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Evaluating the Effectiveness of RC04 Maintenance Strategies
Plant & Asset Engineering AMCA6007

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Table of Contents

1	Abstract	iii
2	Introduction	1
3	Current Maintenance Approach	2
3.1	Current Benefits.....	3
3.2	Shortcomings.....	4
3.3	Historical Justification.....	5
4	Process Improvement Overview	6
4.1	Data & Information Consolidation.....	6
4.2	RCM and CBM Process Application.....	7
4.3	Maintenance Scheduling.....	8
5	Cost Implications.....	9
5.1	Current Cost; Sample June 2025-April 2026.....	9
5.2	Improvement Implementation Costs	10
5.3	Return on Investment.....	10
6	Conclusions	12
7	References	13
	Figure 1 RC04 Robot Welding Cell Image (Bisley, 2018).....	2
	Figure 2 Drawing of 'Carcase' Assembly Manufactured on RC04 (Bisley, 2026a).....	2
	Figure 3 Bisley Internal Work Order Example (Bisley, 2026d)	3
	Table 1 Replaced Components with Electronic Monitoring Alternatives (Bisley, 2026e) (Bisley, 2026f).....	7
	Table 2 Estimated Costs of Component Maintenance from June 2025	9
	Table 3 Estimated Costs of Implementation (Emerson, 2026) (YIYADECO, 2024) (Tuya , 2026)	10
	Table 4 Estimated Costs of Component Maintenance under Improvements from June 2025	11

1 Abstract

This report evaluates the maintenance strategies for the RC04 robotic welding cell at Bisley's manufacturing facility in Newport. The primary objective of the review is to assess the current maintenance processes and explore the feasibility of transitioning to a data-driven Condition-Based Maintenance (CBM) approach to improve operational efficiency. Currently, the facility utilises a Planned Preventive Maintenance (PPM) system, which relies on fixed time intervals and partly-digital, partly paper-based data collection methods. This approach makes it difficult to accurately predict component wear, leading to data fragmentation, maintenance-induced failures, and significant unscheduled downtime with high hidden costs.

To address these shortcomings, the report proposes a series of process improvements focused on data consolidation and the application of electronic monitoring. The implementation of hardware, amongst other improvements, was suggested to track the actual condition of high-wear components. By utilising this real-time data, maintenance can be scheduled during non-productive periods, avoiding the costly interruptions to production that occur under the current system.

Financial estimation shows that the proposed improvements would have a short payback period measured in months by reducing downtime and preventing the unnecessary replacement of parts that have not yet reached their end-of-life. The report concludes that shifting to a digital, condition-based strategy will significantly enhance long-term asset management, reduce operational costs, and provide a more flexible maintenance framework.

2 Introduction

Bisley is a UK-based manufacturer of steel and wood storage products, operating primarily from its manufacturing headquarters in Newport, South Wales. With over 90 years of experience, the business has integrated various levels of automation to enhance manufacturing flow and product quality.

Bisley utilises robotic welding cells as a core competency to ensure precision and efficiency in metal fabrication at high volumes. Robotic spot welding specifically for the production of sheet metal 'carcase' assemblies (empty cupboard & locker bodies). The use of robotic welding supports the company's objective to manufacture innovative, value-for-money workspace solutions through advanced engineering and development capabilities.

This review aims to assess the maintenance processes responsible for looking at one of these robotic welding cells, RC04, and explore the means and feasibility of improving the maintenance process. To achieve this, the current process is compared with theory around condition-based maintenance (CBM) to explore alternative methods of regulating the condition of equipment.

3 Current Maintenance Approach

RC04, pictured in Figure 1, is a robot spot-welding production cell producing cupboard 'carcasses', such as that shown in Figure 2. This cell contains three operations. The first involves components being picked from the cell's WIP (work-in-progress) area and placed by hand onto the welding jig bed. From there, the bed progresses to stations 1 and 2, where spotweld fixings are applied by the robotic tool-head.

