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REDESIGNING TROLLEY JACK TO BE MORE EFFICIENT, CONVENIENT AND SAFE

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Abstract

This research examined the efficiency of a specifically modified trolley jack in extracting car components particularly gearbox and transferring these components to a specific workspace. This project was built to minimize physical workload, reduce the time taken to perform this

task, and mitigate health and safety risks. There were 20 respondents involved in this study and they were required to test the project before completing observation checklists and questionnaires. The findings revealed that the students had strong approval on each function and feature of the project. There were a few recommendations on how the project could be improved to be safer and more efficient.

Keywords

Trolley Jack, Gearbox, Hydraulic Jack, Ergonomic, Floor Jack, Worktable

1. Introduction

To advance manufacturing, working conditions need to be improved and this includes increasing the efficiency of working conditions without imposing excessive workloads on workers. Macroergonomic analysis is an approach of accumulating data on the occupational performance of workers in specific working environments assigned to work in designated positions within the organizations particularly on the tasks and the operation (Butlewski, Misztal, Jasiulewicz-Kaczmarek & Janik, 2014). As Jasiak (2015) narrowed their research on automobile companies, they analyzed the workers whose job is to repair and maintain cars and other vehicles. Some of the duties that they regularly perform are elevating vehicles to access mechanical components, remove mechanical components like engines with power wrenches and jacks, disassemble parts, and replace them with manual tools. The findings of their studies revealed some of the hazards that workers are at risk of when they are on duty. The three hazards with the highest risk that these workers were prone to be overstraining of motor system or organs, impact from objects and moving items, and being crushed by heavy objects.

Misztal, Belu, and Rachieru (2014) recommended a preventative measure against the overstraining of the motor system or organs which is to adopt ergonomic principles and use a safer way of lifting and moving objects which may require the usage of proper equipment. Workers are strictly encouraged to limit their physical burden when handling heavy objects manually. This study focused on improving the equipment often used by car mechanics to boost the efficiency of their performance while offering them a safer work condition. This project specifically studied the improved features of trolley jacks that are usually used to lift a motor vehicle to access its interior component or extract certain parts for repair and maintenance.

Sainath et al. (2014) described a jack as a type of equipment that utilizes force to elevate or lift heavy objects or loads. Its operating mechanism differs in accordance with the types but two main aspects determine the specification of a jack: mechanical and hydraulic. Both jacks can lift heavy loads but the hydraulic jack has stronger capacity. This study focused more on the trolley jack which is closely related to floor jack but with mechanical features. This research aimed to redesign the jack to be more ergonomic, safe, and efficient than the original design.

This research examined the efficiency of a specifically modified floor trolley, which had been incorporated with functions and features of a hydraulic jack, in facilitating the process of extracting gearbox from any vehicle and transferring it to a worktable. There were several concerns related to this task that needed to be addressed and these included workplace hazards and physically demanding workload. This could have negative effects on students at a vocational institution who had to learn to perform this task and possibly, car mechanics and people whose jobs were related to repairing and modifying cars. Thus, this specifically modified floor trolley was designed to help students and repair mechanics in performing this task efficiently in a more convenient manner within a safer environment.

2. Problem Statement

One of the most common problems faced by the students of the automotive technology program at a local vocational institution was the physical demand on several activities that required the students to test, repair or maintain vehicle gearbox. The students needed to extract the gearbox from a vehicle with a hydraulic jack, place this gearbox on a floor trolley and carry it to a workplace using this trolley. This entire process was exhausting, time-consuming, and dangerous. Another problem that could occur was the risk of damaging the gearbox during its extraction and transfer process. These risk of health and safety hazards were consistent with the risks at automobile workshops and factories that Jasiak (2015) highlighted in his study where the findings indicated that overstraining organs was one of the dangers that could do the most damages yet it was likely that the workers would suffer this regularly.

