NO DOWNTIME MACHINE: A THEORETICAL CONCEPT

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Abstract

Machines have become quite popular nowadays. Machines reduce human effort and even multiply human effort. Different types of machines exists each to perform a specific task. Tough some similarities exist between every machine. These similarities are in the form of the heart of the machines as they require rotation (linear forces converted into rotational forces or rotational forces produced by electricity) and also the similarities in the effort multiplier or say the torque multiplier (gear trains increase and decrease the number of rotation). When the machines have similarities in the design then the machines also possess the same disadvantages and the advantages or in other means machine possess the same problems. The very common problem of all of them is that the machine elements worn out with use and some with time. The elements those worn out have to face a necessary evil and that necessary evil are responsible for their wear and tear. The necessary evil is the frictional force which offers resistance to a moving body in contact with other things (it's not wise to say a surface as even the air offers resistance) friction is required to stop a moving body but it exists wherever two things are in contact with each other. Due to friction machine elements need to be replaced and this requires time and the machine is stopped. There exists various maintenance techniques but every technique requires the machine to be stopped for the maintenance. Due to large scale industries a need for a machine arises that can work without any breaks and a fast maintenance technique. Due to the use of the similar elements across different machines the maintenance technique may be similar but every machine maintenance technique depends upon the output required. Paper shows design of machine and maintenance technique.

Introduction

The various machines used in the industries are required for performing the various tasks special purpose and multipurpose machines exists. The machines are responsible for the saving of the human effort in all around the world as well as machines are used to save the time of the manufacturing by the humans. Also there is a saying that "wherever light strikes there exists shadows" in case of the machine there exists a shadow in the form of the elements worn out or the elements used in the machines worn out with use and some with time. The main thing responsible for the elements worn out is the frictional force as the elements stay in contact with each other the elements are said to be the very basic building blocks of the machine. When close observation is done then the various reasons for the same are also found but with the contact came the frictional force. It is not quite responsible for the designers to completely eliminate the frictional force but yet the force of the friction can be minimized by the use of the lubrication and use of other parts like magnetic bearings. The frictional force and other matters also lead to the worn out elements and the worn out elements can only be replaced with the new ones as the surface areas of the same and other properties are also degraded of the elements.

Maintenance

Maintenance means the process of preserving a condition or situation or the state of being preserved [1] The basic types of maintenance is the –

(i) Predictive maintenance where equipments or facilities are being inspected maintained and protected before breakdown or other problems occur
(ii)Corrective maintenance where the equipment is repaired or replaced after wear, malfunctions or breakdowns
(iii) Predictive maintenance which uses sensors data to monitor a system, then continuously evaluate it against historical predict failure before it occurs.[2]

The maintenance exercises are slow and the waiting in maintenance and the unpredictable failure leads to decrease in the customer reliability. The automobiles are used everywhere in the world and so does the machines there waste increases the size of junkyard. Tough the automobiles use the planned maintenance. Among other types of the maintenance there are two-

(i) Unplanned maintenance is also known as the reactive maintenance, corrective maintenance, breakdown maintenance, or run-to-failure maintenance.[3]
(ii)Planned maintenance is a proactive approach to maintenance work is scheduled to take place on a regular basis.[4]
(iii) The cause study and the paper represents a design of automobile to reduce waste and the design of the maintenance technique of the same as the breaks for the maintenance decreases the customers

satisfaction. A no maintenance break machine should use elements and techniques that are fast for replacing the faulty or worn out elements and also the machines output must be increased in order to have both good results and the customer satisfaction. Before that the common things that are used in the industries and the common things that are used to perform the common work within the machine so below is the table of the machines or such things.

Table 1 .Common parts used across different machines

Things	Uses	Maintenance requirement
Engine	Supply rotational motion	Heavy
Electric motor	Supply rotational motion	Low
Clutches	Isolate the input shaft from the other shaft	Low
Gear trains	Multiply the torque	Depend upon the use

The above mentioned elements are used to describe the common parts now when the maintenance of the elements is required so let's see how the maintenance process is being carried out and what things are done in the maintenance process. First the things in engine the replaced elements during the maintenance are piston rings, valves, main bearings (when the maintenance of an engine is done it consumes time as the engine is opened and then the maintenance work is done means the elements are replaced and then the engine is fitted with the elements). The clutch plates are worn out then the replacement also consumes time as the clutches are the part of the flywheel. The gear trains are the most complex element of the transmission system and yes they also consume time as the bearings and the shafts have fixed gears and the movable gears and they are mounted upon each other. There arises a need to stop the machines with the current design of the automobile whenever the failures in any of the elements occur and the element need to be replaced planned maintenance is the solution to the problem but it's not the permanent solution to the maintenance problems there must be a way to find a concept that leads to no maintenance.