Over the lifetime of this asset, the products which it's designed for have steadily reduced in volume, and earlier robot welding cells under the label RC01 & RC02 have been retired.



Figure 1 RC04 Robot Welding Cell Image (Bisley, 2018)

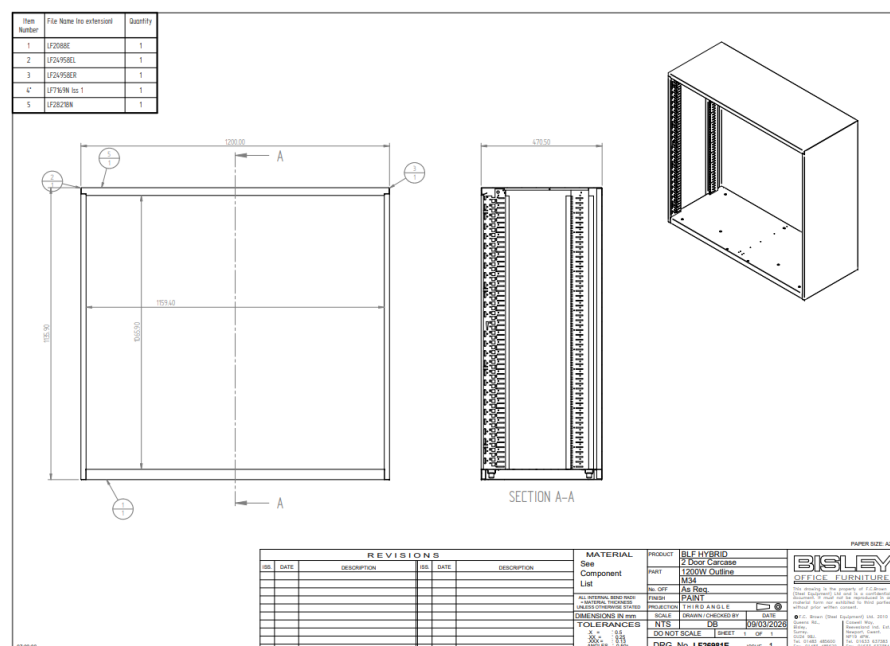


Figure 2 Drawing of 'Carcase' Assembly Manufactured on RC04 (Bisley, 2026a)

3.1 Current Benefits

The current maintenance process at Bisley for the RC04 robotic welding cell is a Planned Preventive Maintenance (PPM) system managed through software called 'ShireSystem' (Bisley, 2026b).

ShireSystem provides a central asset register where organisations can record and track detailed information for each asset, such as location, lifecycle history, maintenance records, repair costs etc. This allows informed decisions on whether to repair, refurbish, or replace equipment (Elecosoft, 2026).

This system generates scheduled maintenance reports that maintenance technicians carry out (Bisley, 2026c). RC04 exists as an entry within this framework. The maintenance checks are carried out at different levels, including weekly, monthly, and bi-annual checks (Bisley, 2026b). Similarly, operators of RC04 are tasked with daily 'Operator PM' tasks, which are done regardless of scheduled maintenance. The operator PM sheet is shown in Figure 3. These include basic measures of performance along with safety-driven concerns, including checking emergency stops, air/water pressure, and sensor damage. In addition to the maintenance plan enacted by the in-house maintenance team, specialist engineers from the manufacturer, ABB, perform annual servicing to ensure oversight of critical aspects. ABB engineers have better access to complex, large and long-lead-time spare components. Additionally, the manufacturer has specific technical knowledge required to maintain a piece of equipment this complex.

Bisley Office Equipment

Work Order 218777

Type	PPM	Assigned To	[REDACTED]
Origin	Scheduler	Status	Scheduled
Requester	SCHEDULER	Planned Start	23/03/2026 06:00
Respond By	23/03/2026 07:00	Task	RC04/Op/Daily
Work Subject	RC04 - Automatic robot cell		
Description	RC04 - Operator Daily		
Safety Notes			

[Task Safety Info]
All work must be carried out in accordance with any current or applicable H&S procedure or safe system of work.
Please ensure that Personal Protective Equipment (PPE) is worn and that where applicable equipment is isolated.
It is important that any residual energy or pressure that may be contained within hydraulic, pneumatic or electrical systems is fully discharged before any work is undertaken.
Your Safety is extremely important and if you are in doubt please seek further advice.

