A Review on Critical Time –Motion and Economic Analysis of Linear and Rotary Gravity Conveyor for application one man multi-machine setup as low cost automation in material handling.

Mr.Deokate A.Y.[1] , Prof.Mundhe V.L.[2]
[1, 2] Department of Mechanical Engineering
[1] SVPM'S ITE Malegaon (BK), India
[2] BIT Barshi, Solapur, India

Abstract- *The rapid growth of technology in the last two decades has been characterized by full automation. As only the affluent and developed countries can afford to adopt full automation, a large productivity gap has been created. This gap can be bridged through low cost automation. The concept and principles of low cost automation are basically the same as those of full automation except that the former builds improvement around existing equipment and machine system rather than replacing whole system with automated processes. Material handling is the primary activity of every manufacturing organization. It has been estimated that at least 15 to 25% of the cost of the product is attributable to material handling activities. Unlike many other operations, material handling adds to the cost of the product and not to its value. It is therefore important first to eliminate or at least minimize the need for material handling and second to minimize the cost of handling.*

Karakuri mechanisms use a single force or motion to simultaneously perform multiple operations, and also lead directly to energy conservation and resource (facilities) savings. Conventionally gravity conveyors are used to perform material handling task but they are more often of fixed layout type with a singular application. The proposed linear gravity conveyor for flexible manufacture system uses the principle of Converting the force from a dropped weight into gear rotation to activate a conveyor thereby saving the cost of motor and electricity. Conveyors are ordinarily activated by using drive from a motor. In this example, when the conveyor is lifted with a cylinder, a weight drops from the top portion of the conveyor. The force of dropped weight rotates gears that provide movement needed for slide delivery of work (semi-finished products). This mechanism eliminates the need for a motor and enabled a reduction in standby electricity and electricity for operation. Slide delivery requires only the necessary amount of driving energy at the time when needed and is therefore consistent with the concept of "just-in-time" electricity.

Objective of project is carry out critical analysis as to time-motion and economics of the developed conveyor system with linear and rotary conveyor to determine the i)Transfer time ii)Maximum load carrying capacity .Comparative analysis of the performance of the developed system with conventional conveyor to derive: Change in job transfer time

I. INTRODUCTION

The rapid growth of technology in the last two decades has been characterized by full automation. As only the affluent and developed countries can afford to adopt full automation, a large productivity gap has been created. This gap can be bridged through low cost automation. The desire to increase productivity can effectively accomplished through the adoption of low cost automation by their characteristic small and medium size companies.

The concept and principles of low cost automation are basically the same as those of full automation except that the former builds improvement around existing equipment and machine system rather than replacing whole system with automated processes.

material handling is the primary activity of every manufacturing organization. It has been estimated that at least 15 to 25% of the cost of the product is attributable to material handling activities.

Unlike many other operations, material handling adds to the cost of the product and not to its value. It is therefore important first to eliminate or at least minimize the need for material handling and second to minimize the cost of handling.

The project done was an effort to amalgamate the two concepts of low cost automation and material handling by implementing very simple and innovative ideas for achieving effective material handling.

The project was done in two phases; the low cost automation involved conceptualizing, designing and fabricating a Job Auto Loader, whereas in effective material handling several innovative ideas of improvising upon the existing material handling system were proposed and implemented.

The design was made as per the requirement we assumed within the limit of space, mass and cost budget. The designs were found acceptable and most of them were implemented.

II. PAPER OBJECTIVE

Linear & Revolving material transfer system

It is always advisable to minimize or if possible eliminate operator's involvement in transferring materials. There was a need to develop a simple, compact and robust material handling equipment that would suit almost any short distance material transfer task. Such a system would eliminate the need of power conveyors, chutes or roller conveyors that need operator attention and picking of jobs by hand to transfer it between two stations.

The system would be of great use in manufacturing lines having U type or Zig Zag type layouts where human handling of jobs is presently unavoidable, as use of powered conveyors or gravity conveyors cause interruption in line operations.

Thus the objective of the project was to develop material transfer equipment that:

- Would eliminate the operators handling of jobs for transferring them between stations required in U type, circular type, or Zig Zag manufacturing lines.
- Would be simple, robust and compact, and would suit almost any short distance material transfer task.
- Would consume no electrical power.
- Would result in increase of effective productive time.
- Would require negligible maintenance attention.

The rapid growth of technology in the last two decades has been characterized by full automation. As only the affluent and developed countries can afford to adopt full automation, a large productivity gap has been created. This gap can be bridged through low cost automation. The desire to increase productivity can effectively accomplished through the adoption of low cost automation by their characteristic small and medium size companies.