Many attempts have been made to make machine elements that are economical in design and are fit to fulfil the needs of the customer with less material consumption and less power or energy consumption but every attempt from the present design leads to increase in the waste or worn out parts of the machine elements. A concept of the magnetic bearings came into the mind when studying over the ball bearings from the internet on the Wikipedia but the use or adding those in the design leads to various problems in the design also. Studying the concept tough that the magnetic bearings work on the principle of the magnetic levitation and to levitate an object the magnets must be installed upon the shaft and the magnets are also required at the parallel end of those magnets. This increases the design cost as well as the weight of the shaft is also increased and when the machine operates its parts have to move at different speeds and when the contact between the work-piece and the machining end of the machine establishes then the loads on the machine elements slow down due to frictional force. This frictional force offers resistance in the speed of the machine and the shafts deflect from there mean position. When the shaft deflects the machines inner parts are at danger and the machine is likely to suffer the design out maintenance. The cost of replacing the machine with the updated one is more and it need to be replaced because of the fact that the machines have to face fluctuating load during its course of action. Also the moving magnets induce electric current. Increase in weight of the shaft leads to the raised consumption of the inputs. In short the application of the magnetic bearings consumes more power than the power it saves by completely removing friction. A single shaft consumes the power equal to the sum of all the frictional forces in the design. One may conclude that it's better to have waste or worn out parts than applying bigger energy consuming products. But they are also suitable for the products that require heavy load for performing operations like the building moving or simply they find application in the giant machines. Where power or energy input requirements are more and the outputs doesn't have to suffer sudden changes in speed etc.

With the increase in the machines and emerging new technologies the machines designs become old and new technologies are moving forward with time. Machine becomes old with time and losses strength to satisfy the desired output. So therefore the new machines need to be installed due to design out. As everything in the universe had its limit and therefore the machines meet their limit with time and need to be replaced with the new one.

Problem Formation:

There are many types of machines that are used now-a-days. As far as we know that the friction being a necessary evil exits in between the surfaces that are in contact with each other. Machine parts can be of electrical type just consider electric motor for the example- power be generated using the magnetic forces and the electrical properties of the electricity but yet both the ends of the shaft (shaft upon which windings of then conducting wire are present or in short the shaft that provides the output) have ball bearings to decrease the friction and to decrease the damage of the shaft. As reducing the friction also leads to the decrease in damage of the machine elements. A damage decrease that doesn't mean that the damage goes away it still exists. So they need to be replaced. Replacement comes with a cost that is during replacement the machine stops working and also the wide use of machine leads to more replaced parts so the waste or worn out parts also increases. The other main problem that rises is the transmission systems waste or worn out parts. Concluding the problems faced and the problems that are noticed:-

- The waste or worn out parts increases with the increase in number of the elements of the machine.
- Waste or worn out parts increases with the increase in load variation during use or the frequency of load variation per unit time.
- The elements of the machine must be in contact with each other in order to give the best value output.
- The speed of the machines vary with time as the machines need to touch the work-pieces and stay there for some time thereby decreasing the speed and the machine should move away from the work-piece so that it can perform the machining operations on other work-pieces which lead to increase in speed.
- Machine can be divided into different sections depending upon the needs of the machine that the assembly of the machine elements satisfy but when the maintenance of the machine is carried out then during that interval of time those needs are not fulfilled. Machine stops working.
- Even when a robot/mechanism is installed to repair and maintain the machine in best possible condition then also the machine stops working therefore the problem rises in the form that the machine losses the rotational energy during the maintenance that it gains from the machine sections and stops working.
- Using the sensors and the other equipments for condition monitoring of the machine need electrical circuits for sending and receiving the signals about the health of the equipments and everything is in motion and in contact so the electrical signals gets disturbed.
- Condition monitoring of the machine can be done on the basis of the vibrations but as every machine have vibrations so it can be done on the basis of the raised vibrations but in some machines like the casting hammer whose output leads to increase in vibrations within the machine is not possible.
- It's difficult to predict the life of the machine elements.
- Parts are moving and the visual inspection is not possible as the machine is vibrating.
- Operator's safety is under question. A man with imperfections is a man with a history. Labours trust is labours safety.
- The machine requires lubrication even the machine stops working for lubrication.
- The output of the machine decreases with the decrease in health of the various elements that are used in the machine.
- The machine is operated in the low maintenance situation so therefore the life of the machine decreases. This leads to the situation where the design out maintenance can be done.
- Machines sections have different elements across them as almost every element that is used in the section is different than the elements of the other section. Use of different elements in different sections increases the types of the waste or worn out parts placed together on the basis of their size.
- Only a small layer of the elements is worn out as the surfaces in contact have small area due to the fact that the surface areas increases friction and worn out rate the surface area in contact is kept small.
- Machine becomes old with time and the design out maintenance is needed so the design out maintenance requires new machine to be installed the design out maintenance also leads to the downtime far more than the other type of maintenance requirements.

