

Ergonomic Design of Porter's Load Bearing Device Using Digital Human Modeling

Harish Kumar Sharma, Department of Mechanical Engineering, GLA University, Mathura, U.P., India

Article Info**Volume 83****Page Number: 10355 - 10359****Publication Issue:****May - June 2020****Article History****Article Received:** 19 November 2019**Revised:** 27 January 2020**Accepted:** 24 February 2020**Publication:** 18 May 2020**Abstract:**

This paper expects to recognize the problems arising load lifting by a porter and application of DHMs to give a solution with low risk factors. Author designed a Load bearing device for helping porter at railroad stations considering ergonomic factors using digital human modeling (DHM). To assist the design advanced simulation CAD software CATIA-V5 is used for assessment of ergonomic factors examination to evaluate the potential harm possibilities, thinking about difference among using and not using the help gadget. The task of the porter is carrying heavy loads manually. So as to carry load the subject needs to twist his body parts which might be liable to different injuries. Motivation behind assessment was improvement to conveying and to recognize risk that could achieve physical harm in a genuine work environment. Outcomes recommend, utilizing the proposed model can diminish injury hazard conceivably and increment load conveying limit.

Keywords: Porter, Ergonomics, Digital Human Modeling (DHM), Biomechanics.

1. INTRODUCTION

VR/AR broadens the physical reality with virtual articles and condition, and consistently combines both. This innovation gets an extraordinary benefit in the field of product development & its production [15-17]. DHM innovation has been used to separate and improve the physical ergonomics of different structures with diminishing every planning cost [7]. The innovation in advanced human modeling is being utilized in numerous ongoing investigations to aid the development of a product [8]. The procedure licenses configuration to make digital human having specific populace data to have the option for installed as 3-Dimensional work environments.

In this Study with respect to porter's safety while baggage carrying was finished utilizing digital human modeling in CAD system CATIA-V5 [13]. Design of load conveying outline is suggested for proper division

of baggage weight in order for expanding load conveying limit.

Inappropriate load lifting of baggage could result in improvement of different injury issues (Work related musculoskeletal disorders). Work related musculoskeletal disorders present dangers to porter to decreases the productivity & furthermore influence wellbeing which was shown by Nicolas [2]. Karmakar et al. [4] discussed biomechanical investigation acted in the virtual condition utilizing CAD system V5-CATIA.

Because of substantial load porter for the most part face numerous problems like back torment, shoulder torment and neck torment. Lumbar spine can encounter critical stress assignments because of gravity following up on the chest area hence to confine load against spine inside the NIOSH (National

Institute for Occupational Safety and Health) suggested standards.

The target of this investigation was to design load assisting device for porters to minimize different hazard issues. Connection in injury probability factors and the WMSD was especially characterized by Nirathi et al. [3]. Granata et al. [3] endeavored to choose ergonomic agreeable cutoff points as demonstrated by the National Institute for Occupational Safety and Health technique. National Institute for Occupational Safety and Health, limit showed significant to recognizing specific lifting applications which poses to structure to make loading related back stress.

2. METHODOLOGY

Modeling was done on CATIA-V5. Primary center was to discover reason for weakness and decrease work related hazard among porter. To design, photos are caught at various stances while working of the porter. Body of the subject stances & motions were caught for the analysis purpose to investigation utilizing Rapid Upper Limb Assessment (RULA) act assessment procedure and to assess using ergonomic consideration for the design interventions [5]. If design considerations are not fulfilled, one can change the plan likewise and repeats the above methods until an acceptable structure is achieved.

2.1. Current Procedure

Assignment done by subject was lifting & conveying traveler's baggage utilizing hands on procedure. Hence lifting baggage, subject need twisting his trunk & neck. Method involves excess errands which is undesirable from ergonomics point of view.

2.2. Anthropometry of the porters

Author surveyed about forty subjects. Author in like manner evaluated maximal loads of baggage run upto 40 kilograms. Information of taken from measurements of all the subjects, described in Table 1. All porters belong to Indian railway. Each datum is shown as percentile Fiftieth in mm.

Table 1. Information of subjects at different railway platforms in Mathura district

Body measurements	mm(min-max)	percentile (50 th) mm
Standing Elbow Height	900 – 1110	1080
Standing Shoulder height	1240 – 1480	1390
Weight	58.0 – 87.0	76.5
Stature	1510 – 1810	1700
Leg length	195 -235	216

Above anthropometrical information was utilized for digital human models in CATIA-V5 CAD package, which might be utilized for approving the given design.

2.3. Load Assisting Device Design

Blueprint for mechanical assembly is done based on anthropometrical data accumulated by porters to use for the design of load assisting device using CATIA-V5.

