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Case study on Automation of Production Line system in Industry

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Abstract

Due to inherent advantages of automation such as easy material handling, easy transportation of raw material as well as finished material with minimum risk thus every company is moving towards automation. It also save time and help to remove burden from worker, as a result automation helps to increase overall productivity of company. Thus now many industries are using application of automation for efficient manufacturing. Automation is the use of control systems such as computers, controllers to control industrial machinery and processes, to optimize productivity in the production of goods and delivery of services. Whereas mechanization provides human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements. In this project I have to make a robotic arm using pneumatics which can feed cam shaft from conveyor belt to CNC machine and then after operation remove the shaft from CNC machine and placed it back on conveyor belt. By practically applying this system we can save both time and money.

Keywords: Production Line; Automation; CNC Machine.

1. Introduction

A valve train is a mechanical system that controls operation of the valves in an internal combustion engine, in which a sequence of components transmits motion throughout the assembly. Camshaft is an integral part of this valve train system. Line 1b manufacture cam shafts for General Motors. Currently human workers are working in this line and they produce cam shafts on average 35/hour. Cam shafts produce in this line are low weight which is around 1.5 kg. There are 3 machine in this line 1st is for centering the cam shafts. 2nd and 3rd are for turning process. The problem assigned for us was to improve productivity of the 1b line. The company was facing problem of inefficiency in the working of human labor in terms of the total time spent in operating the CNC Lathe machines. From the several options available to improve the productivity, we were asked to go in for automation of some processes in the machine line, taking cue from the different automation systems already present. This development also involves getting a cheap and efficient solution. The line 1B which involves three process is currently operated by manual workers, the jobs are manually fed to the machines and transferred during the different stages by the worker. There is a considerably time wastage due to the regular breaks taken by the workers for food, relaxation and washrooms. As the production process goes throughout the day for 24 hours in three shifts, there is a clear focus on increasing the production capacity. Hence if there is automation of the production line for feeding and transferring the jobs, a significant amount of time can be saved along with improving the cycle time. This would lead to an increase in production per day, reduction of cost by elimination of manual labor use. Thus the system design should be low maintenance as all the know-how and development is in-house and many parts, fixtures which are involved can manufactured within the company which will help reduce the total installation cost.

2. Literature Study

An automation system is not a single part, but an amalgamation of several sub systems. These sub-systems need to designed first and then integrated together to make a whole automation system. The design of these subsystems depends on several aspects. They are Spatial dependency: Requirements related to the place available, the orientation of the structure, the assembly and the weight; Structural dependency: Requirements related to framework which is used to carry the loads along the production line, the mounting of various linear actuators, sensors and grippers on the frame; Material dependency: Requirements related to framework material, and other media required for systems to work, like air, oil and water; Energy dependency: Requirements related to electrical power, noise and vibration; To evaluate all these we used different parameters like weight of the load, cycle times required, space available, maintenance costs. linear actuators systems are an integral part of an automation system which are responsible for the motion and controlling the mechanism or the system. An actuator requires a control signal and source of energy. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power. The supplied main energy source may be electric current, hydraulic fluid pressure, or pneumatic pressure. When the control signal is received, the actuator responds by converting the energy into mechanical motion. In Robotics, it is generally known as effectors - the end part of any robot's hand where it interacts with the environment. In the automation discipline, these effectors or robotic grippers are specifically used to pick

up, hold and drop the products being processed. Pneumatic Cylinder are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Single-acting cylinders (SAC) use the pressure imparted by compressed air to create a driving force in one direction (usually out), and a spring to return to the "home" position. More often than not, this type of cylinder has limited extension due to the space the compressed spring takes up. Another downside to SACs is that part of the force produced by the cylinder is lost as it tries to push against the spring.

3. Proposed Concept

Keeping in view of the financial and performance constraints expected by the company in mind, we have developed an automation system which utilizes several subsystems from the data given in the above section. The entire layout is modelled in CREO and snapshots with detailed explanation of those are presented in this text

