Semi Automation of frame change Assembly in Automobile Industry

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***Abstract*— In the automobile industry, double chain conveyor assembly lines are used to produce medium and heavy-duty vehicles chassis. In the truck chassis turn over process, removing and placing fixtures on the double chain conveyor is done manually under a suspended frame, which can result in fatal or permanent disability for workers, as well as major material handling issues. This article seeks to conduct a risk assessment (HIRA) of the process and fabricate a fixture that can be fitted with a double chain conveyor during the turn-over stage. With the help of the pneumatic system, the fixture is automatically removed and placed on the double chain conveyor. Solid works is used to design, model, and analyses the fixture replacement equipment. Using FluidSIM software, the pneumatic cylinder operating sequence + is constructed, demonstrating that the fixture replacement equipment meets the requirements and proving the viability of the design study.**

***Index Terms*— HIRA ,Double chain conveyor design study fall Hazard, suspended load styling, insert.**

I. Introduction

In general, Electrified Monorail Systems (EMS) (or) conveyor systems are used to assemble Medium & Heavy duty components in the automotive industry. In this scenario, the truck is assembled using a double chain conveyor system. As various components are assembled by different stage workers, the frame advances along an assembly line. The assembly stage is divided into two parts, one for assembling lower frame components and the other for assembling upper frame components. While moving the frame within the conveyor, two types of fixtures are used. One fixture is used to hold and move the frame when assembling the lower side, while another fixture is used to hold and move the frame while assembling the upper side.

A Turn-over crane is used to raise and Turn-Over the lower frame into the upper frame after the lower frame components are installed. During the process, the fixture must be manually removed and replaced from the conveyor, and employees must be present in the region of the Turn-Over crane's suspended frame. To avoid this difficulty, other companies use two independent assembly lines to produce lower and higher chassis components, with a Turn-Over robot switching between the two lines. However, replacing the crane with robots is not only inefficient, but it also takes up more room due to the two conveyor lines. As a result, by using fixture-replacing technology, the process becomes more cost-effective and removes the risk of injury to the worker.

R.J. ORSATO AND P. WELLS "U-turn: the rise and demise of the automobile industry"

This article outlined a basic reason for modern automotive assembly's 'technical regime,' as well as its capacity for stasis and transformation. It covers automotive design concepts, material choices, and economic foundations that apply to today's truck (or) heavy vehicle assembly and commercialization. Proposed design to reduce the plant's total environmental impact.

WONJOON CHO AND HYUNOH SHIN "A Real-Time Sequence Control System for the Level Production of the Automobile Assembly Line"

In this study, mixed-model assembly lines are employed to create vehicles per minute in the automobile business. It included the development of a new pneumatic system sequencing approach for level assembly line production, as well as the establishment of a semi-automated sequence-control system to ensure a safe working environment.

PIERRE E. C. JOHANSSON, SANDRA MATTSSON, "Multi-Variant TruckProduction - Product Variety and its Impact on Production Quality in Manual Assembly"

In this work, eight manual assembly stations in a truck manufacturing company are studied. The vulnerability of manufacturing truck plants to quality deviations in the assembly line process grows with the introduction of a new system of customization. With the support of safety needs investigations, this research focuses on adopting a new system that does not disrupt the assembly line process. Even though these experiments were conducted in high-production situations, the authors show that they especially targeted the truck manufacturing business.

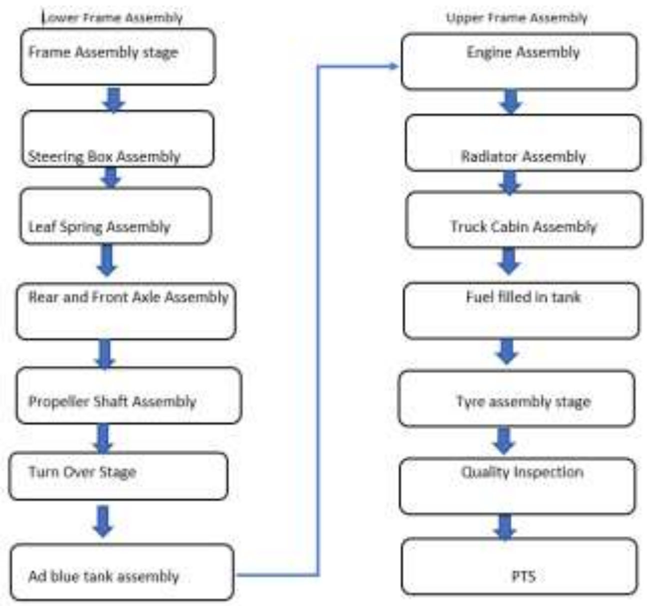
YUAN YUAN AND ZIDONG WANG "Active disturbance rejection control for a pneumatic motion platform subject to actuator saturation: An extended state observer approach"

This study is about a large inquiry into the design of an active disturbance introduced by a pneumatic system that is used on a conveyor. This research presents an ESO-based pneumatic controller for controlling conveyor motion.

