

# Design and analysis of transfer trolley for material handling – a review

Kaustubh V. Wankhade<sup>1</sup> and Dr. N. A. Wankhade<sup>2</sup>

<sup>1</sup>ME-Mechanical (CAD/CAM) Scholar, PRMIT&R, Badnera, Amravati, Maharashtra, India

<sup>2</sup>Associate professor, PRMIT&R, Badnera, Amravati, Maharashtra, India

## ABSTRACT

*Material handling task (of handling molten metal) in casting industries is very difficult and risky one. At present this task carried out manually for small-scale castings and with the help of ladle attached to the overhead crane hook for medium and large-scale castings. Now a day this operation required at least two workers in both cases, and aim of this research paper is to minimize labour requirement for handling and pouring molten metal and with less risk. This paper reviews the design, modelling and computer simulation as a tool for aiding trolley used by various researchers earlier. The results of computer simulations and results obtained by real experimentation compared to get detailed idea about the design ideas. Design and analysis carried out with various CAD software like CREO PARAMETRIC or CATIA and ANSYS.*

**Keywords:** Computer Aided Design (CAD), Computer Aided Engineering (CAE), Ergonomics, Gearbox, Trolley frame, etc...

## 1. INTRODUCTION

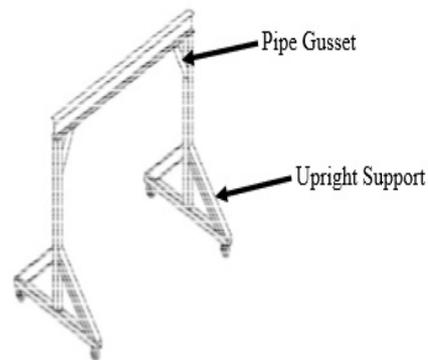
Rapid growth of industrialization is today's need to meet the goals of each and every industry. Faster the production, much faster the profit. Any company looks after customers satisfaction, it take care for some parameters like lead time, production rate, optimal cost and most important quality. Earlier various researchers have done research to make material handling task in factory or warehouses, a safer and economical one. This research paper studied the earlier inventions for handling material in factory. As existing system like crucible and gear ladle which hooked to overhead crane is old methods and the risk associated with it, the need is to optimize these processes. Casting processes now a day's becoming the key process of metal manufacturing because of wide range of materials suitability and also economic conditions. Here includes several steps like design of part itself, specification of the material to be used, information to choose right casting process also environment. Then design the system necessary to get molten metal into the all region of the mould cavity to produce sound casting. Two major considerations in the casting designing is not only quality of product but also yield of the casting [1] Now a day newer technologies are available to give exposure to work in any field of engineering and technology. These techniques are computer aided design (CAD) and computer aided engineering (CAE). It really helps researchers to give wings to their thoughts and with practical knowledge and test or otherwise check the ideas of research in actual environment.

## 2. APPROACHES

Approaches are divided into three parts like frame approach, gearbox approach and ergonomic approach.

### 2.1 Frame approach

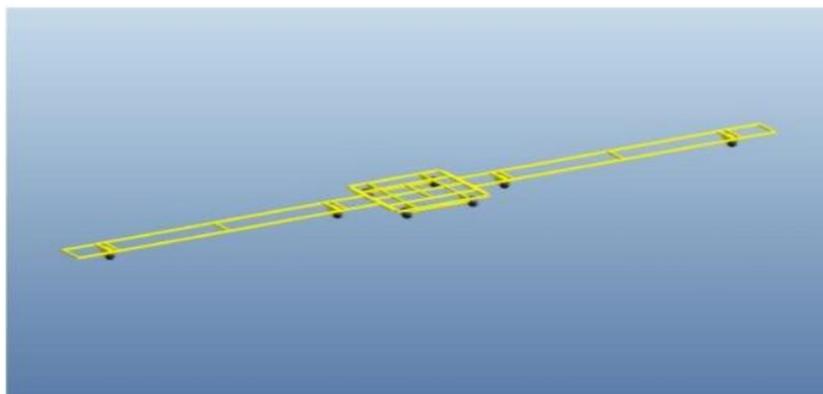
Sam Hutcheson [2] has done research in area of portable gantry hoist. The aim of this research is to design an overhead lift with chain hoist which can easily disassembled, carried out to site of application for easy transportation and assembled to required site of application or at job site. It has two tons lifting capacity. By reducing materials which are already available and put money for increasing quality of hoist. Caster wheels is solid rubber wheels having very high strength. These also have higher load carrying capacity which is more than two tons to sustaining extra weight of frame, hoist and trolley. Caster flat tyre wheels are applicable in soft soil and also gravel drive ways. Custom hoist allow much more customization to the basic overhead hoist designs like racks for tools, parts, and other items maximum bending moment in the centre of flange beam is found out by breakdown of material for maximum holding capacity. Caster is the limiting factor of designing because of low load rating as compared to other factors and also expensive. The hoist tested by lifting 265 Massey Ferguson for assuring weight holding capacity to which it rated for. a hoist must able to lift for its load rating so the design is adequate.