Work Instructions

* Please tick boxes when checks complete *

Mon	Tue	Wed	Thurs	Fri	Sat
am	pm	am	pm	am	pm
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐

1. Check all emergency stops.
2. Check all access gate switches.
3. Check all covers are present.
4. Check all air and water for pressure & leaks.
5. Check quality of electrodes for wear & tear.
6. Clean and tidy area at the end of each shift.
7. Check all sensors for damage.
8. Check operation of Light Guards.
9. Inspect condition of suction cups

Figure 3 Bisley Internal Work Order Example (Bisley, 2026d)

3.2 Shortcomings

In this system, there are shortcomings. Some of these are inherent within the chosen system, and some are areas open to incremental improvement. The fluctuations in production volume create a unique challenge in applying the current PPM process for this production cell. Moving away from PPM is a core component of Industry 4.0, focused on proactive forms of maintenance suited to better integrate legacy equipment (Sanchez-Londoño et.al., 2022). With production volumes uncertain more than 2-3 weeks out, it's impossible to predict how much component wear is going to be experienced by RC04, and by extension, accurately create a PPM schedule.

The technician's PM is issued on a paper worksheet from the server (Bisley, 2026b), which is part of a manual and dated internal mode of operation. Working off a physical worksheet, created at set intervals, greatly restricts the flexibility of the process. Additionally, problems identified during operator PMs or breakdowns are transferred to a separate worklist sheet rather than being integrated into one schedule (Bisley, 2026b). Separating work orders for the same piece of equipment is an obvious point at which confusion can be created, especially during atypical circumstances, if staff are on leave or at shift change-overs.

Tasks on the worklist are only completed when the machine is made available, not during scheduled maintenance periods (Bisley, 2026b). Leaving maintenance work dictated by a production schedule could lead to a backlog of repairs if production demands are high. Additionally, during periods of high demand, the rate of wear is likely to increase, leading to failure, unexpected downtime and pressure to complete production quotas, creating a negative cycle.

The current approach is purely time-based (PPM) rather than condition-based. For example, water couplings on the robot head currently fail two to three times a year, causing 2–5 hours of downtime per incident (Bisley, 2026e). There is currently no mechanism to predict these failures before they occur. Relying on scheduled overhauls (second-generation maintenance) can result in maintenance-induced failures and excessive replacement of parts that do not yet require it.

3.3 Historical Justification

As a company, Bisley has a greater challenge than many to balance the requirements of a large range of ageing and outdated equipment with the needs of new and digitising assets. Production of steel office furniture within the company dates to the 1940's (Bisley, 2025), and with that legacy comes unique challenges.

Historical transitions to digital systems have been a slower process than in many companies, and the application has been constantly uneven. Organisations often choose a cheap short-term option for infrastructure, which is new and untested; total unified data collection is also sometimes impractical with extremely aged assets. The combination of a complex maintenance environment, legacy practises and the higher upfront challenges with setting up data collection methods has ultimately led to higher long-term costs than might otherwise be possible.

4 Process Improvement Overview

4.1 Data & Information Consolidation

The current maintenance system is hampered by the semi-digital structure, which has been implemented over several attempts at reform. The current maintenance process for the RC04 robotic welding cell can be improved in various ways. Transitioning from a purely time-based system to data-driven methods of driving maintenance intervals.

The current process transfers the information from a central system to a paper worksheet. Creating a digital interface for recording work completion directly into a system would be required to increase the frequency with which the current planned maintenance requirements can be updated. Issues found during operator PMs are sent to a second worksheet, as currently discussed. This is due to the inability of the regular schedule to be updated to reflect current maintenance conditions. An efficient software layer, the core of which already exists, is a crucial component of CBM methodology in order to improve communication and facilitate informed predictions (Prajapati, Bechtel, & Ganesan, 2012). Integrating this worklist directly into the Shire system would prevent data fragmentation and ensure better tracking of pending repairs. This would also open the way to a method for pulling up-to-date condition information on RC04.