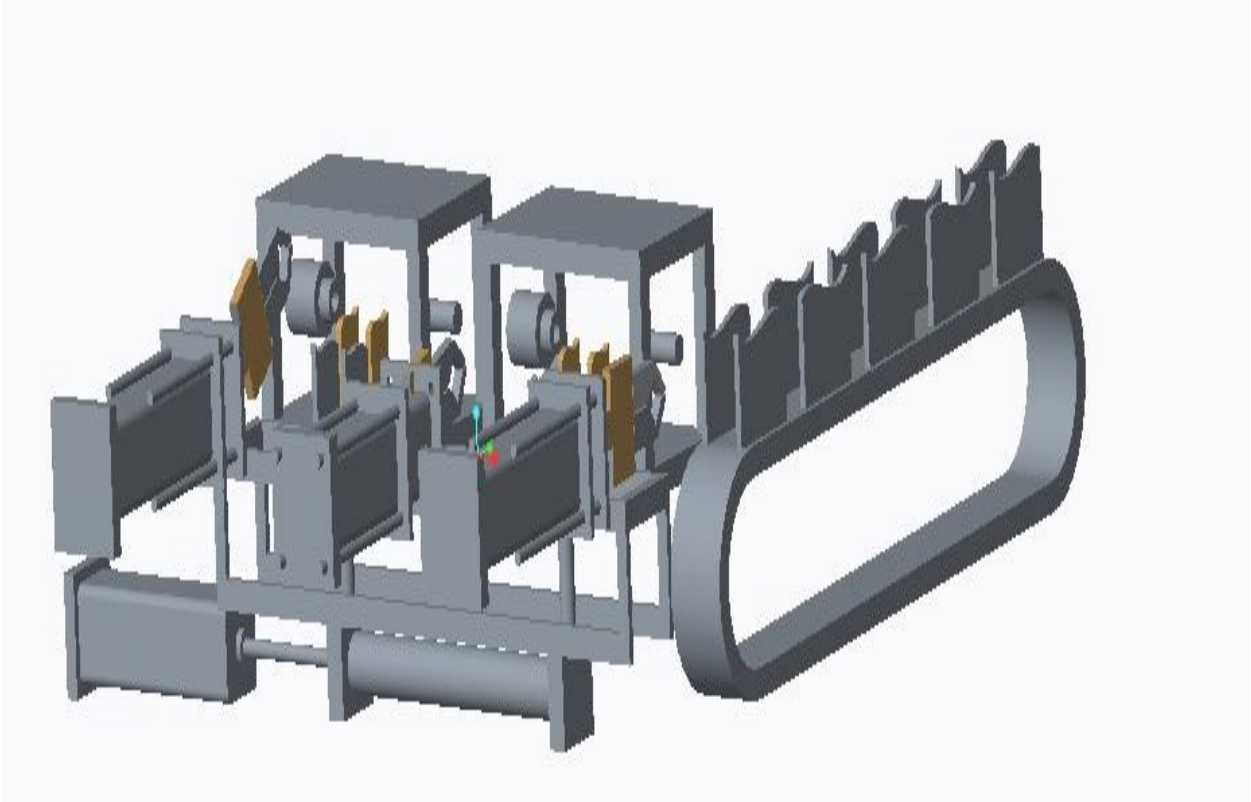

Fig. 1. Complete overview of the system

The telescopic cylinder used in the drive of the conveyer system. It works on similar lines to that of the pneumatic cylinder. The pneumatic cylinders used are a 600 mm stroke cylinders which will house the gripper jaws to felicitate the holding of the job. The jaws attached to the gripper will be of steel and are designed to hold the job accurately using the dimensions from the camshaft. This fixture has curved surface. The material used to make this fixture is brass due to its property. By using brass we can avoid the chances of dent on our job. Indexer is used as a platform for fixture as we have to rotate our job as we fed it to 2nd turning machine. As camshaft is processed in machine 1 it has to be turned 180 degree before feeding it into the next machine. The indexer is a machine which is installed at the base of the fixture of telescopic cylinder drive mechanism. Indexing in reference to motion is moving (or being moved) into a new position or location quickly and easily but also precisely. After a machine part has been indexed, its location is known to within a few hundredths of a millimeter (thousandths of an inch), or often even to within a few thousandths of a millimeter (ten-thousandths of an inch), despite the fact that no elaborate measuring or layout was needed to establish that location. Indexing is a necessary kind of motion in many areas of mechanical engineering and machining. A part that indexes, or can be indexed, is said to be indexable. Usually when the word indexing is used, it refers specifically to rotation. That is, indexing is most often the quick and easy but precise rotation of a machine part through a certain known number of degrees. For example, Machinery's Handbook, 25th edition, in its section on milling machine indexing, says, "Positioning a work piece at a precise angle or interval of rotation for a machining operation is called indexing." In addition to that most classic sense of the word, the swapping of one part for another, or other controlled movements, are also sometimes referred to as indexing, even if rotation is not the focus. Indexing in reference to motion is moving (or being moved) into a new position or location quickly and easily but also precisely. After a machine part has been indexed, its location is known to within a few hundredths of a millimeter (thousandths of an inch), or often even to within a few thousandths of a millimeter (ten-thousandths of an inch), despite the fact that no elaborate measuring or layout was needed to establish that location. Indexing is a necessary kind of motion in many areas of mechanical engineering and machining. A part that indexes, or can be indexed, is said to be index able. When the job is gripped by the jaws and gripper from the fixture on the drive mechanism, due to one jaw set and uneven distribution of weight of the