3. RESULT AND DISCUSSION

Considering the method examined above author has designed the proposed model also shown below in figure 1, 2 and 3 with various perspectives.

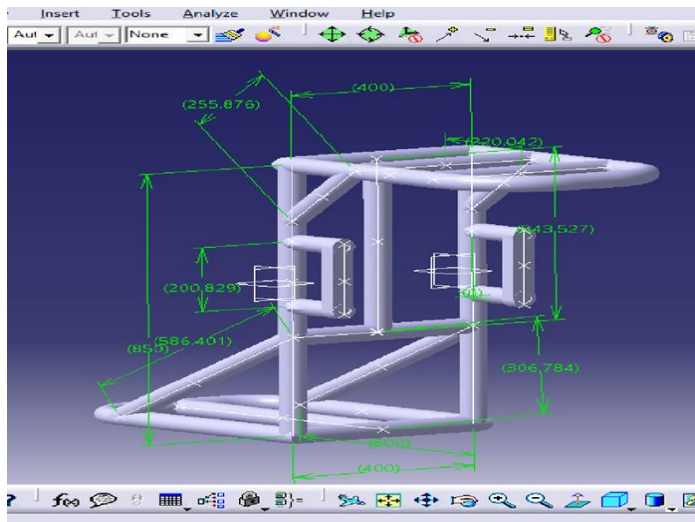


Figure 1. Proposed model created in CATIA

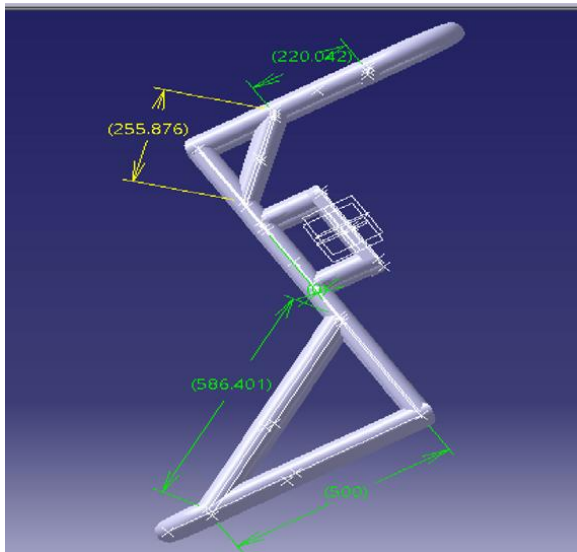


Figure 2. Side view of the model

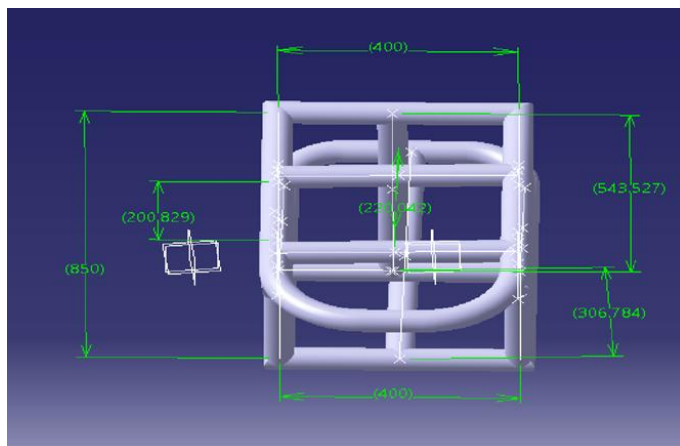


Figure 3. Top view of the model

Another table depicts below arm parameters utilized for accompanying investigation. They are calculated by the statistical information an average porter having stature of 1.6m & weight of 76.5Kg.

Table 2. Parameters of the arms

Link	Dimension (mm)
Lower Back	306.8
Upper Back	543.5
Width of the device	400.0
Lower support for Luggage	500.0
Upper Arm	500.0

Light material like Aluminum-7075 which solid simultaneously might be chosen for the connections. The complete load of the gadget would be 6.5 kg approximately. Porter won't have to wind upper limb oftentimes. Porters going up against issues of less productivity and in some outrageous cases perilous medical problems were complained. Now undertaking is made for perceiving risk causing factors which brief diminished efficiency of porter.

Analyzing & exploring reasons behind less efficiency using Digital Human Modeling would be used to consider ergonomic design aspects. Other reference for data can be meeting porters and filed questionnaire reports. Enhanced design of luggage conveying casing will help diminished weight on porter, stress appropriation, disposal of recurring activity and consequently expanded profitability. On execution, porters would not confront a lot of torment in the upper limb.