The main challenge is expanding the current condition monitoring and including automatic and continuous information. There are many examples on RC04 of components which would benefit from data gathering through a more unified system. An example is the water couplings, part of the water cooling system, which regularly fail 2-3 times per year and result in up to 5 hours of downtime when this occurs (Bisley, 2026e). Similarly, the weld tips have a lifespan of 10,000 cycles and are also replaced at the point of failure. While these components are expected to be changed as part of PPM, they are regularly replaced too late or too early due to the extreme variation in production volume. This variation excludes the use of MTTR as a meaningful method of analysing the maintenance requirements on RC04. Long periods of idleness or sudden large orders don't offer a constant state from which to measure a nominal rate of wear. A key assumption for applying MTTR, or any mean, is that the conditions affecting what's being predicted can be approximated as constant. Secondly, as the weld tips wear, weld quality degrades, leading to failure. Replacing this component too late has associated costs in addition to downtime.

4.2 RCM and CBM Process Application

Applying RCM (Reliability Centred Maintenance) requires defining RC04's primary functions and performance standards under its current operating context. Currently, monitoring is limited to binary functional failures reported by operators. To accurately identify failure modes and their effects, the system must move beyond identifying 'worn/damaged' components, such as bearings, via visual inspection (Bisley, 2026f). Instead, data must determine what causes each failure and the specific consequences, whether safety-critical or operational. Maximising the live monitoring system requires defining failure effects—what happens when weld tips fail—and how they impact operators and production (Bisley, 2026e). By tracking weld cycles electronically, Bisley can move from reactive states to proactive tasks, such as scheduled condition-based monitoring methodology, and measuring end-of-life wear-out patterns. This data-driven approach identifies the technical feasibility of restoration before failures matter, impacting quality and safety. In areas where proactive tasks are not applied, responses are established to ensure physical assets continue fulfilling production requirements. The digital system can automate the maintenance schedule, establishing a framework for in-house upkeep. Table 1 lists operator-checked items that lend themselves to electronic monitoring, improving uptime by addressing the seven basic RCM questions for each identified robotic component.

Component / Part	Current Operator Monitoring Method	Potential Electronic Monitoring Method
Water Couplings (Robot Head)	Visual inspection for leaks and failure.	Implement a routine to track operations and alert for replacement before typical failure.
Robot Weld Tips	Visual inspection of weld quality.	Automated routine to trigger a tip exchange at the identified weld count.
Electrodes & Copper Plates	Manual check for 'wear & tear' and weld quality.	Monitoring the cumulative number of welds or electrical resistance/conductivity changes.
Air & Water Lines	Manual check for leaks and set pressure.	Installing meters to detect pressure drops or flow rate changes with automated PLC alarms.
Tower Indicator Lamps	Visual confirmation of operation.	Using the PLC to monitor the electrical status and alert if a lamp circuit is open (blown bulb).
Suction Cups	Visual inspection of condition.	Monitoring for reduced vacuum efficiency by way of peaking vacuum pump uptime, indicating a worn or leaking cup.
Linear Bearings & Slides	Manual check for excessive backlash.	Using sensors to detect abnormal periods of running the motor without translating into weld-head movement from mechanical deterioration over time.

Table 1 Replaced Components with Electronic Monitoring Alternatives (Bisley, 2026e) (Bisley, 2026f)

4.3 Maintenance Scheduling

Scheduling maintenance within busy production environments presents a significant challenge, as the need to maximise profit often conflicts with the requirement for downtime to perform essential upkeep. Maintenance should ideally be planned for times when no productive capacity is scheduled, such as weekends, holidays, or during a site shutdown. However, the reality is that during busy times, natural downtime is at a premium. These times will see the higher rates of component replacement. To balance these competing requirements, it's crucial to identify which maintenance operations are critical and which can be delayed in such circumstances. The higher-Arcy begins with safety-critical parts, followed by quality-critical parts and followed by the remainder of parts listed most-to-least complex and costly mitigating actions.

