



# EVALUATING THE EFFECTIVENESS OF CHOSEN MAINTENANCE STRATEGIES FOR DEDICATED EQUIPMENT

ACMA6007 – Level 6

Plant & Asset Engineering

By Ben Shears

## Contents

|                                                                                         |   |
|-----------------------------------------------------------------------------------------|---|
| 1.0 - Introduction: .....                                                               | 2 |
| Personnel Introduction: .....                                                           | 2 |
| Company Introduction: .....                                                             | 2 |
| Equipment Introduction:.....                                                            | 2 |
| What the equipment does? .....                                                          | 3 |
| Assignment objective:.....                                                              | 3 |
| 2.0 - Critical review of current maintenance practices:.....                            | 4 |
| Weekly Preventative Maintenance – .....                                                 | 4 |
| Bi-weekly Preventative Maintenance – .....                                              | 4 |
| Other Preventative Maintenance – .....                                                  | 4 |
| Why this Preventative Maintenance was chosen:.....                                      | 4 |
| Reactive Maintenance approach: .....                                                    | 4 |
| How the machines work: .....                                                            | 4 |
| Advantages and Disadvantages of current maintenance: .....                              | 4 |
| 3.0 - Evaluation of how the current approach to maintenance could be improved: .....    | 5 |
| Changes to Preventative Maintenance:.....                                               | 5 |
| Changes to Breakdown Maintenance:.....                                                  | 6 |
| How this approach can be used strategically in the future: .....                        | 6 |
| Alternative approaches:.....                                                            | 6 |
| 4.0 - Consideration of cost & resource required to implement the proposed changes:..... | 7 |
| Costings: .....                                                                         | 7 |
| Justification: .....                                                                    | 7 |
| Change Management:.....                                                                 | 7 |
| 5.0 - Conclusion & Recommendations:.....                                                | 7 |
| Works Cited.....                                                                        | 8 |
| Appendix: .....                                                                         | 8 |

## 1.0 - Introduction:

### Personnel Introduction:

My role at Renishaw plc is a Process Improvement Technician within the encoders engineering team.

Within the job role some of the key requirements include:

- Keeping the production line running by fixing the jigs and equipment including automated machinery.
- Carrying out preventative maintenance on production jigs and equipment.
- Performing process improvement activities and cost saving exercises to reduce the cost of quality, improving product quality, process step locking and the overall process flow of production.

The aim is to become a Process Improvement Engineer upon completion of this degree. This will allow the concentration and resource to be focused on the design and process elements of the job which are of most interest and where it is believed the biggest positive impact on production can be made.

### Company Introduction:

Renishaw is a British company which was founded in 1973 by Sir David McMurtry & John Deer. It remains a large employer in the UK with over 3,000 people employed to carry out the majority of the R&D (Research and Design) as well as manufacturing.

Renishaw is a global, high precision, metrology and healthcare technology company. Renishaw predominantly specializes in making a range of encoders for machine axis such as CNC's. They also manufacture CMM (Coordinate Measurement Machines) probes for measuring-high precision parts within multiple sectors such as the automotive and aerospace industry. Renishaw have also recently started producing metal 3D printers that can print medical and dental parts to a high standard with great precision from materials such as Titanium, Cobalt Chrome, and Aluminium.

(Renishaw plc, 2022)

### Equipment Introduction:

The equipment that has been chosen to evaluate the current maintenance on is the Encoders Asymtek Gluebot & UV Oven process. The Gluebot process is a vital part of Renishaw's RGH encoder product lines and when it experiences downtime, production have no other efficient way of continuing to produce RGH encoders, therefore making it a single point of failure. The Gluebot & UV Oven process can be seen below in Figure 2a.

