

Design and Evaluation of Multi-level Height Adjusting Trolley

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Abstract

Ergonomics & worker safety are often overlooked when product quality & quantity are considered as primacy in the industries. The paper ambitions to propose a design of a trolley used in the industries during the manufacturing process, the trolley have a multi-modification facility, to enhance the quality & quantity of the manufactured goods & also to keep the workforce safe & healthy. In big business different operations were considered & posture analysis was conducted for two different work stations employing the similar material handling equipment. The ergonomic assessment score for legs, neck & trunk became 8. That score is a warning for great threat of Work Related Musculoskeletal Disorders (WMSDs) in the operators. The operators had to use such posture because of the practice of ordinary trolleys for all work stations. The workplace were under observation on platforms of varying heights depending on which device was used for their operations. To maintain the features of the finished product from a single operation, the product needs to be finely placed in the trolley that needs to be carried forward to the next workflow. The design mainly aims to achieve three goals, the safety of the operator is first by providing better position, second is to keep and carry the products without having to affect quality & be able to adjust the dimensions to suit different workflows. The design has two different variables, first is the rugged adjustment that can be made with variable heights for workstations on different platforms & the second is a platform loaded with self-adjusting fountain that pushing down the datum plane according to the heaviness of the outputs applied to it. The new proposal was grounded on increasing the ergonomic assessment score of about 3 by employing human manikin with anthropometric measurements for 50th percentile.

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I. INTRODUCTION

Material management tools in industry is one of the vital tools at play at all stages of manufacturing/industrial, assembly & packaging. But material management implements like trolley are frequently ignored in business for the reason that everyone uses it each day in addition just

increases manufacturing methods, automated machines, high precision & size[1].

Material management equipment for instance trolleys & lubricants play a dynamic role in upholding the quality & accuracy of products made by progressive machinery. Herein, paper's idea in big business be there accepted with the trolley employed for material handling at

various workstations & its movement was monitored[2].

The trolley is employed to transport sheet metal module to a number of workplaces positioned in the industry for numerous operations. The workspaces are designed conferring to the machine executing the job; also the member of staff stands on platforms at numerous heights. The trolley employed is of a long-lasting fixed size that lacks flexibility to provide accommodationsunpredictability in the height of the platforms where the worker has to work[3], [4].

Because of these problems the personnel have to bend at extreme angles to reach the base of the trolley to keep the finished or machined product safe without damaging it. Staff have reported frequent severe back & neck aches. Herein, paper a novel trolley was designed to decrease the risk of Work-Related Musculoskeletal Disorders (WMSDs) in the industry's operators[5], [6].

II. METHODOLOGY

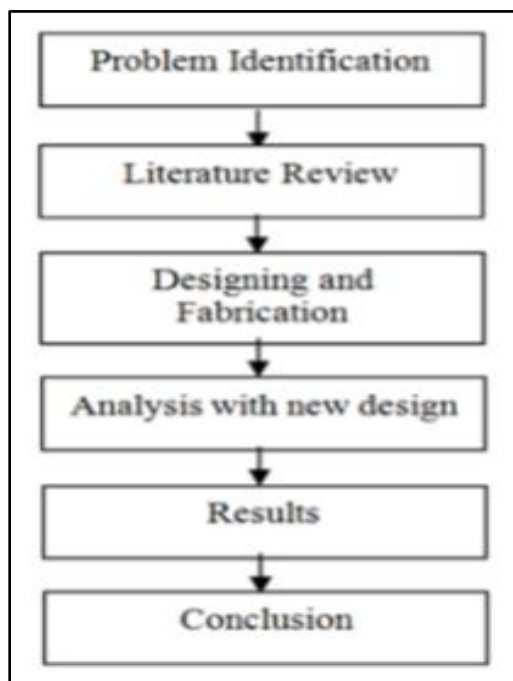


Figure 1. Flow diagram of adopted methodology

The material management trailer is a conservative trailer that cannot bump into the necessities of the

number of measurements of each workstation. Because of this flexibility, it is the accountability of the staff and the workers to choose bodies that increase the risk of developing MSD. A new flexible trolley design must be created to reduce the jeopardy of wound/injure& improve the comfort and safety of staff[7].