YUGUANG ZHONG AND ZEXIAO DENG, "An effective artificial fish swarmoptimization algorithm for two-sided assembly line balancing problems"

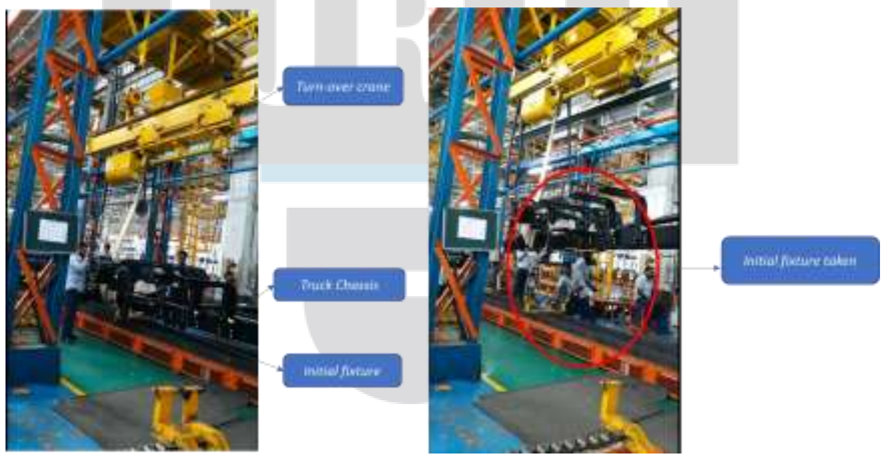
The manufacturing of heavy-vehicle items such as autos, buses, and trucks is discussed in this study using two-sided assembly lines. This assembly line has the benefits of a shorter line, higher fixture usage, and more workspace for workers. An effective discrete chain conveyor system algorithm is created in this study work to handle cost-oriented assembly line balancing productivity and safety challenges with the goal of lowering maintenance costs.

II. PROCESS FLOW



2.0 Problem identification

In the truck manufacturing sector, an unsafe fixture replacement method resulted in a deadly accident. The Turn-Over crane is used to lift and turn the frame (lower frame into upper frame position). During this procedure, the fixture must be physically removed and replaced from the conveyor, and employees must be present in the region of the suspended frame in the Turn-Over crane. The fixture is then modified for positioning the turned over chassis, which may collapse on the worker. This results in death (or) long-term impairment. The assembly of truck chassis components in this company involves many processes, and then the loading of components up to the finishing process causes issues for workers.
This HIRA study could aid businesses in being more proactive in safeguarding worker safety and health. To get a evaluate the risk and complete study should be conducted. If the RPN value from the risk matrix analysis still indicates an unacceptable or medium risk, a redesign or other improvements should be implemented to lower the risk of prospective accidents. In the turn-over stage, this project seeks to fabricate a fixture replacing equipment that can be fitted with a double chain conveyor. With the use of a pneumatic system, the fixtures are semi-automatically removed and placed on the double chain conveyor, eliminating the need for humans to enter the frame suspended area to replace the fixtures.



Methodology:

HIRA Study
HIRA is an analytical technique that combines technology with worker (or) supervisor expertise to identify a process's likely future failure mechanism and prepare for its elimination. HIRA is a "pre-event" step that requires a collaborative effort (Safety, Maintenance, and Production) to mitigate changes quickly and economically in the manufacturing process. To manage safety concerns, this risk assessment method is applied. After the hazard has been identified and assessed, possible control methods for the safe execution of activities will be recommended. It's a technique that's always evolving. An dangerous operation should be avoided, and a safe execution procedure should be provided.