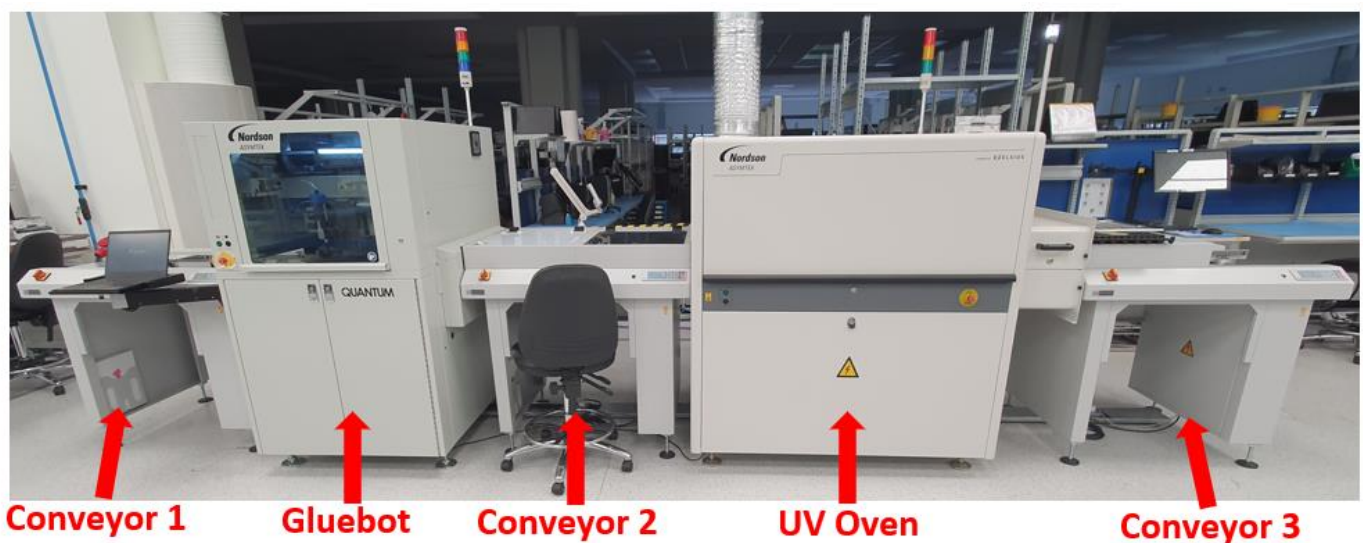


Figure 2a

### What the equipment does?

The equipment uses a valve shown in Figures 3a & 3b below, along with the jetting technology shown in Figure 3c to apply UV adhesive around the optical glass on the RGH encoders. The machine glues the products in batches of 48 units on a specially designed tooling tray which has machined fiducials to allow the machine to identify the encoders positions before applying adhesive, this tooling tray can be seen in Figure 3c. The gluing process is made up of a system of conveyors along with the Gluebot itself and a UV oven to cure the adhesive as shown above in Figure 2a. An image of an encoder post Gluebot can be seen below in Figure 3d & 3e.