A material handling trailer/trolley that is stretchysufficient is needed not only for the safety of the operator & the employee, but similarly to conserve the quality & accuracy of the results produced. The poor situationsselected by the workers touches their long-term health, as well as reducing the amount produced by the amount of output produced per unit time[8][9].

Because the employee is stressed & tired by reason of pain & poor body condition, his work speed will decrease & this will rise the machine's deep time. Poor body condition is supplementary with health, quality/class& quantity[10]–[12].

Segment	Score Range	Color associated to the score					
		1	2	3	4	5	6
Upper arm	1 to 6	Green	Green	Yellow	Yellow	Red	Red
Forearm	1 to 3	Green	Yellow	Red	Grey	Grey	Grey
Wrist	1 to 4	Green	Yellow	Orange	Red	Grey	Grey
Wrist twist	1 to 2	Green	Red	Grey	Grey	Grey	Grey
Neck	1 to 6	Green	Green	Yellow	Yellow	Red	Red
Trunk	1 to 6	Green	Green	Yellow	Yellow	Red	Red

Figure 2. Body Segment-wise range of score and colour coding

GHAZALI et al. in the investigation work has made known the importance of ergonomic assessment apparatuses. The use of equipment's such as Total Physical Assessment (REBA) & Upper Limb Speed Assessment (RULA) was discussed. In order to appraise, pictures & video of the staff while executing the tasks & jobs need to be furthered as ideas[13], [14].

These drawings illustrations are then investigated to regulate the RULA or REBA scores by tables &

charts. Liable on position of body & the angles b/w the organs & other joints, the severity of the risk is judged in that particular condition. The better the score value, greater the danger of injuries & pains. Table 1 illustrations the purpose relationship that should be taken with the ergonomic rating score[15], [16].

Action Level	REBA score	Risk level	Action (Including further assessment)
0	1	Negligible	None necessary
1	2 to 3	Low	May be necessary
2	4 to 7	Medium	Necessary
3	8 to 10	High	Necessary soon
4	11 to 15	Very High	Necessary NOW

Figure 3. Relation between the assessment scores and the urgency of actions to be taken

YADHU et al. in the investigation on photographing employees working in the foodstuff packaging industry. The employees employing the standard material handling tools were examined according to their body situation. On the source of the REBA score the risk & severity of the risk were identified[17].

The writer redesigned the material management tools & made a 3d model in CAD software. The CAD model was then investigated in CATIA V5 reproduction software to associate the assessment scores of an old ordinary method to the novel technique using well-designed equipment. The diagnosis was made by reducing the REBA score with the help of better-quality body position & well-designed tools[18], [19].

III. PROBLEM IDENTIFICATION & OBJECT [19]–[23]

The business fabrications/manufacturing several modules that are assigned to parent corporations, these parts are mass-produced by executing numerous procedures on the metabolic & non-metallic components. The material processing tool observed for this research paper is used in the

manufacture of sheet metal component. The metal part is administered & operated at several levels, & all work is complete on automated machines.

These machineries are high meticulousness machines with high-quality goods, and are to be found according to the variety in the industry center. Machines are of different sizes according to the jobs they perform, & according to the size the platform & its surroundings are constructed so that the worker or machinist can provide the machine & also to remove finished parts from it.

The material treating equipment must work with all workstations & to feed the machines & also to transport the finished products. The products made at a high degree of accuracy must also be carried with care so that the damage & quality are not maintained.

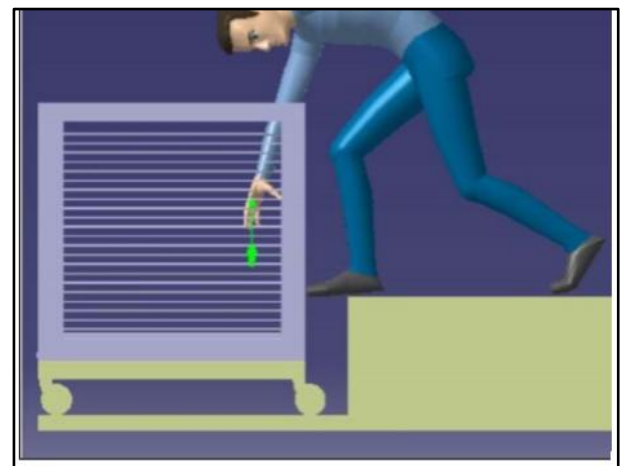


Figure 4. Posture opted by the worker at 1 of the platforms

In Figure 4 the setting is selected by the worker to hold the finished product into the trolley. Because the product required to be taken into account in terms of surface finish & accuracy in dimensions, the trolley datum required to be kept & not just thrown into it.