5.6 HAZARD IDENTIFICATION AND RISK ASSESSMENT OF TRUCK CHASSIS ASSEMBLY LINE

HAZARDS IDENTIFIED	WHAT IS THE RISK ASSOCIATED WITH THE HAZARD? (Injury, Ill health, Loss of life, Property Damage, Fire Explosion)	WHAT IS THE SEVERITY OF THE RISK? (If S is "5" it is "Urgent" & Intolerable)	WHAT IS THE PROBABILITY: LIKELIHOOD OF THE OCCURRENCE OF THE RISK?	HOW MANY PEOPLE ARE LIKELY TO BE EXPOSED OR AFFECTED? (Enter the rating only)	RPN	IS IT - LOW, MEDIUM, HIGH, URGENT?	CONTROL MESURES		
							ENGINNEING CONTROL	ADMINISTRATIVE CONTROL	PPE
Holder slippage while moving the assembly	Injury	4	2	2	16	H	Modification of holding pin, Fencing the machine.		
Accidental slip of leaf spring while loading	Injury	3	3	2	18	H	1. Tackle modified for lifting leaf spring (PEP) Completed 2. Rear and front axle spring crane colliding with each other. Rail and crane modifications required.		
Axle slipand fall off trolley while loading	Property damage	3	3	2	18	H	Tackle design to be modified to increase area of contact to avoid axle falling down		
Accidental slip of hook and hit against person	Injury	3	3	2	18	H	Not standardized tackle (welded hook) used for lifting front and rear axle. Shall be checked and certified for loading		

							capacity periodically.		
Frame slip and fall off from trolley while loading	Injury & Property damage	4	3	3	36	H	Limit switch to be install on the VIN marking machine rail.		
Exposure to Noise	Injury	2	5	2	20	H	Noise mapping	Job rotation practiced shall be follow.	
Frame slip if multi spindle not released from frame	Injury	4	3	2	24	H	Install safety limit switch on the machine.		
Partial clamping of cylinder mouth side leads to cylinder falling down	Injury & Property damage	4	3	2	24	H	Automatic crane operation (turn over operation) and evacuation on the stage to be verified		
Hand / fingers caught while expanding	Injury	3	3	2	18	H	Rope to be monitored for lifetime and weariness of the belt.		
Air hoses lying on the floor hinders operator movement	Injury	3	3	2	18	H	Air hose hung over stand shall be install.		
Accidental slip of torque machine while operating	Injury	4	3	2	24	H	Wire mesh cover install over the spindle to avoid accidents and near miss incidents.		
Fatal (or)Injury to workers due to chassis turn-over process during	Injury, Loss of life & Property damage	5	5	2	50	U	Design and fabrication of fixture replacing equipment		

3. **Propesed Fixture replacing Equipment**

Exciting Method: The fixture is taken and replaced from the double chain conveyor done in manually.

Proposed Fixture Replacing: The fixtures have automatically taken and replacing into double chain conveyor withthe help of fixture replacing equipment, without manpower.

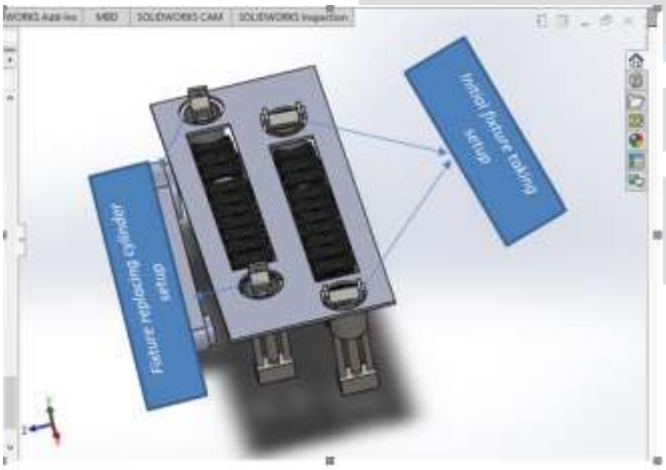


Fig.3. Fixture replacing equipment

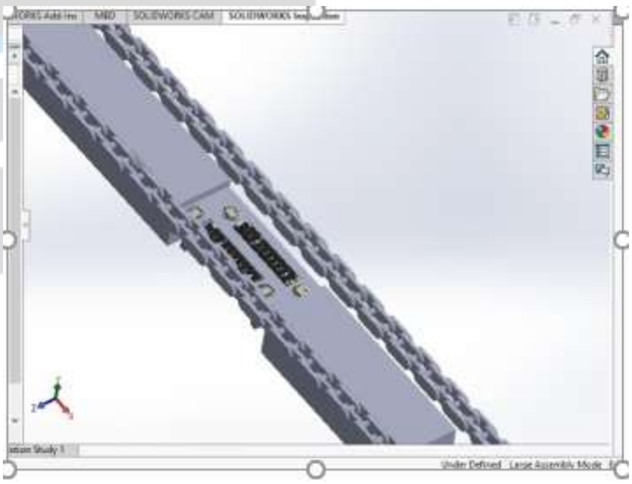


Fig.3.1 Doble chain Conveyor

Design of Pneumatic Circuit

A fixture that will be used to replace equipment in an experimental setup sequence that will be simulated using the FluidSIM programme