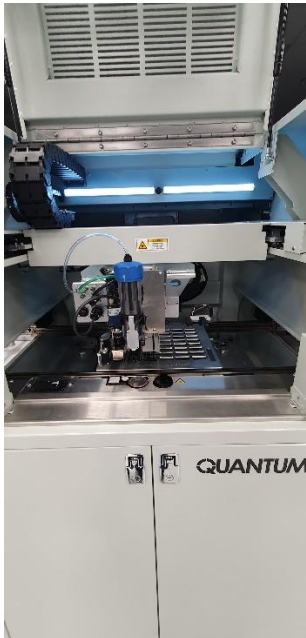


Figure 3a

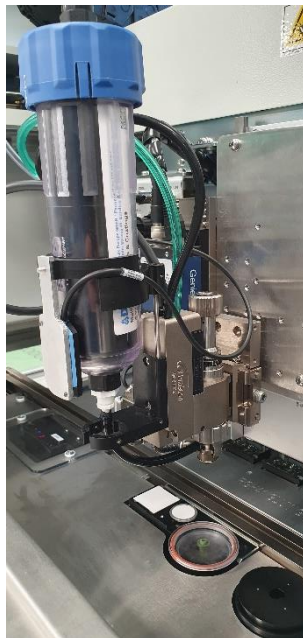


Figure 3b

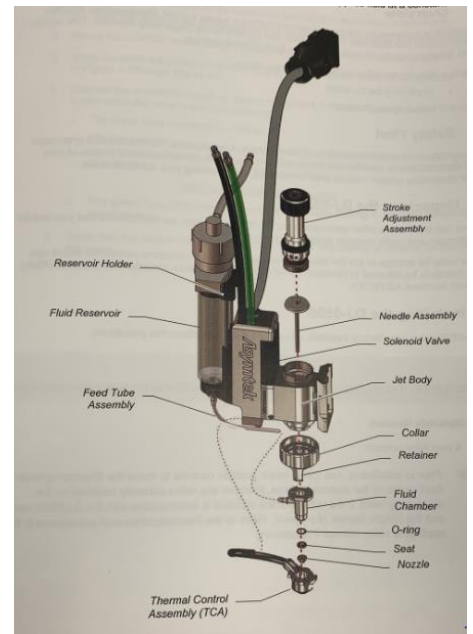


Figure 3c



Figure 3c



Figure 3d



Figure 3e

### Assignment objective:

This assignment requires me to critically evaluate the maintenance on the encoders Gluebot and UV Oven process and suggest improvements along with why the current maintenance schedule may have been decided upon initially. It also requires me to review how the revised approach taken could be implemented onto future machines/equipment purchased while considering cost implications and the required resource for the maintenance tasks to be actioned.

## 2.0 - Critical review of current maintenance practices:

Currently the only types of maintenance that are carried out on the Gluebot and UV Oven process are planned maintenance where it is scheduled in with production to be down for a set amount of time for preventative tasks to be carried out. Then breakdown maintenance which is reactive maintenance carried out when the machine has a fault and stops production from running. Due to only currently having one of these machines in production and it being a single point of failure, the maintenance needs to be improved and kept on top of.

**Below is a list of the current preventative maintenance schedule that are carried out on the Gluebot & UV Oven process:**

### Weekly Preventative Maintenance –

- Gluebot: The jetting valve is taken out of the machine and stripped down every Friday to prevent adhesive curing in the nozzle.

### Bi-weekly Preventative Maintenance –

- UV Oven: The reflector on the UV Oven is checked for damage and replaced if necessary.

### Other Preventative Maintenance –

- Gluebot: To stop the adhesive drying up and partially thermally curing under the nozzle heaters temperature, causing the valve to seize up, the machine has a purge programmed in so that every 5 minutes the nozzle is purged with material for 5 seconds.

### Why this Preventative Maintenance was chosen:

The above approach was taken due to the schedule being created by someone who wasn't overly familiar with the machine(s) and general maintenance techniques. This was down to a lack of resource for admin tasks at the time of the machine's implementation. The schedule was then never revisited until now.

### Reactive Maintenance approach:

The reactive maintenance is carried out when the machine(s) have issues in production causing them to halt production, this type of maintenance is not documented anywhere currently, and the root cause and solutions are passed between maintenance engineers.

### How the machines work:

The Gluebot machine works by accepting a tray full of product in from the process's entry conveyor. It then scans the tray for products. Once it has scanned the full tray and found all the products via their defining fiducial marks it will dispense adhesive around each of the component's optical glass. The Gluebot will then eject the tray onto a central conveyor. The UV Oven functions by accepting the tray from the central conveyor then pushing it under and through a UV bulb and reflector to cure the adhesive around the optics. Finished product is then ejected onto the exit conveyor post oven, where it can be decanted from the tray by an operator.

### Advantages and Disadvantages of current maintenance:

| <b>Advantages:</b>                                                                                                        | <b>Disadvantages:</b>                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Gluebot: Prevents the adhesive from the sticking the valve together overnight or over a weekend when not in use.          | Gluebot: Only covers the Gluebots valve and not the rest of the mechanisms within the machine.        |
| UV Oven: Checks on the state of the UV Ovens reflector quite regularly.                                                   | UV Oven: Only covers the UV Ovens reflector and not the rest of the mechanisms within the machine.    |
| Gluebot: Keeps the Engineers familiar with stripping the valve down due to it being carried out on such a frequent basis. | UV Oven: Doesn't prevent the UV Ovens reflector from deteriorating, it simply monitors its condition. |
|                                                                                                                           | Gluebot: Purging overnight to prevent the valve seizing could be seen as a waste of adhesive.         |
|                                                                                                                           | Both: No reactive maintenance records are kept to help assist in future breakdowns.                   |

### 3.0 - Evaluation of how the current approach to maintenance could be improved:

After reviewing the current maintenance, it is believed both the preventative/planned maintenance and the breakdown maintenance could be improved along with the strategy used to execute the maintenance. Below is a list of the improvements that it is believed should be implemented to reduce the probability of a breakdown along with the justification as to why.