The concept and principles of low cost automation are basically the same as those of full automation except that the former builds improvement around existing equipment and machine system rather than replacing whole system with automated processes.

material handling is the primary activity of every manufacturing organization. It has been estimated that at least 15 to 25% of the cost of the product is attributable to material handling activities.

Unlike many other operations, material handling adds to the cost of the product and not to its value. It is therefore important first to eliminate or at least minimize the need for material handling and second to minimize the cost of handling.

The project done was an effort to amalgamate the two concepts of low cost automation and material handling by implementing very simple and innovative ideas for achieving effective material handling. The project was done in two phases; the low cost automation involved conceptualizing, designing and fabricating a Job Auto Loader, whereas in effective material handling several innovative ideas of improvising upon the existing material handling system were proposed and implemented.

The design was made as per the requirement we assumed within the limit of space, mass and cost budget. The designs were found acceptable and most of them were implemented problem definition : linear gravity conveyor

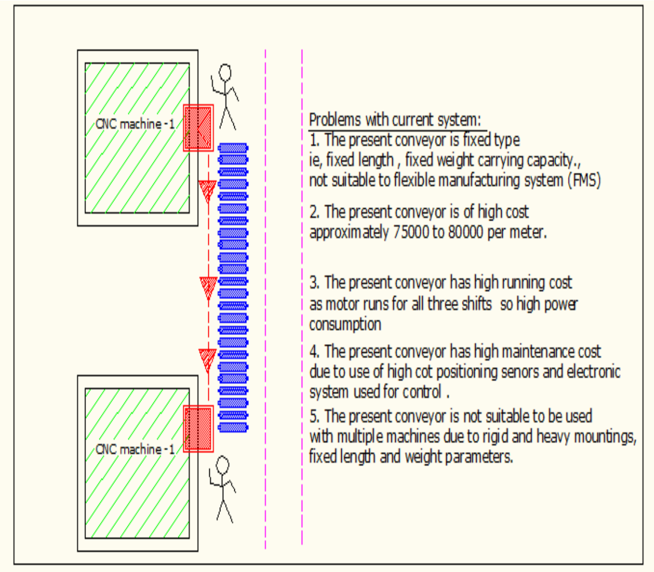

Figure 1.

Hence there is need of innovative material transport system that is proposed to have following properties:

a) Conveyor should be modular ie ,

i. Length of conveyor is to be adjustable to be able to connect any two machines spaced between 1 metre to 1.8 metre

ii. Weight carrying capacity of conveyor to be varied from 5 kg to 12 kg in tray system.

b) Conveyor should be powerless in operation

This means that there conveyor is to be powered by gravity action so that there will be no running cost.

c) Conveyor weight carrying capacity should be made such that the conveyor system will automatically adjust the slide angle using a comparator and hydraulic dashpot mechanism to ensure that the job does not fall out of tray due to momentum of job at end of stroke.

Solution : Active-Gravity Conveyor system for Flexible manufacture system using Karakuri mechanism

Conveyors are ordinarily activated by using drive from a motor. In this example,when the conveyor is lifted with a cylinder,a weight drops from the top portion of the conveyor.The force of dropped weight rotates gear that provide movement needed for slide delivey of work (semi finished products).

Conceived based on a one-way clutch that rotates a bicycle tire in onky one direction, this mechanism eliminates the for a motor and enabled a reduction in standby electricity and electricity for operation.

Slide delivery requires only the necessary amount of driving energy at the time when needed and is therefore consistant with the concept of “Just – In Time”electricity.

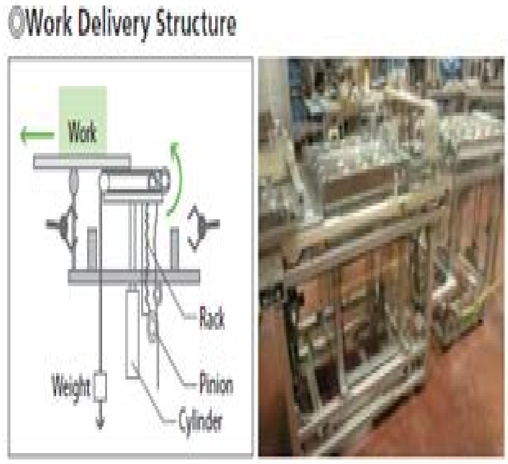

Figure 1.