camshaft, the camshaft will twist around the axis of the pneumatic cylinder and hence to solve this, the movement of the cylinder shaft has to be restricted. This is done by attaching a holder which is fixed to the exterior body of the pneumatic cylinder. The figure below illustrates the provision. M Guide way stands for Linear Motion Guide way. This system provides a linear motion in one single direction and houses the fixtures which will hold the jobs to be fed in the CNC machines. This is used in the place of the belt and pulley mechanisms and gantry systems. The drive is provided by a telescopic cylinder mechanism. The guide way will have roller slides which will provide frictionless, non-motorized low-friction motion for the fixture arrangement. Rack slides are typically compound or 3-part slides allowing full extension of the mounted equipment and generally include provision for sliding the inner member completely free to allow removal of the equipment from the rack. They can also include stops to prevent accidentally pulling the equipment out of the rack without releasing the stop mechanism. They are sized to fit into racks with mounting flanges on the ends to mate to the mounting holes in racks. In some cases, one mounting flange is formed into the rack slide with an adapter bracket attached to the other end to accommodate different depths of the rack. The outer fixed member is attached to the rack and the inner moving member is generally screwed to the side of the mounted equipment. LM guide way are also the house of the fixture and they are spaced accordingly to the machined arranged on machine shop. Indexer is also attached on the base of the fixture. Indexer turn the job before feeding it to the turning machine 2. The camshaft arrives on the first fixture over the LM Guide way from the previous operation. The Pneumatic cylinder which is fixed on the shop floor via a stand is on front of the machine with the LM Guide way in between machine and the pneumatic cylinder system. The gripper system along with the jaws are mounted on the plate fixture over the shaft of the pneumatic cylinder. The job is held by the gripper jaws which by its first stroke come to the fixture position over the guide way. The job is held by the jaws which takes it inside the machine in its second stroke and it gets placed on the twin fixtures by virtue of its design. The gripper jaws retract back to the home position in one single stroke and the door of the machine closes to start the process. The Turning 1 process starts in the first machine which takes 70 seconds. The machine door opens and the gripper jaws move in one stroke to the fixture position inside the machine and grip the job and bring them to place it on the fixture of the LM Guide way in the first backward. The jaws release the job on the fixture and return to the home position in the second backward stroke. The indexer below the fixture rotates the job by 180 degrees. The LM guide way moves forward and places the job in front of the second machine. And along with it one new job over the fixture comes in front of the machine 1. After going to the machine 2 same steps are carried out by the second gripper jaws installation to place the job inside the machine while simultaneously same steps are carried out by the first gripper jaws for the machine one. The job undergo Turning 2 process in the second machine which also takes a machining time of 70 second. The job is taken out from the second machine by a similar process as done for the first machine and is taken from the fixture to be stacked for further process. We should note that the time taken by both the machine is same thus we can perform the feeding and extracting of shafts at same time.

