Linamar CAMTAC C9 OP70 Ergonomic Solutions

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Abstract. Ergo Engineering Solutions was retained by the Linamar corporation to design a solution for the ergonomic issues on the C9 OP70 line. After background research and critical evaluation of preliminary designs, it was concluded that a motor-assisted arc device was best suited to solve the problem. An electric motor is used to flip the engine block in a manner similar to the current method. The device can be stopped to allow gauging during the flipping, as well as keeping the block accessible.

Key words: Ergonomics, Industrial Flipping, Heavy Object Manipulation

1 Introduction

When a workspace is well designed with employee comfort and safety in mind, the efficiency and quality of their work can be significantly increased. ErgoEngineering Solutions was retained by Blue Sky Consulting (on behalf of the Linamar Corporation) to develop a feasible solution to one of the ergonomic issues revealed through a safety assessment conducted in the plant.

In particular, the employees operating the C9 OP70 line are subjected to awkward posture and high loading forces while repositioning a 250 lbs cylinder head using a simple lever in a flipping motion. This action is performed up to 100 times in a single 8-hour shift and has a high potential for injury to employee elbows and lower backs. A study conducted by the Department of Physical Education at University of Montreal found that lifting was only slightly more demanding than lowering for maximum muscular moments [1], indicating that, while designing a solution, it is essential not to introduce any additional lifting or lowering motions. In addition to these findings, a study [2] performed by the School of Human Kinetics at the University of Ottawa found that vertical displacements induced higher muscular loads on the shoulder than horizontal weight displacement conditions.

It is evident that Intelligent Assist Devices (IADs) are an ideal solution to the problem. These are devices programmed to sense the weight and inertia of an object such that minimal input from the operator is required. This type of technology is currently being used in the CAMTAC plant, however, it should be noted that although these methods are available, this technology is not appropriate for the C9 line due to space and accessibility considerations, therefore a new and novel solution is required.

In working towards a design to solve the ergonomic issues associated with the C9 OP70 line at the CAMTAC plant, the following constraints were applied:

1. solution must fit in the prescribed workspace,
2. solution must be able to produce adequate force to move the cylinder head,
3. solution must be able to operate within an industrial environment, and
4. materials, construction, and implementation of the solution must not exceed $50000.

The following criteria were also applied to maximize the feasibility and practicality of the solution:

1. maximize simplicity of the solution by producing a simple, straightforward design with a minimum of moving parts,
2. maximize the ease of use for employees,
3. ensure reliability and safety of the solution, and
4. keep the time to flip the head as close to the current time the worker takes.

2 Methodology

Evaluation and processes of developing a feasible and workable design solution were as follows:

1. ergonomic assessment of current practice to determine existing risk,
2. brainstorming and selection of 3 preliminary designs for the preliminary report,
3. selection and justification of final optimal design solution, and
4. development of a detailed final design solution including specific components and suppliers.

Once the final design was detailed, mechanical and ergonomic analyses were conducted to ensure the design met all constraints and optimized desired criteria. Stress concentration locations that would likely fail first were identified and often reinforced to increase the factor of safety at these locations. An ergonomic analysis was then done to ensure that the required force to move the unit laterally (for necessary occasional repositioning) did not exceed recommended ergonomic guidelines.

3 Detailed Design

The final design consists of a rectangular device with arc-shaped ends which will attach to the table. This device
will be able to slide laterally along the table if necessary. The system includes a pin which will insert into the top hole of the cylinder head, which is attached to a lever, turned by the motor. The motor (with a system of gears) will then move the lever in an arc, flipping the part along its long axis, with one edge always resting on the table. This design is shown in Figure 1.

Fig. 1. ERGO Arc final design solution for C9 OP70.

This overall design can be broken down into its individual components for ease of understanding. The major components with recommended suppliers are described below.

3.1 Housing

Arc shaped end guides and outer frame are stainless steel, chosen for its strength and resistance to corrosion. This follows the constraint that the solution must function within an industrial environment. The casings for the motor, end pieces and chain cover are made of ABS plastic, which was chosen for its light weight and durability.

3.2 Motor

After extensive mechanical analysis, a 0.5 hp electric motor with built in gear reducer was chosen from Bison Gear and Engineering Corp. This motor rotates at 12 rpm and produces 112 Nm of torque. It will be attached to the lever arm via a 4:1 ratio system of gears, reducing the speed down to 3 rpm and increasing the torque. This will cause the block to rotate the full 180° required in approximately 10 seconds. This is in an attempt to optimize the speed of rotating criteria, by making the process faster than the current process, but not so fast that it will be dangerous to the operator.

3.3 Controller

A 3 phase AC motor inverter from KB Electronics was selected based on desired functions, which included reversibility, automatic stop at each end, and simple on-off capabilities. This controller also offered increased startup torque and dynamic braking. A double handed push button system to ensure operator safety was chosen. This push button system is also similar to the controls used on other devices on the line which will minimize the learning curve for existing employees.

3.4 Wheels

High load bearing industrial casters were chosen for their robust characteristics and low friction bearings. These wheels will allow the device to be moved laterally along the bench if necessary with minimal effort, and come supplied with locking mechanisms to increase safety.

4 Discussion

The total cost of the unit including parts and assembly will be approximately $8000, allowing multiple units to be installed along the line and still remain well under budget. Multiple units will allow the functionality of the line to remain as similiar to the current process as possible.

The previously outlined design solution optimizes many criteria and meets all necessary constraints. It was necessary to make some sacrifices in terms of maneuverability and overall weight of the final design in favour of stability and structural integrity. The final design may therefore be moved if necessary, but this will rarely be required. Instead, the design team chose to increase the factor of safety in the motor size and stainless steel lifting lever size, thus increasing the overall weight.

Through extensive research and iterations, a final solution was designed which solves the ergonomic issues associated with the flipping of the engine head on the Linamar CAMTAC C9 OP70 line.

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References