here).