3. Objectives

The purpose of this research was to modify the existing equipment to create a more practical and efficient type of equipment that could facilitate the process of extracting a

gearbox from a vehicle and transferring it to the worktable. There were three objectives of this project:

1. To minimize the physical workload involved in the process of extracting the gearbox from an automobile and transferring it to a worktable or a workspace.
2. To merge the two separate processes (extraction & transfer) that required two types of equipment into one single type of equipment that could be used to perform the entire task.
3. To mitigate health and safety risks at workspace especially during practical classes.

4. The Design of Trolley Jack

Friedrichsen (2000) explained that an automotive jack is used to elevate a vehicle or certain sections of it for repair and maintenance and there are three main types: screw jacks, trolley jacks, and bottle jacks. A primary feature of an automotive jack is its capacity in lifting heavy loads despite its lightness and portability. Ranglani et al. (2014) attempted to redesign the existing trolley jack to increase its general capacity, the height of its lifting arm, and its firmness by replacing its piston with a larger one, installing a detachable extension road on it, and equipping it with six legs. They discovered that it became more stable, economical and it was able to lift load better while requiring less effort. This signified the possibilities on how trolley jack could be modified in various manners to improve its function and capacity and such modifications might be necessary to ensure automotive workers can work in safer conditions with minimal or no risk of hazards.

The first jack was invented by Curtis in 1838 which was known as “Hydraulic Jack” and this was followed by an improved version by Richard Dudgeon in 1851 that he referred to as “Portable Hydraulic Press” (Detroit Listening Post, 1969). Since then, multiple types of jacks were manufactured and commercialized. A trolley jack manufactured by Dhaliyan Industries was small in size and could easily be carried but it did not have a handle and its surface plate was not large enough in a way that made it harder to carry the gearbox or any car component to a workspace (William Cox, 2001). Another jack sold by Restoration Hardware was an adapted version of conventional trolley jack with larger wheels. However, the height of this equipment could not be adjusted and its design was flawed in a way that it would not be able to be placed properly under cars (Brian S. Elliot, 2006). One of the newest versions of the trolley jack was “Quick Lift Hydraulic Trolley Jack” produced by Kennedy Bottle and Trolley Jacks. This trolley jack could easily be adjusted for height but it did not

have a large surface plate and this made it harder to carry large components like an engine block and fuel tank (John Norman, 2009). Taking the features of the existing trolley jacks as well as their limitations into consideration, this project was built to provide students and possibly car mechanics with equipment that may improve the process of extracting and transferring gearbox or any car component.

There were nine main steps in designing this project. The procedure involved a lot of processes related to welding duties since metal plates were the main components. Some of the main tools and materials required for this process were a double-ended scribe, angle grinder, MIG welding machine, scissor jack, and steel plate. Figure 1-9 illustrated the steps.



Figure 1: *The First Step was to Measure the Metal Plate*



Figure 2: *The Second Step was to cut the Metal Plate*



Figure 3: *The Third Step was to Smooth out the Exterior Surface of the Cut Metal Plate*



Figure 4: *The Fourth Step was to Drill Parts of the Cut and Welded Metal Plates*



Figure 5: *The Fifth Step was to Grind the Surface of the Cut Metal Plate*



Figure 6: *The Sixth Step Sing was to Cut Certain Parts of the Metal Plates for the Second Time*



Figure 7: *The Seventh Step was to Create Clearance Holes on the Metal Plates*



Figure 8: *The Eighth Step was to Fix the Metal Plate to a Scissor Jack properly*



Figure 9: *The Final Step was to Weld the Metal Plate with the Scissor Jack to create an Operational Trolley Jack*

5. Methodology

20 respondents took part in this study. These 20 individuals were students of the automotive technology programme at a local vocational institution. There two main instruments and these were testing checklist and questionnaire. The questionnaire was used to identify what the respondents thought of the project while the testing checklist was used to determine whether the project was operational. Three students were randomly selected to test this project while being observed by the researcher as well as other respondents. The three randomly selected students were required to use the trolley jack to determine whether the three main features of the project; surface plate, chain and scissor jack nut lock were functional and operational. They were then expected to fill in the testing checklist. All 20 respondents were given the questionnaires which they had to complete in 10 minutes.