Before jumping into what is believed the preventative maintenance should include. The manuals for each machine were studied to look at the recommended maintenance along with how often the supplier suggested each maintenance task should be carried out. The opportunity was also taken to speak with production and the maintenance team to find out what problems they commonly face. The manuals can be found in the Appendix.

The below preventative maintenance strategies in Figure 5a were reviewed and considered. It was deemed that the condition based, and time based/predictive strategies were best suited to the equipment under consideration due to the manual and suppliers recommendations being condition and time based. Therefore, these strategies were implemented to the new schedule which can be found below.

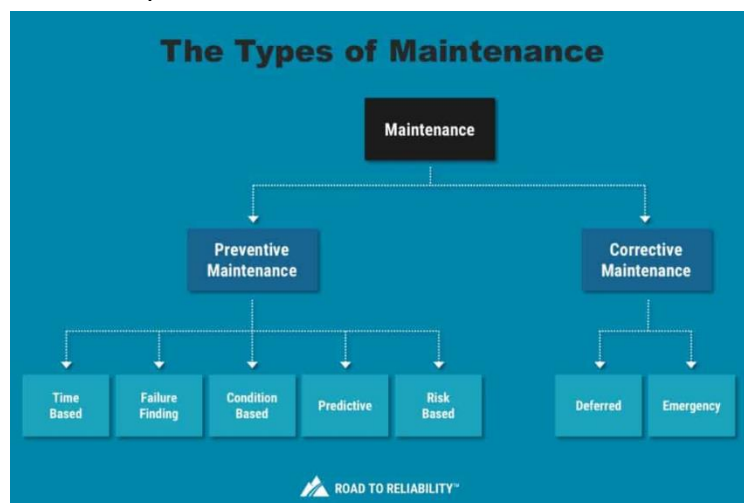


Figure 5a (Fixx, 2023)

#### Changes to Preventative Maintenance:

- UV Oven: Added a time based replacement of the Mercury UV bulb within the UV Oven every 12 months, this time based maintenance technique ensures that the bulb doesn't degrade beyond its recommended lamp lifecycle hours of 9500 hours (13 months) as stated in the manufacturer's manual. Estimated replacement time expected: **1.5 Hours**
- UV Oven: Added a light cleaning operation onto the UV reflector within the UV Oven every 2 weeks. This will extend the reflectors operating life and prevent it from being changed so frequently. As well as this prolonging the reflectors life is forces the condition of the reflector to be changed. This was recommended by the supplier in their manual and it also stated it on the reflectors back panel also. Estimated time expected: **0.5 Hours**
- Gluebot: Added a greasing operation to the Gluebots pulleys that control the XYZ movements of the machine's main carriage every month. This was added this due to complaints from the operators stating that the carriage is heavy to push out of the way when needing to change the purge cups. Estimated time expected: **2 Hours**
- Gluebot: Added a greasing operation to the Gluebots stop pins that engage the product tray when it has been loaded into the machine. This maintenance is to be carried out every month. This was added this due to a reoccurring issue where the pins would not return to release the product tray after the product had been dispensed on. Estimated time expected: **0.5 Hours**
- The machine(s) warranty was due to expire so a warranty extension and maintenance package was purchased with supplier. This will help combat any dramatic breakdowns the machine(s) encounter in the future.

### Changes to Breakdown Maintenance:

To reduce the time it takes for an engineer of various skill sets to solve a breakdown on the machine(s) from now on a reactive maintenance guide and record book has been set up next to the machine. This book is to be manually filled out by the maintenance engineers attending the breakdowns and will allow the machine to be monitored more closely. It is expected to take the engineers an extra **0.75 Hours** to carry out.

### How this approach can be used strategically in the future:

It is believed this approach and strategy can be used in the future by ensuring the maintenance schedules that are written/amended going forward are reviewed and signed off by senior maintenance engineers who have the in depth knowledge on the relevant machine. This will stop any inadequate schedules making it into service with crucial condition or time based activities being missed.