Problem definition Rotary Conveyor

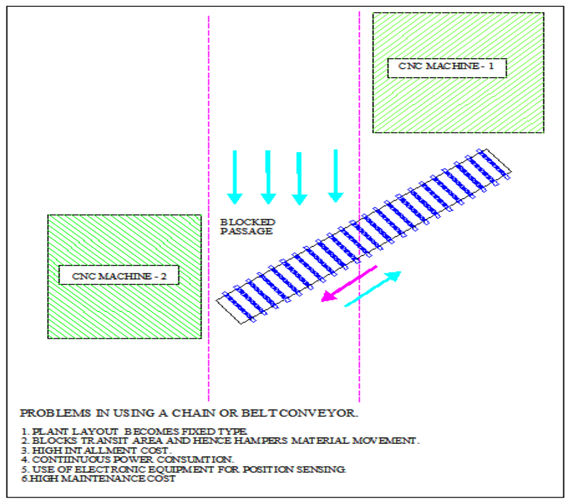

Figure 2.

Solution

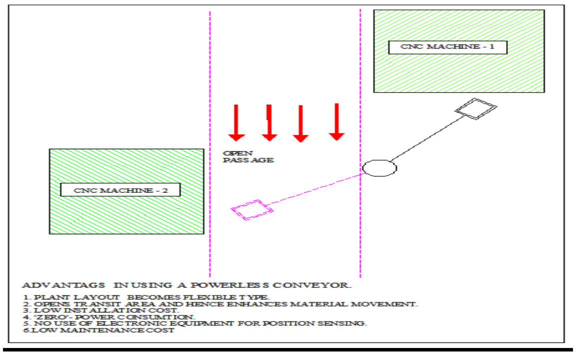

Figure 3.

III. ADVANTAGES

- Low fabrication, running and maintenance cost.
- Reduces operators handling thus reduces operators fatigue.
- Robust, simple, compact and flexible design makes it suitable for almost all short distance material transfer application.
- Consumes no electrical power as works on counterweight principle.
- The effective productive time increases as the operator can utilize time for loading or unloading jobs from machine which was otherwise wasted material transfer.
- If intelligently mounted online it does not block the passages for operator's movement.

Limitations:

- Application is restricted to small distance material transfer
- The revolving long arms demands more space and may obstruct the operators movement
- Not suitable for heavier components.

IV. ECONOMIC ANALYSIS OF THE LINEAR AND ROTARY CONVEYOR :

Considering that the time required by the operator to move from Point (a) to Point (b) by time and motion study to be 10 seconds the effect of using gravity linear conveyor will be studied and documented to derive the total time and distance travelled by operator per shift for given batch of production. The cost of operation and machine downtime as a result of material handling will be derived to justify the implementation of low cost automation .

V. OBJECTIVES OF PAPER

1. Study and analysis of present material handling system to identify and derive the time , distance and motion with objective to need and feasibility of implementation of low cost automation in material handling system.
2. Critical study of time, distance and motion study after implementation of linear gravity conveyor system to present layout to determine the reduction in time , distance movement and machine downtime to derive the savings after implementation of the system.
3. Critical study of time, distance and motion study after implementation of linear gravity conveyor system to present layout to determine the reduction in time , distance movement and machine downtime to derive the savings after implementation of the system
4. Comparative analysis of the linear gravity and rotary gravity conveyor systems with conventional method of material transfer to prove the effectiveness of new system over conventional or existing system.

Scope :

In today's manufacturing environment, assembly work is routinely characterized by short production cycles and constantly diminishing batch sizes, while the variety of product types and models continues to increase. Constant pressure to shorten lead times adds to these demands and makes the mix truly challenging, even for the most innovative manufacturers.

The ability to respond quickly to rapidly changing customer demands requires the use of manufacturing systems that can be re-configured and expanded on the fly, and which can accommodate advances in assembly techniques without making any initial manufacturing investments obsolete.

Lean manufacturing, an approach that depends greatly on flexibility and workplace organization, is an excellent starting point for companies wanting to take a fresh look at their current manufacturing methods. Lean techniques are also worthy of investigation because they eliminate large capital outlays for dedicated machinery until automation becomes absolutely necessary.

Indeed, the concept of lean manufacturing represents a significant departure from the automated factory so popular in recent years. The "less is better" approach to manufacturing leads to a vastly simplified, remarkably uncluttered environment that is carefully tuned to the manufacturer's demands. Products are manufactured one at a time in response to the customer's requirements rather than batch manufactured for stock. The goal is to produce only the quantity required and no more. And since limited numbers of

parts are produced, it may be necessary to change processes during the day--to accommodate different parts and to make maximum use of personnel, equipment and floor space. The flexibility inherent in manual assembly cells is therefore preferable to automated assembly. This requirement for maximum flexibility creates unique demands on the lean workcell and the components that make up the lean workcell.
Granted, the lean approach is not the solution for all manufacturing problems. But it does offer a uniquely flexible solution for assembling more complex products. This guide describes 9 basic lean manufacturing principles that should help you evaluate lean manufacturing solutions for your own applications.