6. Findings and discussion

The results of the testing checklist were presented in Table 1.0. There were two indicators which were P for pass and F for fail. The component was given a pass (P) if it worked properly when the project was being used while the fail (F) indicated that the component did not work as well as expected.

Table 1: The Findings of the Testing Checklist on the Tool

No.	Components	Trial			Remarks
		1	2	3	
1	Scissor Jack Nut Lock	F	P	P	There was a difficulty in loosening and adjusting the nut lock. Hence, the handle was made longer
2	Chain	P	P	P	There was no complication that occurred on the chain during all three trials
3	Surface plate	F	P	P	The plate was unstable during the first trial. Hence, it was adjusted to be more stable.

Table 2.0 illustrated the students' rating on each of the six items in the questionnaire that attempted to elicit their opinions on the features, functions, and design of the project. There were five rating scales and these numbers represented students' level of approval on the statements regarding the project. 1 was for "strongly disagree", 2 meant "disagree", 3 indicated "neutral" position, 4 was meant to express "agree" while 5 signified the highest level of approval which was "strongly agree".

Table 2: Analysis of the Students' Rating on Features & Functions of the Project

No	Items	1	2	3	4	5
1	It had an appealing design			3	4	13
2	It reduced the amount of time needed to extract the gearbox and transfer it to the worktable.			4	6	10
3	It mitigated workplace health and safety risks				5	15
4	It minimized the physical workload that might be exhausting and time-consuming				5	15
5	It was fully operational				6	14
6	It was easy to handle				4	16

It could be deduced from the findings of the questionnaire that the students had positive opinions on the functions and features of the project. The majority of them believe that it had a great aesthetic feature and it improved the efficiency of the process in a way that it could reduce the amount of time taken to perform the task, minimized the risk of undesirable incidents from occurring and it elevated the students' experience by decreasing the physical demand of the task. They also thought that it was easy to handle, practical, and useful.

Jasiak (2015) stipulated the safety hazards of the working conditions that individuals who work at automobile workshops are exposed to and highlighted few that could be considered as highly harmful. Some of the hazards were the risk of overstrained organs and physical impacts. These findings necessitated prompt solutions to protect workers from any undesirable incidents at their workplaces. Misztal, Belu, and Rachieru (2014) urged companies to provide proper equipment that could help workers lift and carry heavy objects more safely with ergonomic features. The findings in this research implied that the respondents' approval of the characteristics and advantages of this modified trolley jack could assist automotive shops to offer better safety to their workers while reducing their physical workload.

The findings from the testing observation revealed that the project was functional and operational. Few minor flaws could be seen during the first trial that could be attributed to basic mistakes that might have occurred during the building of this prototype. However, these minor flaws had been repaired and subsequent trials showed that every component functioned accordingly. The testing checklist showed that the project could still be improved as the plate surface could still be lowered so that it could be placed under cars properly and wheels could be attached to the equipment to stabilize its plate. Other than that, barriers could be placed around the plate to prevent any components from falling off the surface. Ranglani et al. (2014) presented their objectives in modifying the trolley jack to increase its capacity, enhance its stability, and improve its efficiency. The findings of this research indicated that these three features remained as the most essential features that need to be improved and tailored to create trolley jacks that are safer, more ergonomic, and durable.

7. Conclusion

There were three objectives of this study. The first one was to reduce the physical workload that students often had to endure while performing this task. The second objective was to merge two different processes into one task that could be performed quicker and easier by combining the process of extracting car components, mainly gearbox, and transferring them to a workspace into one single process. The third objective was to prevent undesirable incidents from happening by mitigating health and safety risks usually associated with this task. The findings showed that all three objectives were achieved and this suggested that this project could be potentially used across any car workshops either at learning institutions, manufacturing industries, or commercial centres.

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