Objective of Paper:

The objective of the paper is to present the theoretical approach to the reader for carrying out the maintenance exercise. The other objective is to make the person familiar with the classification of the maintenance on the basis of the time. The maintenance is of two types planned and unplanned. The planned maintenance can be done when the failures are fixed and the life of the equipment is fixed also the time of occurrence of the failure is fixed and predictable to the operators. The machine can be overhaul by stopping it before the time of the occurrence. The unplanned maintenance comes into play when the failures are predicted wrong or the new failure comes into the design during the unplanned maintenance the preventive maintenance can be done. But in both the machine need to be stopped for the overhaul no approach or classification comes which tells about the no downtime machine. Another objective is to deal with the failures or the maintenance issues as fast as possible. Decrease the costs of maintenance to deal with the design out maintenance situations as fast as possible.

RESEARCH METHODOLOGY & A THEORETICAL CASE STUDY

Close observations shown that the elements that are replaced during maintenance of the engine and the reason behind their degradation are friction. Let's see what the reason behind those replacements is and what lead to their worn out wear and tear in detail from the following table.

Table 2 .List of the elements in detail

Elements of the engine	Reason
Piston ring	Piston reciprocates inside the cylinder and rapid change in direction of the

	piston at the high speed and the piston is mounted upon the crank shaft that receives power from the flywheel piston rings are in contact with the cylinder so every time they change direction the rings grind with the cylinder. Also when the gear is shifted up and down the load on the piston increase due to the interlocking of the gears and speed increases in the manual transmission system.
Valves	Abrasion of the piston ring and the smoke also the fuel vapours deposit upon the valves and due to the up and down motion the valves surface and the cylinder surface acts like a hammer and makes the deposit strong and the fuel and the air can't enter.
Main bearings	As the fluctuation in the load occurs so the main bearings undergo strong opposing forces during the reciprocating motion and the change in speed of the piston due to reciprocating motion and the fluctuation at the time of gear shift and the breaking and then accelerating.
Connecting rod	Connecting rod slides over the crankshaft and at the piston end faces fluctuation due to reciprocating motion so its surface degrades with time.

Therefore it's wiser to conclude that everything that moves degrades with time. The other conclusion from the above table is that the thing that changes direction rapidly degrades even faster as well as the thing that suffers more load fluctuation also degrades with time faster.

From the above conclusion clear conclusion is seen that the replacement of the parts will consume time and the prediction of the breakdown is not possible. So therefore the maintenance will consume time as the opening of the engine consumes time and the every part of the engine is facing trouble.

An approach can be adopted before designing the machine "noting all the advantages that can be taken from the machine and then working on the outcomes desired by the users and making or designing the elements of the machine accordingly". Another approach is acting like a journalist.

Why can't a working engine's elements be replaced?

The answer to the question is the simple as the working engine is hot and also the process of maintenance of the engines requires time. The working engines have locked parts means the parts are connected to each other and the parts are also locked to each other. Opening the locked parts leads to loss connection and the power receiving parts will displace away from the connected parts and the parts need to move with the power receiving parts and the interlock is loss so the power receiving parts will move faster than the connected parts. So therefore the time of maintenance is more till then the whole machine will stop.

But since the elements can't be replaced but the whole engine can be replaced or say using the two engines in the vehicle is good idea as the one that is replaced with the working one now the engine that requires maintenance so it can be opened up and maintained to the top condition by a robot/mechanism that reaches the worn out engine and maintain it in running condition as fast as possible.

The theory of quick maintenance is that *note the elements within the machine divide them on the basis of the frequent failure and the long time failure then add clone elements parallel to the element which suffered frequent failures and then connect that another element to the before and after parts of the elements of the machine meanwhile repair or carry out the maintenance of the parts and again connect them to the before and after parts. Even the parts inside the elements of the machine are maintained on the same theory if the part can be reused by small instalments then the part be replaced with the perfect part and the part that is extracted must be maintained for further use after the perfect parts installed in the element and that element is maintained to the working condition. If the design of the part is not compatible with the theory than keep the part assembly or the part clone and replace the clone or the assembly with the overhaul requiring part.*

Various procedures for making the sections of the machine-

(i) On the basis of the function they perform within the machine. For e.g. like the automobile divided into sections like the engine, transmission, steering, suspension systems or sections in case the maintenance is to be considered.
(ii) On the basis of the previous failures. For e.g. frequent, never, less failure regions or sections.
(iii) On the basis of the failure rate. For e.g. low failure, medium failure, high failure
(iv) On the basis of the material composition of the elements.
(v) On the basis of the type of failures.
(vi) On the basis of the priority. For e.g. high priority – element that leads to damage within the machine and need to be replaced as soon as possible, low priority the elements that can wait for replacement and can work for long without damaging the man machine and the environment.