To fulfill the necessities based on the manufactured goods the employee has to opt for such a condition weighing about 500 grams per product, and the condition is repeated as often as the number of results manufactured per day. The

position was built in the software using manikin & by manually feeding the angles to it.

The manikin available with the software did not follow the crowd to Indian anthropometric data & therefore the measurements were also assigned to the software, according to the following measurements, made known in *Figure 5*.

Measurement	In millimeters
Stature	1648
Axilla Height	1265.5
Chest Height, standing	1180
Waist Height, omphalion	970
Crotch Height, standing	765
Acromion-radiale length	312
Radiale-styilion length	243

Figure 5. Measurements for the human builder as per Indian Anthropometric data

The above measurements are based on Indian anthropometric data for 50th percentile of the population, with the intention of make such a design of the trolley suitable for almost all workers. The manikin built to the dimensions you want is used for posture analysis and to calculate an ergonomic rating score of “8” for the manikin’s legs, trunk and neck.

This score was examined against a bent neck, a curved stock again of 0.5kg load. A score of “8” suggests that the employee is at high MSD risk and immediate steps should be taken to improve the assessment score. The aim is to design a material management device for instance a trolley that fulfills the need to adjust its datum affording to the height of the operator or platform on which he/she is working.

Elevated platforms for trolley are also not possible at all devices, so the standard trolley needs to be redesigned to enable flexible datum height.

IV. TROLLEY DESIGN

The trolley was redesigned taking in attention for the objective of optimizing the machinist's body situation & treating the results with the ultimate

care. The design should be so large that ergonomic evaluation score should be reduced.

The criteria are as follows:

- Improve the posture condition & the ergonomic evaluation score should be reduced.
- Live height change when the goods are hosted into the trolley or when exported.
- Altitude change depending on the platform where the operators are standing.
- Treat the finished products with the utmost care to prevent damage from surface/exterior finish or dimensions.

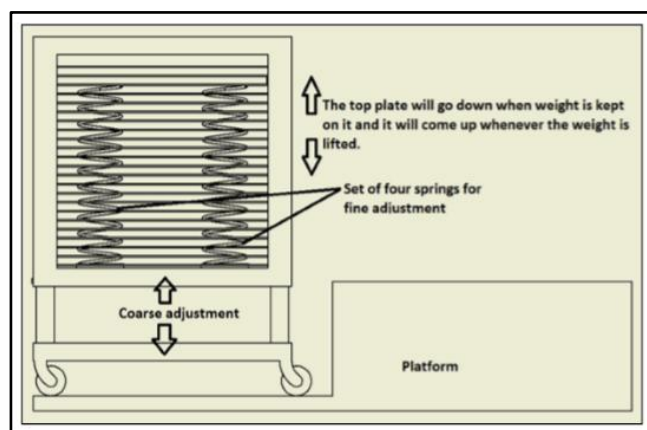


Figure 6. Significant characteristics of the trolley

Figure 6 illustration significant features of the restructured trolley. The trolley has 4 springs which empower it to performance as a dishwasher with height change depending on its weight. The height change is live, if pressure is kept on the top plate it will decrease & if the weight is lifted from the top plate it will rise.

This helps to keep top plate at a continuous height that is convenient for the machinist or wage earner. The details of the spring requirement are given below, which has been premeditated constructed on the weight of the product held on and the desired spring illumination.

Capacity of the trolley (mini load) = 2.5 N

Capacity of trolley (max load) = 600 N

Working load of trolley = 5 N

Diameter of the wire used for fabrication of trolley = 9 mm

Outer diameter = 150 mm

Length (l) of normal spring = 650 mm

No of active/compressed/elongated coils in the spring = 13

Material of spring = steel

Stiffness of spring = 1.7 N/mm

In addition to the live adjustment, the trolley will be capable to amend the spring base known as rough adjustment. This modification is providing to encounter the necessity at the diverse heights of the platforms. *Figure 7* displays a 3D view of the trolley.