5 Cost Implications

The cost-benefit comparison consists of an estimated comparison of the current PPM and proposed CBM methods.

5.1 Current Cost; Sample June 2025-April 2026

Table 2 shows the estimated costs of maintenance applied to RC04 from June 2025 until the present, excluding daily checks by the operator. This table shows that most of the maintenance performed over the last year involved interrupting production due to component failure, such as a lamp failing or weld tips wearing through. These components cost a minimal amount, but the interruption of production adds a major hidden cost, estimated at a tact-time of 3 minutes for a low-value product. There are also intangible costs in lost repeat orders, etc., associated with products reaching the customer late.

Component / Part	Location / Station	Details / Part Number	Maintenance Type / Notes	Typical Component/Material Cost	Manufacture Labour (if applicable)	Downtime est (hr)	Downtime Cost (Lost production)	Downtime Labour Cost	Total Cost	Scheduled or Failure - caused?	Scheduled frequency (if applicable)
Panel Filter	Station 2 Turntable & Control Panel	Filter medium	-	£ 35.00	£ -	0.5	£ -	£ 30.00	£ 65.00	Scheduled	/mo
Tower Indicator Lamps	Station 1	5v lamp	-	£ 20.00	£ -	2	£ 4,000.00	£ 120.00	£ 4,140.00	Failure	-
Top Datum Rail	Station 3	Replacement rail	Manufactured by the Toolroom to replace bowed rail.	£ 65.00	£ 160.00	6	£ 12,000.00	£ 360.00	£ 12,585.00	Failure	-
Magnet Pusher Sensor	Station 4	Part: BIS0028	Replacement for damaged sensor.	£ 70.00	£ -	1.5	£ 3,000.00	£ 90.00	£ 3,160.00	Failure	-
C-Gun Electrode	Robot 1	Part: AWL0022	Replacement for leaking electrode holder.	£ 335.00	£ -	4	£ 8,000.00	£ 240.00	£ 8,575.00	Failure	-
I/O Pins	Robot 1	Sigma convex pins (x4)	Replacement for 4 out of 20 pins on robot exchange unit.	£ 15.00	£ -	4	£ -	£ 240.00	£ 255.00	Scheduled	/2mo
Copper Plates	Station 7	Top and bottom plates	Replacement for worn plates.	£ 120.00	£ -	8	£ 16,000.00	£ 480.00	£ 16,600.00	Failure	-
Brush Linear Bearings	Station 7	Part: KLM25-80-SHS (x4)	Replacement for bearings damaged by water leaks.	£ 2,500.00	£ -	12	£ -	£ 720.00	£ 3,220.00	Scheduled	/yr
Earth Bonding Cable	Station 8	8m x 16mm cable	Entire length replaced in energy chain (vac frame to gantry).	£ 15.00	£ -	3	£ -	£ 180.00	£ 195.00	Scheduled	/yr
Nylon Wear Guides	Station 11	4 x 30 x 2390mm	Replacement guides manufactured by the Toolroom.	£ 16.00	£ 240.00	3.5	£ -	£ 210.00	£ 466.00	Scheduled	/yr
Water Couplings	Robot Head	N/A	Identified as regularly failing 2-3 times per year.	£ 6.50	£ -	3	£ 6,000.00	£ 180.00	£ 6,186.50	Failure	-
Robot Weld Tips	Robot Tool-head	N/A	Have a 10,000-weld lifespan; replaced at failure.	£ 10.00	£ -	4	£ 8,000.00	£ 240.00	£ 8,250.00	Failure	-
									Unscheduled Total	£ 59,496.50	
									Scheduled Total	£ 4,201.00	
									Total: £ 63,697.50		

Table 2 Estimated Costs of Component Maintenance from June 2025

Another cost which the direct costs don't account for is the time involved in outdated administration processes of working on paper records and schedules. The scheduled replacement of items such as I/O pins and cables additionally risks maintenance-induced failure or over-replacement, as it's unclear when or why these specific intervals were set.