For e.g. if the piston ring of the engine worn out then use the another engine parallel to the engine that powers the machine meanwhile the maintenance of the previous engine must be carried out and even in the engine the maintenance can be carried out

by the same method as the piston ring worn out so it takes time to replace the piston rings then to replace the piston so piston be replaced and after the replacement the worn out piston be maintained and saved for further use. The design of the machine should be made according to the ease of access of the parts and the time of access of the parts. The time for accessing the parts must be as small as possible and the ease should be as delighted as possible.

So below is the figure showing the design of automobile designed for the same purpose.

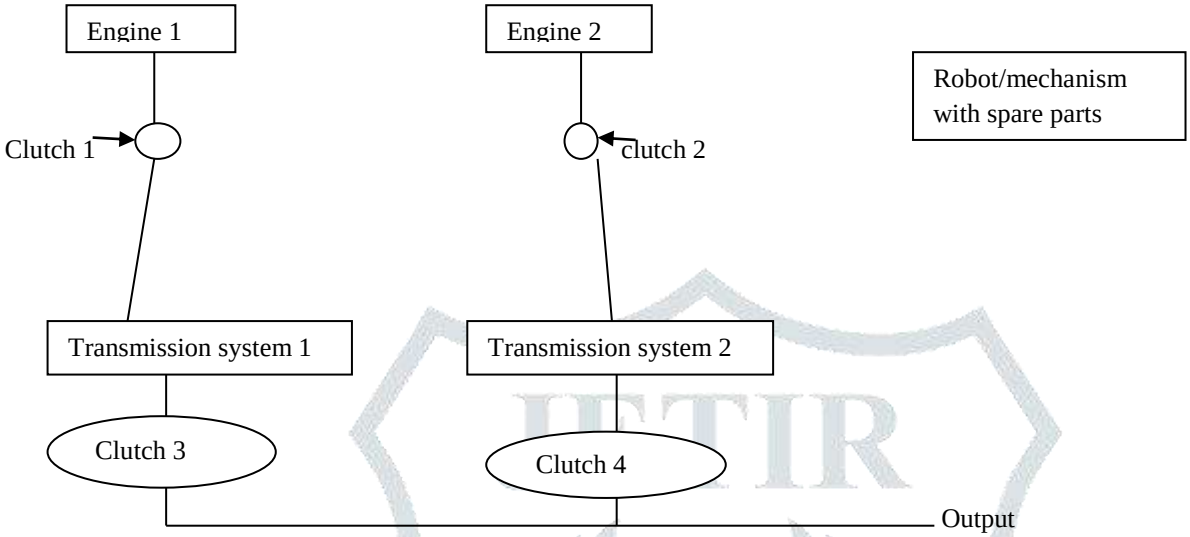

Figure 1 .Block diagram of fast maintenance automobile or the heart of the machine.

The block diagram the clutch 1 and clutch 2 are the flywheel of the respective engine. The engine 1 can work independently from the engine 2. The clutch 2 is pressed means the flywheel of the engine 2 is not connected with the transmission system 2 and the clutch 4 is not connected with the output when the engine 1 is working and vice versa. When the engine 1 is maintained then the engine 2 should provide output by connecting the clutch 4 and disengaging the clutch 3 and clutch 1 respectively. When the engine 2 is maintained then the engine 1 should provide power output in this situation the clutches 3 and 1 will be engaged and others remain disengaged. The inputs of the engines like the fuel and air supply are also disengaged as the inputs might leak. The plan of the machine design is same as that of the plant layout (Plant layout is the most effective physical arrangement, either existing or in plans of industrial facilities i.e. arrangement of machines, processing equipment and service departments to achieve greatest co-ordination and efficiency of 4 M's (Men, Materials, Machines and Methods) in a plant. Layout problems are fundamental to every type of organization/enterprise and are experienced in all kinds of concerns/undertakings. The adequacy of layout affects the efficiency of subsequent operations)[5] or the no downtime plant layout. The maintenance of the plant can also be carried out the need of the concept of the no downtime plant is more popular but the no downtime machine leads to the quick repairs and make the machine elements repair fast. In other terms the no downtime machine is more superior to the no downtime plant as the plant layout the machines are considered and the length and weight of the inputs and the outputs connection is more than that of the plant layout. Maintenance can be kept pending in the case of the maintenance of the machine in plant layout and the overhaul can be done of both the machines as soon as the other machine shows the requirements of the maintenance but this might lead to the risks. The pending maintenance gives invitation to downtime of the machine as we know that the unpredictable failures also exist. So it's wise to treat or repair or attend the maintenance of the machines as soon as possible.