Ultimately, one of the goals of the lean workcell is to eliminate all non-value-added movement; hence its U-shape. When the worker has finished the process, he simply turns around and is back at step one.

The workpiece may be carried from one value-added operation to the next. However, there are times when the workpiece or the fixture holding the workpiece is too heavy and must be transferred mechanically between workstations.
Although very heavy parts may be transported on belt conveyors, manual push or gravity conveyors are ideal for moving parts between workstations. Their minimum complexity makes them easy to service and minimizes down time. In addition, they are easy to connect end-to-end, which makes it easy to move workstations within a workcell

Primary work will be to do time and motion study for pilot study where in the the targets of motion will be as follows:

Linear distance covered is 1m
Rotary distance covered is 1.5 m
Net distance travelled is 2.5 m

The system will be studied and tested as per below:

1) System design as to the number of components required , their sizes as per machine layout conditions
2) Selection of following parts:

a) Linear conveyor system components
b) Shock arresting machine at the end of stroke for linear conveyor
c) Rotary conveyor system components
d) d)Shock arresting machine at the end of stroke for Rotary conveyor

B) Manufacturing of set-up

1) Manufacturing of linear conveyor system
2) Manufacturing of Rotary conveyor system
3) Fabrication of combined set up to integrate both work motions to get net effect of conveyance.

Testing of the linear conveyor for following parameters

1) Variation of weight Vs Time of transit
2) 2) Cycle time of Transfer
3) Energy expenditure balance sheet for the given operation

Results To Study (Analysis)

1) Cycle time for linear conveyance
2) Economics of motion (distance travelled saved)
3) Economics of time and cost (time and cost saved)

Graphs :

a) Travel speed VS Weight of component
b) Cycle time VS Weight of component
c) Time saved Vs Weight of component
d) Cost saved Vs Weight of component

Testing of the Roatary conveyor for following parametrs

1) Variation of weight Vs Time of transit
2) Cycle time of Transfer
3) Energy expenditure balance sheet for the given operation

Results To Study (Analysis)

1) Cycle time for rotary conveyance
2) Economics of motion (distance travelled saved)
3) Economics of time and cost (time and cost saved)

Graphs:

a) Travel speed VS Weight of component
b) Cycle time VS Weight of component
c) Time saved Vs Weight of component
d) Cost saved Vs Weight of component

Testing of the combined conveyor for following parameters

1. Variation of weight Vs Time of transit
2. Cycle time of Transfer
3. Energy expenditure balance sheet for the given operation

Results To Study (Analysis)

1) Cycle time for combined conveyance
2) Economics of motion (distance travelled saved)
3) Economics of time and cost (time and cost saved)

Graphs :

a) Travel speed VS Weight of component
b) Cycle time VS Weight of component
c) Time saved Vs Weight of component
d) Cost saved Vs Weight of component

Validation Of Results :

Statistical tool of One –way Annova between two subject factors will be used to compare the experimental results with the theoretical expected results to fin the variance in data and target variance will be 5%.----for linear conveyor system Statistical tool of One –way Annova between two subject factors will be used to compare the experimental results with the theoretical expected results to fin the variance in data and target variance will be 5%.----for rotary conveyor system Statistical tool of One –way Annova between two subject factors will be used to compare the experimental results with the theoretical expected results to fin the variance in data and target variance will be 5%.----for combined conveyor system

VI. EXPECTED RESULTS FROM PROJECT

A. Effect of application of linear gravity conveyor system on the following parameters of the material handling system

- Cycle time
- Motion
- Time
- Cost

B. Effect of application of linear gravity conveyor system on the following parameters of the material handling system

- Cycle time
- Motion
- Time
- Cost

C. Effect of application of combined linear – rotary gravity conveyor system on the following parameters of the material handling system

- Cycle time
- Motion
- Time
- Cost

D. Comment on the application of the combined system as to a ideal solution to continuous flow –approach of lean manufacturing system

REFERENCES

[1] Patrick M. M., Conveyors: Application, Selection, and Integration, 1st Edition: CRC Press, 2010.

[2] Altamuro V. M., Marburg K. H., Marks Standard Handbook for Mechanical Engineers, 11th Edition: McGraw- Hill 2006.

[3] Groover M. P., Automation, Production Systems, and Computer Integrated Manufacturing, 3rd Edition: PHI 2008.

[4] Erbe H. H., "Low Cost Intelligent Automation In Manufacturing," In 15th Triennial World Congress, Barcelona, Spain,2002.

[5] Pattanayak S., Bensingh R. J., "Design, Development And Simulation Of Low Cost Automation For Special Purpose Turning