### Alternative approaches:

An alternative approach to carrying out the maintenance on the machine(s) would be a time based or predictive maintenance approach, this technique would mean that critical components are replaced before they fail or begin to wear past a certain stage. This approach sometimes means that components are replaced well before they require replacement, this adds an extra cost implication as over the years of service you will be consuming a lot more components than you possibly couldn't get away with. The method is often referred to as a wasteful method, however if keeping production running with very minimal risk of downtime is what is necessary then this is a good method to put into practice. Due to the cost implication, it is important that you create an accurate prediction of when you believe the component will fail before introducing the scheduled replacement intervals.

(Hupje, 2023)

## 4.0 - Consideration of cost & resource required to implement the proposed changes:

With every change, cost and resource needs to be considered. Due to more activities being added to the Gluebot & UV Ovens preventive maintenance schedule the maintenance team will be spending on average approximately **44.5 hours** extra maintaining the machine every year.

### Costings:

- Labour rate of a maintenance engineer including heating/lighting etc: **£41.32 per hour**
- Cost of the machines downtime (this is based off an average production capacity model): **£205 per hour**

### Justification:

As you can see by the above costs, the extra maintenance cost/time massively outweighs the risk of the machine breaking down or not lasting their full life expectancy. The extra preventative maintenance measures total up to an extra **44.5 hours** of annual downtime at the cost of **£1,838.74** in resource and **£9,122.50** in downtime costs. Totalling **£10,961.24** a year.

The machine(s) run 24/7 and therefore this is a small price to pay in the whole scheme of things, as the above extra cost incurred by the added preventative maintenance doesn't even account to one weeks run time of the machine(s).

### Change Management:

To manage this change in maintenance, management will have to enforce that the schedules are actually followed and signed for and the relevant training will need to be supplied whether it be an internal knowledge transfer or a supplier training day.

## 5.0 - Conclusion & Recommendations:

To conclude, it is believed that with the improvements and maintenance strategies that have been made to the planned/preventative maintenance schedules along with the change in approach to reactive breakdowns, the machines will see both an increase in productivity but also an increase in their life expectancy. The additional resource costs per year have a very quick return on investment as the machine(s) will run for longer before experiencing issues and breakdowns. It has been learnt through the research carried out that maintenance of such high technology pieces of equipment are constantly evolving and improving, therefore it is critical to review and question schedules to continuously improve the life expectancy and run time of plant and assets within production. The longer term improvements that are suggested moving forward for the above equipment are to record as much data as possible, whether this be spares consumptions or fault descriptions/root causes. It is also worth considering higher levels of condition monitoring medium term to see if any wear or degradation can be slowed down to prolong when preventative/reactive maintenance is required.

## Works Cited

Fixx. (2023). *Fixx*. Retrieved from

[https://www.bing.com/images/search?view=detailV2&ccid=JXdh15if&id=93F488B854ED12CB82E55EF38E1B6FBF7F3C4C1C&thid=OIP.JXdh15ifDyKukqwpXbFMbwHaE8&mediaurl=https%3a%2f%2fwww.roadtoreliability.com%2fwp-content%2fuploads%2f2018%2f06%2fr2r\\_types\\_of\\_maintenance-1](https://www.bing.com/images/search?view=detailV2&ccid=JXdh15if&id=93F488B854ED12CB82E55EF38E1B6FBF7F3C4C1C&thid=OIP.JXdh15ifDyKukqwpXbFMbwHaE8&mediaurl=https%3a%2f%2fwww.roadtoreliability.com%2fwp-content%2fuploads%2f2018%2f06%2fr2r_types_of_maintenance-1)

Hupje, E. (2023). *9 Types of maintenance: How to choose the right maintenance strategy*. Retrieved from Road to reliability: <https://roadtoreliability.com/types-of-maintenance/#h-time-based-maintenance-tbm>

Renishaw plc. (2022). *About Renishaw*. Retrieved from Renishaw.com: <https://www.renishaw.com/en/About-renishaw--6432>

## Appendix:

### Gluebot Manuals -



Installation,  
Operations and Maint



User Guide.pdf

### UV Oven Manuals -



SOFTWARE  
INSTALLATION & STA



UV-9 Oven Manual  
(Asymtek).pdf