Another way of checking the problems that lead to the maintenance of the machine is the step by step method. In this the designer proceeds step by step and see's the inputs and how they are affecting the other parts. Let's see the methods that are involved in the working of the automobile.

- First is the start the engine
- Then press the clutch pedal and shift the gear
- Accelerate
- Shift gears to up and down once the automobile starts moving

Steps that are taking place inside the machine should also be considered for the same as when the engine starts the piston starts reciprocating decreasing the life of piston rings. When the clutch pedal is pressed the flywheel is isolated from the transmission shaft making the shifting of gear easy and less burden on the piston ring but in the process the piston attains speed along with the flywheel as the as both of them become fast when the clutch pedal is released then the friction plate is slow as compared to the flywheel so the piston is subjected to withstand the sudden forces that are responsible for the more failures inside the engine's piston ring. More over the flywheel is used to store energy but when the automobile starts moving the wheels store energy and the flywheel is just waste when the vehicle is moving with constant velocity .Even though it

increases the load acting upon the engine. But during the manual transmission the transmission system is facing problems due to the force changes. This force changes can be overcome due to the disengagement of the clutch when the automobile stores energy in the wheel or starts moving with a speed. The load can be decreased by the disengagement of the clutch or the flywheel from the transmission or the engine when the vehicle starts moving (the flywheel when disengaged can be put on the ideal shaft that is not connected to any shafts of the engine or the transmission system it rests) and slows there and the clutch (flywheel is connected to the engine when the gears are shifted in order to store energy inside it) doing so it becomes fast thereby the load on the engine remains almost unaffected. The whole problem is due to uneven load at the time of the shift. The more problem is caused by the uneven load acting upon the piston so fix the amount of the load on the piston. The variation arises due to the isolation of the input shaft from the gear box the gears keep spinning due to the moment of inertia stored in the tyres or wheel of the automobile. The design of the machine that is based upon the above discussion is that the two clutches are used and they are not always moving opposite to each other first the clutch which is at the gear shift end moves then when the automobile stores energy in the wheels the clutch on the flywheel is disengaged and is only connected during the load shift to balance the load of the wheels. Such a machine leads to less worn out parts in the engine as the load acting on the elements within the engi8ne is same throughout use. Another step in building such an automobile is the calculation of the forces that are required to keep the vehicle wheels rotating about the axle. The reduced worn out rate can be achieved when the engine moves at constant speed during the gear shift and after the gear shift this can be achieved only when the weight of the clutch is made equal to that of the forces required to keep the automobiles wheel rotating. When the gears are shifted then the speed of the engine is increased as the load on the engine is decreased by the disengagement of the clutch from the transmission system as the load on the engine decreases load offers resistance to the movement of the piston inside the cylinder. The piston speed increases suddenly due to the disengagement of the clutch. The piston now reciprocates faster than the time when the transmission system is connected. Sudden increase and decrease of speed is also the main reason for the wear and tear of the piston ring. Below diagram shows the block diagram of the same. The engagement of the flywheel to the piston and cylinder arrangement can be done using a switch. And the rotor mechanisms to first rotate the flywheel with the same speed as that of the piston cylinder arrangement.