**Figure 1** Portable gantry hoist frame

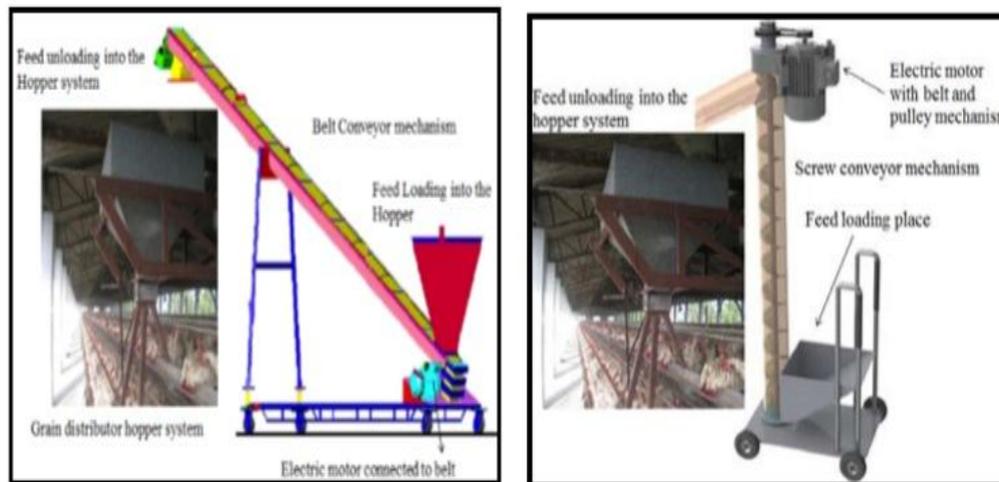
S E Dhage, A V Vanalkar and P R Gajbhiye [3] have invented Hot rolled product transfer mechanism. It is very important issue to handle hot rolled products in rolling industries. Generally angles, channels etc...Are the outputs or final products of these industries. As a finished product is having high temperature. Difficulty arise while lifting and moving billets from one place to another place. Product temperature is high enough to lift, handle and move place to place manually. Also improper handling may cause defects in product and quality gets affected.

Workers use lifting devices for handling hot rolled product but difficulties arises while handling, because different size and dimension for different products from mills to desired locations. And hence Hot rolled product transfer mechanism introduced by these researchers for transporting hot rolled products, which consists of lifting frame with U-shaped leg which is connect to a step and arranged in up right direction on its own wheels chassis, and it can move to desired place in factory. So the handling time required was reduced, handling done with safety and carefully by applying transferring device for this job. This mechanism works like a robotic arm and also the hydraulic pusher used to reduce human efforts. This mechanism improves the quality if billets or product and increases production rate.



**Figure 2** Proposed trolley mechanism

Gali Dileep Kumar, Prakash Unakal, Supradip Das [4] gives grain feeder approach for poultry farm. This research worked on egg collection and grain feeder system, studied customers aspirations. all this done with analyzing data like customer survey and market research. Using the output of the data analyzing quality function development (QFD) matrix and then product design specification made. And according to different concepts invented for grain feeding trolley and overcomes ergonomic issues. Study helped to understand design process. The real problems and working methods were understood, feedback collected from different users and needs refined. Safe working postures applied by doing ergonomic study. Ideas generated by using techniques like mind mapping TRIZ for conceptualization of idea and eliminate problems. These concepts have more advantages as compared to existing product in terms of cost and reliability.