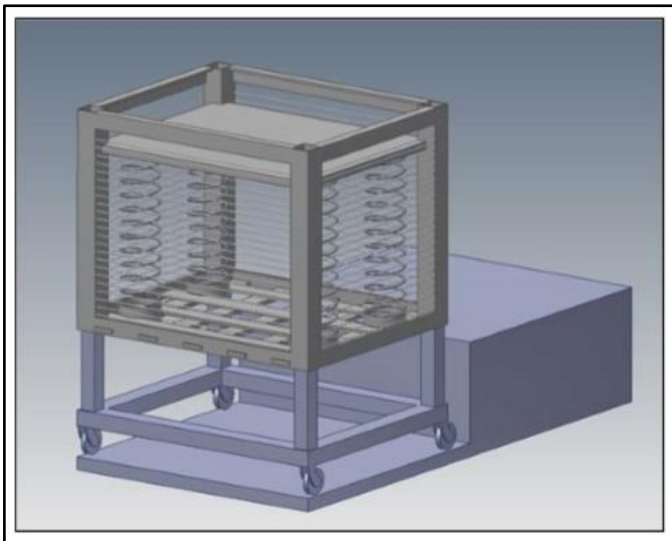


Figure 7. 3-D view of the trolley

V. OUTCOMES OF THE DESIGN

The fresh strategy of the trolley was prepared employing a 3D modeling instrument & the measurements are assumed according to the 50th percentile of the inhabitants & referenced to Indian Anthropometric data. The 3-D model was then assembled via the identical machine & the tools verified.

The computation of force of the springs was accomplished & then applied to imitation software employed to calculate an ergonomic rating score.

Figure 8 displays the model in a simulation software environment. The new analysis report gave an ergonomic ranking score as "3" for an employee's position with the new trolley.

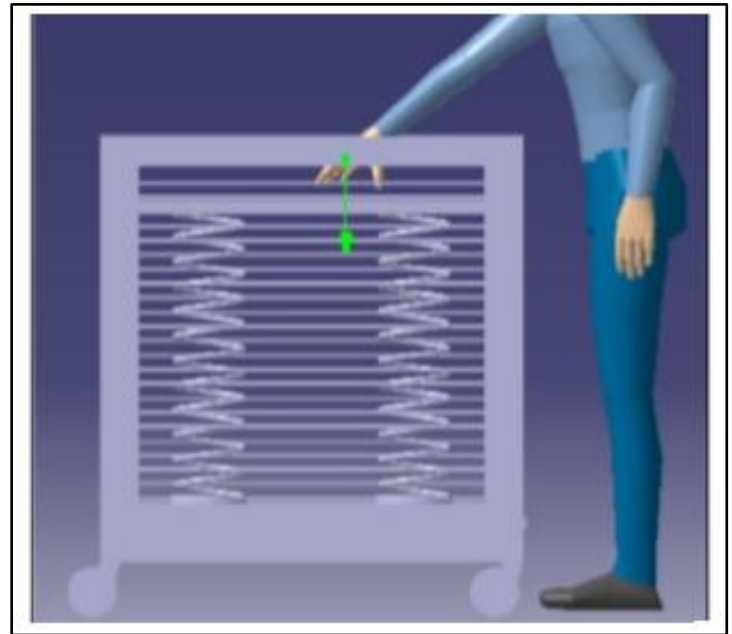


Figure 8. Manikin and trolley in simulation software environment

This score is based on no neck bending, no stock bending and no legs bending. The arms operating over center line and a load of 0.5kg are applied again. The new assessment score showed an improvement in the situation & thus reduced the risk of injury to staff. The comparison of the indicators is presented in *Figure 9* further down.

Body segment	Old design		New Design	
	Posture A	Posture B	Posture A	Posture B
Neck	4	8	1	3
Trunk	4	8	2	3
Legs	1	8	1	3

Figure 9. Comparisons of ergonomic assessment scores

VI. CONCLUSION

The new trolley design capable of rugged & refined adjustment is capable of showing substantial perfections in body position. Also the characteristics of the new strategy will assistance

to keep up the feature of the finished merchandises as they are made. Upgraded body position will assist the machinists accomplish with abundant greater efficiency/performance & efficiently decrease the machine idle time. The new/novel trolley once manufactured/fabricated & employed in the industry will improve operator health, quality & quantity of merchandises. The new design of material management will enhance the overall performance/efficiency of the business & in the long run will also rise the profits.

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