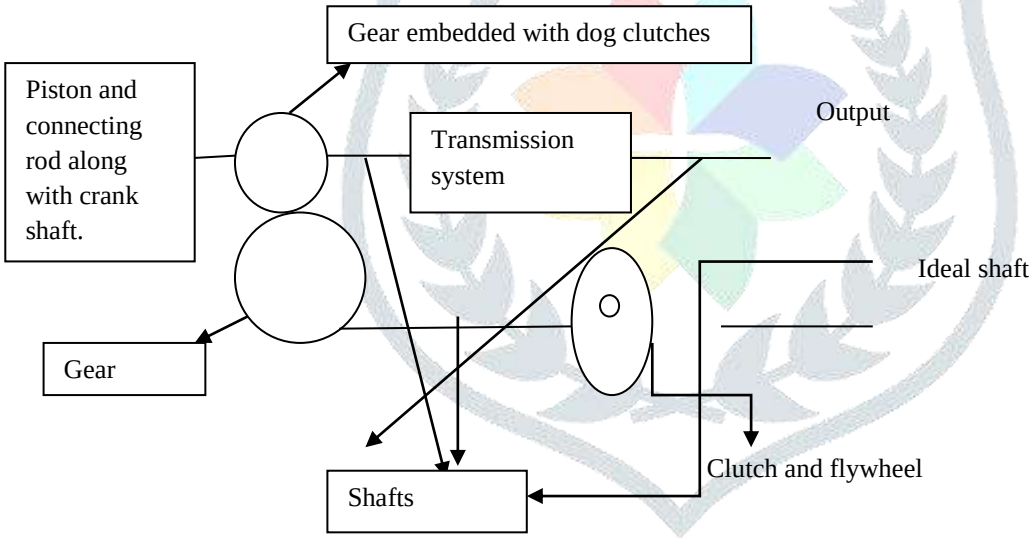

Figure2. Showing the modified engine for all time same load.

At first all the clutches are engaged when the automobile starts moving from rest. Then the gear on the clutch and the flywheel shaft are disengaged as the wheels store rotational energy and now can keep on rotating without the flywheel. When the gears are shifted the gear next to the piston and connecting rod along with the crank shaft are disconnected from the transmission system by using dog clutch and the flywheel is connected to the shaft of the gear. After the gear shift takes place inside the transmission system the flywheel is disconnected and moved back to the ideal shaft and the dog clutches connects the gear embedded with dog clutches to the transmission system. The main condition for that is the wheels should not stop in the mean time. The shift should be as fast as possible. Same analysis can be done for the machines that are lathe, milling etc but in that case multi-plates are used and the plates are moved on the ideal shafts. The plates are placed on the ideal shaft to keep the load on the heart as stable as possible not fluctuating depending upon the various parameters like the density, load variation, material composition etc.

Next step is to calculate the time of the replacement of the mechanical elements. All failures can be predicted but the correct time of the failure can't be predicted as the even expensive equipments can't predict when the failure occurred but there cause and remedies can be predicted. Designers don't have to suffer a lot for the fact that the maintenance is all about the replacement and the parts can be replaced so does the sections divided by the individuals on the basis of the failure. Still the designer has to repair

the replaced section. There are mainly three types of maintenance of the sections depending upon the speed or the rate of the maintenance-

(i) Low speed maintenance: - This type of maintenance is done when the replaced section can hold there for long and the time of replacement of the elements within the replaced section is less than 15- 16 days and it can be carried out by a single robot/mechanism. Ball bearings can be replaced by opening the gear train arrangement or say disassembling the transmission system. The robots must be repaired manually using an indicator that shows the need for the maintenance of the robot. For repair work the small heart robots/mechanisms are required one equipped with every tool required to open the design or the design be made a single tool opener design. A single tool can open design.

(ii) Medium speed maintenance: - This type of maintenance is done when replaced section life span is medium as the machine can withstand the load the duration of maintenance is of 3-4 days less than that of the replaced section. In this type one robot per section can be installed to perform the maintenance exercise. Ball bearings can be replaced by disassembling the gear trains or say the transmission system. Robots also require maintenance so they can be repaired manually and a sensor to monitor the degradation of the robots and an indicator on the machine to tell the same. For repairs the robots/mechanism made have small hearts and they can be designed to open with a single tool.

(iii) High speed maintenance: - This type of the maintenance is done when the replaced section has very short life of 1 or less days. In this type each element of the section or part of the section is assigned a single robot means the number of robots is equal to the number of the parts and the machine must be designed accordingly in this the machine should be very fast in maintenance the robots must take the elements that are to be replaced from the conveyor running parallel to the line of robots near the sections of the machine and ball bearings must be replaced by a belt that goes inside the location where ball bearings are installed inside the machine like the shaft ends have ball bearings then the ball bearings must be sealed using the ball bearing cases on the sides and there should be two holes – one at the bottom from where the belt enters the ball bearing housing and the other one at the top of the ball bearing from where the chain exist the ball bearing housing installed such that when the belt is rotated around the other end it goes inside from the bottom and comes at the top. When the belt enters it carries the new ball bearings inside the ball bearing housing and replace the old ones with new ones and then the small teeth on the belt must be there it should be covered it's use to keep the ball bearing inside and provide support to the inside bearings to leave the ball bearing housing. At the top end the ball bearing must leave the ball bearing housing in so they might fall on the belt below so it's suggested to have a track in between on which the bearing will fall and then displaced to another place. The conveyor in this type of maintenance system resembles to the assembly conveyor. In this the weight is not an issue only issue that is left is the speed and the every robot installed must have its own heart or engine. There should be separate reservoirs for the elements that are replaced from the different sections and a visual inspection robot must be installed at the reservoirs that inspects or do the visual inspection of the parts taken out from the different sections. The elements replaced must be placed or categorized on the basis of the usability of the elements- non-usable, low life- usable, long life- usable. The robots are used to make the no downtime machine but in this type of set-up the clone robots of the robots doing the maintenance must be used in order to do take the place of the robot that are doing maintenance as the robots will also require the maintenance of their own. And a separate maintenance line for the robots where the robots are repaired the repair of the robots must be also based on the medium or the high speed maintenance. The maintenance can be done using a single robot/mechanism as the mechanism can be made after the engine by using the clutches so does the engagement of the mechanism can be done in order to make the mechanism perform the repair of the corresponding element. The major disadvantage of using the one heart in the maintenance mechanism is that if the heart of the maintenance mechanism needs repair is then the whole line or every repairing mechanism is stopped but in the system where the single heart for the single mechanism is needed the only clone robot is replaced while the others are doing their work.