(a) Belt conveyor approach

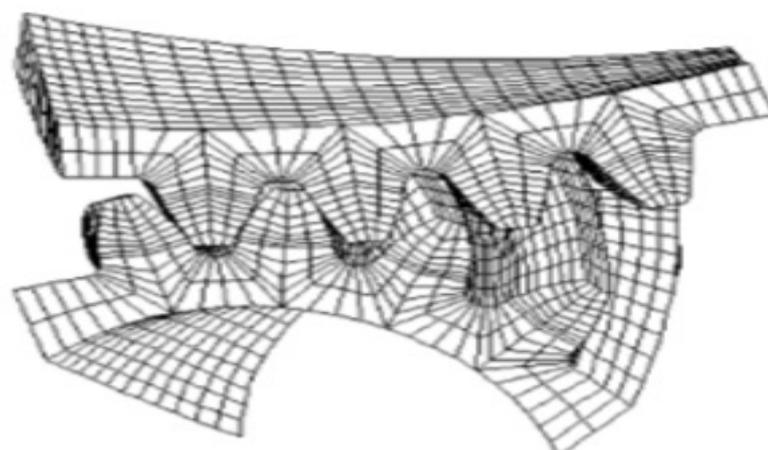
(b) Screw conveyor approach

**Figure 3** Grain feeder trolley mechanisms

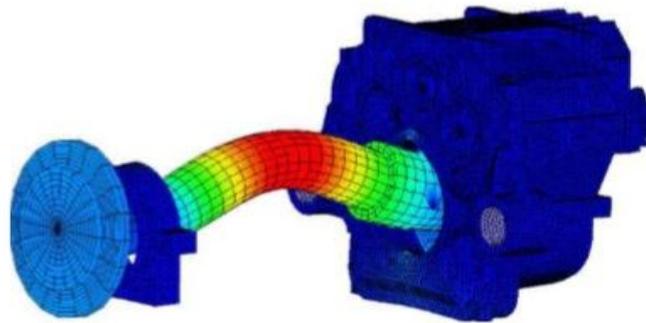
## 2.2 Gearbox approach

Pratik Gulaxea, N. P. Awate [5] has studied gearbox for material handling trolley. It examines design of gearbox and analyze for cupola material handling trolley. As the time taken by existing gearbox was more, the production lead time was also more. Now a day, casting is a key process in manufacturing as a wide range material are available and suitable and also an alternatives available for economic prospect. Priority is to choose the right casting process and then design the system to get molten metal into the mould. The major consideration in designing a casting process are quality of final product and yield strength of casting. Both are depends on rigging system used. Various researchers used different techniques like finite element approach, optimization approach, experimental setup approach, mathematical modelling and wavelet approach. The speed of trolley can increased by increasing the gearbox speed and by reducing failure in loading trolley and gearbox.

Chengyun Yang and Chean, Lihua Wang [6] gives finite element approach and simulated dynamic behaviour of gearbox for speed using finite element method. By using 3D-contact finite element method the time variable stiffness curves of meshing gears and the profile errors where determine by gear precision. As the stiffness and error excitation where determine, dynamic model of new gearbox in which speed increased established. And analyze the normal frequencies and vibrations of gearbox, also analyse transmission shaft for better result. Computed the curve with meshing stiffness by 3D-contact finite element method for gearing. Error curve expressed by simple harmonic function 3D-finite element model constructed for dynamic analysis of gearbox speed. Studied its normal characteristics and vibration response. The reason suggest that sympathetic vibration phenomenon will not occur in this speed increase gearbox while operation.



**Figure 4** Meshed gear model



**Figure 5** Finite element analysis of gearbox shaft in ANSYS

Feng and Yi [7] proposed optimization approach in which contradiction of casting process identified and enhance the conversion capability of specific problem to standard one and improve feasibility of theory inventive problem solving (TRIZ). With the help of integration of systematic method and solving tool like TRIZ increases the casting process optimization efficiency. TRIZ is nothing but the tool for theory of inventive problem solving and it is the important theory which is innovative and has capability to solve the problem to eliminate contradiction from technical systems. Some tools and approaches used to eliminate the conflicts. Some researchers combined quality functions development with theory of inventive problem solving to overcome problems in design process.

### **2.3 Ergonomics approach**

Enid W.Y. Kwong\*, Claudia K.Y. Lai, Ernesto Spicciolato and Martin C.M. Wong [8] studied ergonomic aspects on designing the shopping trolley and implication of development in trolley. Different types of trolleys studied for various markets. Name of trolleys are usually reflects the purpose like truck trolley, rickshaw, golf trolley, cage and shopping trolley. Shopping trolleys used in supermarkets, malls and warehouses for transportation of food and materials to save energy, minimised efforts and for safety from injuries caused by manual handling of heavy loads. As the poor designed trolleys do not achieved this goals. Also it can make injury to the operator or user due to poor ergonomic study. Such as pain and stiffness in the neck, shoulders, upper extremities, lower extremities and back injuries. Conducting the market research on about 30 shopping trolleys, the most of them found poorly design like non adjustable handle height and a lack of pushing motion which is responsible for pushing efforts or force. And this exerts mechanical loading on lower back shoulder and spine. Due to this need arises to develop trolley by optimising the design and made acceptable to the users. survey conducted on views of Hong-Kong adults on shopping trolleys which are customer owned and kept at home. Study informed about development of new design for shopping trolley design which is well suited for customer requirement the result has implications for development of an ergonomically designed trolley which was acceptable and also it has scopes for further modification to develop this trolley and evaluate its efficiency.

### **3. CONCLUSION**

Researchers have done tremendous work in the area of trolley design with greater reliability, protection and robust design also design was adequate and costs reduced. Speed of trolley can increased by increasing gearbox speed and reducing failures in gearbox. Also did ergonomic study like adjustable handle for minimum pushing efforts for users. Trolleys used in many areas like in hot rolled product handling, grain feeding trolley, in casting industries, shopping malls etc... much more work is still needed to make use of trolleys in different Areas.

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## **AUTHOR**

**Kaustubh V. Wankhade** received the Bachelor of Engineering degrees in Mechanical Engineering from Santa Gadge Baba Amravati University, Amravati, Maharashtra, (India) in 2013 and now Pursuing in Master of Engineering, Mechanical (CAD/CAM) since 2013 at Prof. Ram Meghe Institute of Technology and Research, Badnera, Amravati, Maharashtra, (India)