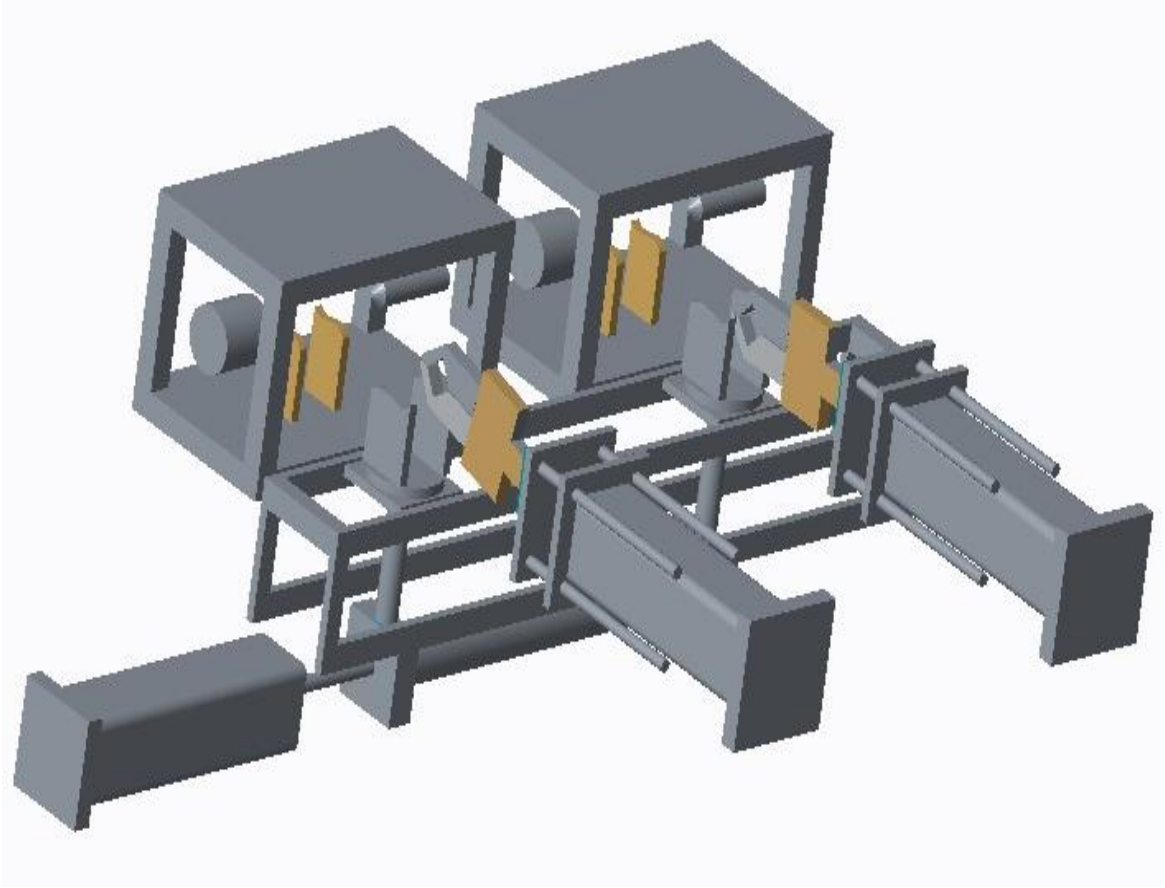

Fig 2. Complete Assembly

The job is to be picked from the fixtures on the drive mechanism and moved in a single direction to place it on the fixtures inside the machine. Overall it is a straight line motion in one direction, but the fixtures have a depression in their shape to hold the job. Originally the fixture is a sharp 'V' shaped design which is used inside the machines. The original V shaped design would require to install two pneumatic cylinders to an upward-downward motion to negotiate into the depression while placing the job on the fixture. The newly created design enabled to reduce the two motions to one by giving a smooth curved tapering to one edge and giving a free hinge on one side to the pneumatic cylinder. Hence as the job approaches the fixture, by virtue of the free hinge and the curved tapering it would get elevated initially and the settles into the depression of the fixture. The shaft of the pneumatic cylinder is free to rotate about its axis inside the cylinder, the shaft provides a forward thrust motion only. The free motion would make the camshaft revolve about that axis and will not keep it firm in one plane. It is to be noted that the CG of the shaft will not be on same line as of jaw thus job will tend to rotate the rod of cylinder. If this rod rotates it will cause the problem for the cylinder to place the shaft on the fixture. The problem is solved by attaching a plate to the pneumatic cylinder's body as shown in the figure. The jaws and the gripper are mounted over the plate and so that the rotatory motion is restricted. And the forward thrust is transferred to the plate and then to the gripper jaws. By using this we can only not eliminate the rotation but also provide the stiffness to our system by providing the additional strength to the arm of cylinder. This will help the cylinder to absorb the shock which will be developed during placing and removing of job. Thus this pneumatic cylinder rod fixture serve multiple purpose on this system, moreover it is also the house of the gripper which will hold the shafts.