The major advantage of the classification is that the classification is superior to other classifications as design out maintenance can be done using the high speed maintenance as the maintenance conveyor can act as the assembly conveyor at that time.

Design out maintenance: - If the maintenance cost or downtime cost of equipment is high, then the Design out Maintenance strategy can often be effective. This strategy differs from all the others in that it is a one-off activity, as opposed to a repetitive activity designed to prevent failure. Design out Maintenance aims to redesign those parts of the equipment which consume high levels of maintenance effort or spares cost or which have unacceptably high failure rates.

High maintenance costs may have been caused by a number of factors, including:

- Poor maintenance
- Operation of equipment outside of its original design specification
- A poor initial design

The Design out Maintenance strategy can only be implemented effectively if high maintenance cost items can be identified and the reasons for the high cost understood. It is often the best strategy to take when breakdowns are too frequent or repair is too costly. [6]

The replaced section means the section that has been brought to the maintenance section and has stopped working or the section whose position is now occupied by the other section with the same elements.

The major difference among the top three is the work that the robots perform the first two can have visual inspection at the time of repairmen of the section and the parts can be replaced on the need and need not basis. But in the third type all the elements have to replace as soon as it has been changed and brought for maintenance. The maintenance is to be done and the parts that can be reused must be put to the maintenance conveyor for instalments.

The section change can be done by two types –

(i) Rotating the section and doing so the section reaches the maintenance robot. All three above mentioned maintenance can be done using this. More energy required as the whole section is rotated.

(ii)Or the maintenance robot reaches the section to be repaired while the perfect condition section is put to work using the clutch mechanism. Only the first two maintenance types can be done the third one requires speed so the section must reach to a standing maintenance section. This section change uses clutch to engage and disengage the sections. The section remains at rest so less energy required during this section change.

All machines based on such type of maintenance must have space for entering new elements and keeping them around the sections and the space to keep them in bulk from where new elements and the worn out ones can be kept in the disassembled form during the section maintenance and the reservoir for the junk or worn out components.

RESULTS AND DISCUSSION

- It's possible to design a machine that has no downtime.
- It's impossible to make a strategy or technique for a no downtime maintenance only a secondary machine can be installed parallel to the machine so that the parallel machine can provide output when the primary one goes down due to maintenance requirement.
- For making a no downtime machine following steps must be followed
  - The machine should have at least three hearts or engines.
  - The machine should have at least two engines so that the machine never stops.
  - The machine should be divided into sections based upon the type of the elements used in each section and the number of elements that require maintenance.
  - The section that consist of elements which require maintenance and consumes time must be replaced with the other section.
  - The machine elements should be made at least two times and be placed parallel to each other.
  - The machine should be isolated from the input and the output before the change of sections.
  - Changed sections should be treated or maintained or repaired as soon as they are replaced with the other section due to the prediction of the failures.
  - There must be space more than the space of the robot or the engine that is going to replace the parts.
  - For changing the ball bearings we must use belt that is rotated with the robot to a specific no. of gear teethes.
  - The maintenance should be done as fast as possible.
  - Running the machine in the unfit condition leads to damage to the machine.
- For fast maintenance the elements that consume time for the maintenance or repairs must be replaced with the perfect ones and the maintenance of that element must be carried out later when all the elements of the machine are working fine the mechanism is ideal and can repair the replaced elements this should be done because unpredictable failures exists and can appear any time.
- Block diagram should be made before designing the machine as it saves time of thinking and analysis the machine.
- The wheel of the automobile store energy as they rotate.
- Four clutches are used at least to make a no downtime machine.
- To separate each moving section with other section we must use clutch in between.
- Flywheel and the clutch consume power and thereby decrease the speed of the automobile after the as well as the load carrying capacity of the automobile.
- Prediction of failure is always not possible so the each element or the section of the parallel parts must be connected to the other parts by means of dog clutch or any other clutch.
- By increasing the performance of the machine the machines elements worn out rate also increases.
- It consumes time for the machine to repair when the machine is big and the number of parts is more so in that case the number of the repairing robots should be increased and they are to be placed every section of the machine.
- The machine section should be divided on the basis of the specific operation they perform.
- The machine section must be replaced in case the error is predicted in that section.
- The machine size increases by more than four times as the 3 hearts and then the space for the robot with the replacement parts and the different hands.