+ -> indicates forward direction
- -> indicates reverse direction
Description of the components of fixture replacing equipment simulation on thesoftware

1	Double acting cylinder A1
2	Double acting cylinder B1
3	Limit actuator
4	Flow control valve
5	5/2 solenoid valve
6	Slide valve

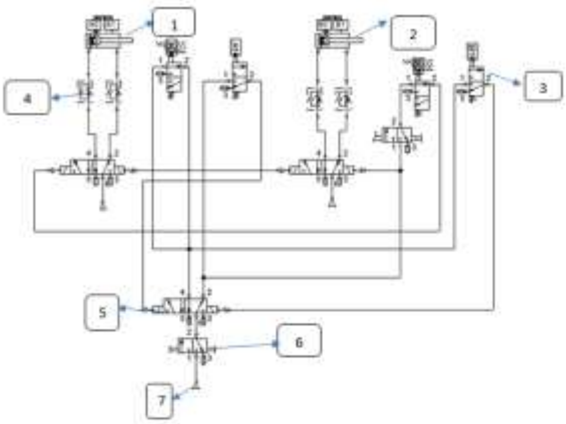


Fig 3.2 Pneumatic circuit sequence A+A-B+B-

4.WORKING PRINCIPLE
Pneumatic cylinders, gear motors, pneumatic switches, 5/2 pneumatic valves, and pneumatic hose kit are all used in this project. Two pneumatic cylinder systems for removing the lower frame fixture and two pneumatic cylinder systems for installing the top frame fixture on the conveyor are employed in total. Each pneumatic cylinder is equipped with supports to keep it from swaying during operation. After the fixture has been hoisted by the pneumatic arm, a gear motor is employed to spin it for around 90 degrees. Each gear motor is encased by a rectangular arrangement that is pushed into the piston to prevent damage from rapid movement. A shaft and bush are utilized above the pneumatic cylinder to prevent misalignment of the gear motor configuration for cylinder motions. The motor shaft is connected to the fixture holding platform. As a result, the motor shaft rotates in tandem with the platform. Switch control is used to operate the pneumatic arm and gear motor. As a result, the fixture's ascent, rotation, and downward motion are all smooth and jerk-free.


Fig.4.Fixture replacing setup

The frame is lifted and turned over by a pneumatic device created with a double chain conveyor and a turn-over crane. When the pneumatic system is turned on, the piston moves higher, lifting the lower frame fixture over the conveyor, the motor rotates, and the fixture position changes. The fixture is removed from the conveyor and it moves downhill. After turning the frame over, align the conveyor with the top frame fittings. The adjacent pistons are operated in the same way, with the top frame fixture placing the fixtures on the conveyor and the piston returning to its original position. Within 15 seconds, the lower frame fixture is replaced with the higher frame fixture. The worker has not entered the frame suspended area where the fixture is to be replaced.

Conclusion

HIRA is a systematic approach to the study of existing control measures, analysis, definition, estimation, and evaluation of risks in a truck manufacturing plant. The HIRA was completed, and the hazards and risks were determined by examining each step in the assembly line's numerous procedures. These dangers could develop as a result of flaws in the production line equipment. In addition, for the safe execution of operations, possible control solutions for identified hazards are advised. HIRA analysis may easily aid in improving the efficiency of the assembly process and product quality, reducing the number of accidents and defective goods while also saving money and time on rework. The goal of this project is to create a fixture-replacing machine that can be equipped with a double chain conveyor during the turn-over stage. With the help of a pneumatic system, the fixtures were semi-automatically removed and replaced into double chain conveyors, with no workers entering the frame suspended area. The fixture-replacing equipment is built, modelled, and analyzed in SolidWorks, and the pneumatic cylinder operating sequence is modelled in FluidSIM. The equipment structure was subjected to a stress study. The stress distribution and displacement of the fixture changing equipment were indicated when the maximum operating load capacity was reached. A+A- is the original fixture sequence, and B+B- is the fixture replacement sequence. Following the termination of the A+A- sequence, the B+B- sequence will begin and will be successfully tested. The FluidSIM software-assisted pneumatic control system was used to test a variety of valves and actuators. For phase II, a constructed replica of the fixture replacement system is attached to a conveyor and tested using model fixtures. This indicates that the worker did not enter the suspended frame area to replace the fittings.

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