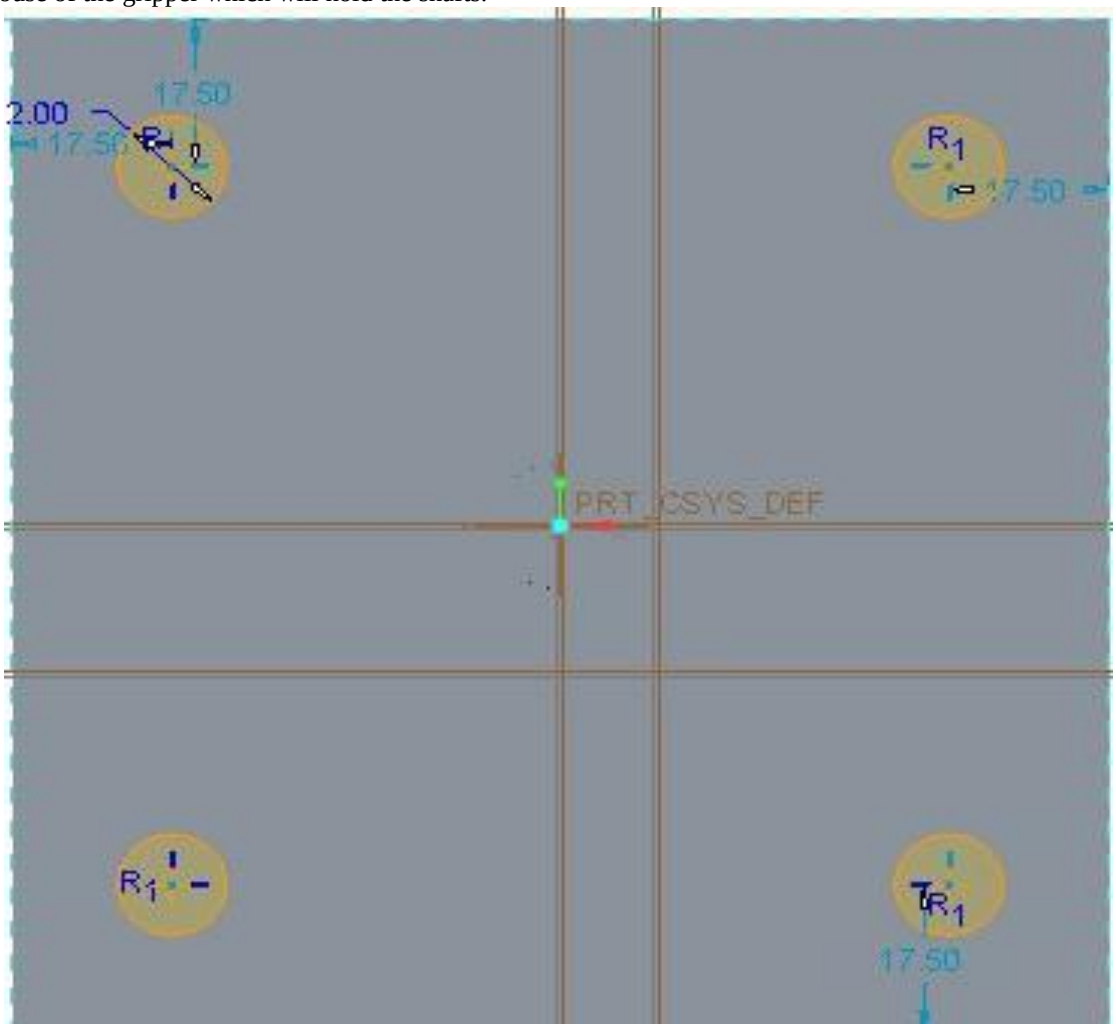

Fig. 3. Dimension of the plate fixture

Thus by the above table we can see time taken by system is 13 sec which is almost equal to the time taken by worker but the system is more efficient as it works continuously and we can utilize the allowance time given to the worker. By this we can manufacture more product in same time and also avoid the chances of mistake. We can also see that the time of both CNC Machine is same. So we can move job from machine 1 to machine 2 and from machine 2 job to storage conveyor at the same time.

4. Conclusion

The pneumatic cylinder systems is to improve the production output while minimizing time wastage is a very practical solution developed. By using this system we eliminate the time wastage by worker and even use the allowance time given to worker. By implementing this we can save time and money. The economic and installation feasibility of the model will enable the organization to implement it in their production line and improve the overall procedure. The drawings and the

models are submitted to the mentor in charge for further implementation of the idea. After the mechanical design and layout is done, there are several other issues to be cleared by an expert in electronics and computing. They are PLC code should be written, Appropriate sensors and actuators should be selected and Fabrication and installation should be done.

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