- For very fast maintenance there is a requirement for the robot have different arms and every arm corresponds to the same number as that of the elements in the each section and every arm is designed especially for the element in front of it in this assembly unit the parts are need to be supplied by the conveyor similar to the assembly line.
- Each elements part must also be designed on the basis of requirements
- Each elements part must also be designed on the basis of the future failures and repair processes.
- Lubrication holes must also be very small and left in the design at the matting parts.
- For that the point of contact or the failure surfaces must be noted in case of the failure that arises due to the surface grinding due to the friction between the mating parts so there should be parts like used that have small surfaces and the parts or the elements can wear them like the clothes and they can be fitted upon with the lock nut and when the failure arises the parts can be replaced and during the repair of the parts the surface clothes must be removed using the nut and then another ones must be fitted upon them locking the nut.
- The surface areas of the machine elements in contact with each other must be as less as possible so that the less friction leads to the less resistance to the output.

Disadvantages –

- Increase the volume occupied by the design
- Increases the weight
- Decreases the output due to use of the clutches as the clutches have weight and they rotate with the other elements so less output is received.
- Very expensive art
- Even so the failure occurs due to the forgetfulness of the human beings or the operator.
- Even so the machine design elements can be designed theoretically but the size calculations can't be done and the variations in the output of the machine.
- Waste or worn out parts increases (as every things comes with the price but the machines come in instalments) due to use of robot mechanisms or the repair mechanisms.

CONCLUSION:

The main thing is that the downtime of the machine can be made zero by applying some efforts. It is also true that the no downtime machine will have size more than the four times of the actual machine. The second machine can be installed in the plant to deal with problem of the downtime due to repairs but at the end it's all the same no downtime plant layout or no downtime machine whatever we use both will require at least two hearts and the mechanism to repair along with the space to keep the parts in the disassembled form. The load fluctuations of the machines lead to the increase in wear and tear or the worn out parts/elements. The load of the machine as well as the automobiles can be stabilised by just adding a gear and making the flywheel in less weight plates and then removing those plates from the moving mechanism as the weight increases the resistance to the output. So the plates should be removed based on the properties of the work piece. The weight of the output end of the machine stores energy that's why the machines should have more weight at the end where the rotation is done or at the moving end so that they can store energy and more force is applied by the machining end. The unpredictable failures exist so the machine should be in top maintenance condition as soon as possible. There are various classifications of the maintenance but the classification of the maintenance on the basis of the speed is more superior to the other types of the maintenance techniques. The sections can be replaced with the clone sections depending upon the types used by the designer and they are rotational and the clutch mechanism. The clutch mechanism is preferred over the rotational section change as in the rotational section change the whole section is rotated. The robots can make even new designs so the design out maintenance can also be done using the mechanisms all that's needed for the same is the right tools to perform the design out maintenance. The high speed maintenance uses the conveyor for performing the maintenance. The maintenance conveyor is similar to that of the assembly conveyor. Only small contact area elements are used in machines. Only small parts of the elements suffer wear and the rate of replacement of the components increases size of the junkyard. The small surfaces that are degraded due to friction can be casted and doing so a fine layer of the elements is achieved that layer can be fitted on the elements by the lock nut mechanism thereby making the machines economical to use.

Future work

- Decrease the size of the high speed maintenance machines
- How to decrease the size of the machines made for self maintenance
- How to increase the power output
- More power engines are required to do so how to make the machine that consumes less power

- Making mechanism of the high speed maintenance so that the maintenance can be done with the single engine robot that have different arms each arm corresponds to the each element within the section and does replace every element in the section.
- Making the magnetic bearings.
- Making the magnetic gears the gears that can have magnets at the gears teeth so that it can repel the gears teeth of the opposite gears.
- Design a machine whose elements doesn't require maintenance even the self maintenance.
- Designing a machine that doesn't suffer from load fluctuations.
- Developing maintenance tools and techniques like the seven tools of quality.
- Extract more advantages from the design of no-downtime machine.

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