4. CONCLUSION

Digital Human Modeling to assess posture and design of suggested luggage conveying device has executed for the porter utilizing CATIA-V5 for ergonomic assessment considering bio-mechanical factors. Proposed design will diminish gravity of

musculoskeletal disorders, by assessing risk components & proposals of decreasing threat may be found.

The Adjustable Physical Testing System presents the physical condition of the new model created in CAD [14]. It should be commitment by government body for providing agreeable work environment & assisting porters.

5. FUTURE SCOPE OF RESEARCH

This examination may moreover enhance analyzing psycho-social information concerning the porter, Energy utilization depicted by Adams et al. [6]. Post processing based on motion capture analysis of joints of human under study is to be done to create human model of the subject [9]. Marker-less movement catch is more prominence utilizing one or numerous cameras, for example, Microsoft Kinect [10]. Regardless of whichever system is utilized, the movements capture can be utilized as base for simulation of new movements in another workspace [11, 12].

The work presented here focuses on Digital human modeling of parts and structure enhancement may be done in next study. More upgrades are necessary dependent on biomechanical contemplations, for example, setup incorporating belts, cushions, augmentation springs and adjustable height arrangement might consolidated with casing to energizes author for future investigations. Proposed device is enormous in size & weight with the opportunity to be further improved.

ACKNOWLEDGMENT

The author is highly thankful to the support gave by the GLA University administration & Head of Mechanical engineering department.

References:

1. Sougata Karmakar., Sanjog J and Thaneswer Patel., 2014. Digital Human Modeling and Simulation in Product and Workplace Design: Indian Scenario. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622.
2. Nicolas Vignais ., Markus Miezal ., Gabriele Bleser ., Katharina Mura ., Dominic Gorecky and Frédéric Marin., 2013. Innovative system for real-time ergonomic feedback in industrial manufacturing. Applied Ergonomics 44, 566-574.
3. Nirathi Keerthi Govindu and Kari Babski-Reeves., 2014. Effects of personal, psychosocial and occupational factors on low back pain severity in workers. Available from www.elsevier.com/locate/ergon.
4. Granata.K.P ., Marras.W.S ., Davis.K.G., 1999. Variation in spinal load and trunk dynamics during repeated lifting exertions. Clinical Biomechanics 14.
5. Biomechanical guideline for occupational low back disorder prevention a field assessment and prevention guideline setup, January 2005. Occupational Safety and Health Council.
6. Arja Uusitalo ., Terhi Mets ., Kaisu Martinmäki ., Saija Mauno ., Ulla Kinnunen and Heikki Rusko., 2011. Heart rate variability related to effort at work. Applied Ergonomics 42, 830-838.
7. D.B. Chaffin, ed., Digital Human Modeling for Vehicle and Workplace Design, Society of Automotive Engineers, Warrendale, PA, 2001.
8. Demirel H.O., and Duffy V.G., 2007, "Applications of Digital Human Modeling in Industry", Digital Human Modeling. ICDHM 2007.
9. Wang, N. et al., 2013, "Motion Capture and Its Application for Vehicle Ingress/Egress", The 2nd International Digital Human Modeling Symposium, Ann Arbor, MI.
10. <https://developer.microsoft.com/en-us/windows/kinect>.
11. Monnier, G. et al., 2006, "A Motion Simulation Approach Integrated into a Design Engineering Process," SAE Technical Paper 2006-01-2359.

12. Kwon, H. et al., 2011, “Simulating Ingress Motion for Heavy Earthmoving Equipment”, V.G. Duffy (Ed.): Digital Human Modeling, HCII 2011, LNCS 6777, pp. 109–118.\
13. <http://www.3ds.com>.
14. Jian Wan, Nanxin Wang, A METHOD OF MOTION-BASED IMMERSIVE DESIGN SYSTEM FOR VEHICLE OCCUPANT PACKAGE, IDETC/CIE 2018, 2018, Canada.
15. Nee, A.Y.C., and Ong , S.K., 2013, “Virtual and Augmented Reality Applications in Manufacturing”, 7th IFAC Conference on Manufacturing Modelling, Management, and Control International Federation of Automatic Control. Saint Petersburg, Russia.
16. Nee, A.Y.C., Ong, S.K., Chryssolouris, Mourtzis, 2012, G., D., “Augmented reality applications in design and manufacturing”, CIRP Annals - Manufacturing Technology 61, pp. 657–679.
17. Novak-Marcincin, J., et al., 2013, “Augmented Reality Aided Manufacturing”, Procedia Computer Science, Vol 25, pp. 23 – 31, 2013 International Conference on Virtual and Augmented Reality in Education.