5.2 Improvement Implementation Costs

The implementation costs include an estimate of the equipment and installation costs associated with setting up the CBM electronic equipment discussed previously. In order to get these costs, example equipment was used, and a day's labour for one person to install the equipment was applied where applicable. The Vibration Monitor is a more sensitive and complex asset, and so has an external installation fee attached to it (Emerson, 2026). Cycle counting is possible to implement within RC04's programming, which is accessible to the maintenance team.

CBM Device	Cost	Install Cost	Warrently / Lifespan
Pressure Gauge / Electronic Monitor	£ 103.00	£ 240.00	1 year
Weld Cycle counter	£ -	£ 240.00	-
Voltage Electronic Monitor (x2)	£ 134.00	£ 240.00	1 year
Vibration Electronic Monitor	£ 5,000.00	£ 1,000.00	1 year warrently; expected 10 year
Android tablet (x3) for portable access to Shire-System	£ 810.00	£ 240.00	2 year
Total	£ 6,047.00	£ 1,960.00	£ 8,007.00

Table 3 Estimated Costs of Implementation (Emerson, 2026) (YIYADECO, 2024) (Tuya , 2026)

The physical hardware of the equipment, as shown in Table 3, has a warranty specified by the manufacturer. In a worst-case scenario, maintaining this equipment would cost an average of £1,242.00 per annum for the first 10 years. Data-collection equipment, such as this, is crucial in order to effectively deploy CBM. This type of maintenance is only cost-effective when sufficient data is available to make accurate predictions based on historical data (Prajapati, Bechtel, & Ganesan, 2012).

To inform technical decisions, it's important to involve the staff who will be using this equipment to select the exact items purchased. Staff competence and acceptance must evolve with the system, as they are the people who will ultimately interpret data from new electronic monitors.

5.3 Return on Investment

In order to get a cost difference between the proposed changes and the current process, Table 4 shows potential costs for the same period of time, where CBM has been used to schedule components close

to wear before failure. Because of this, downtime scheduled in quiet periods doesn't incur a missed-production cost. It's assumed that CBM catches 50% of worn components before maintenance intrudes on production time (50% of the absolute downtime cost).

Component / Part	Location / Station	Details / Part Number	Maintenance Type / Notes	Typical Component/Material Cost	Manufacture Labour (if applicable)	Downtime est (hr)	Downtime Cost (Lost production)	Downtime Labour Cost	Total Cost	Scheduled or Failure - caused?
Panel Filter	Station 2 Turntable & Control Panel	Filter medium	-	£ 35.00	£ -	0.5	£ -	£ 30.00	£ 65.00	Scheduled
Tower Indicator Lamps	Station 1	5v lamp	-	£ 20.00	£ -	2	£ 2,000.00	£ 120.00	£ 2,140.00	CBM
Top Datum Rail	Station 3	Replacement rail	Manufactured by the Toolroom to replace bowed rail.	£ 65.00	£ 160.00	6	£ -	£ 360.00	£ 585.00	Scheduled
Magnet Pusher Sensor	Station 4	Part: BIS0028	Replacement for damaged sensor.	£ 70.00	£ -	1.5	£ 3,000.00	£ 90.00	£ 3,160.00	Failure
C-Gun Electrode	Robot 1	Part: AWL0022	Replacement for leaking electrode holder.	£ 335.00	£ -	4	£ 8,000.00	£ 240.00	£ 8,575.00	Failure
I/O Pins	Robot 1	Sigma convex pins (x4)	Replacement for 4 out of 20 pins on robot exchange unit.	£ 15.00	£ -	4	£ -	£ 240.00	£ 255.00	Scheduled
Copper Plates	Station 7	Top and bottom plates	Replacement for worn plates.	£ 120.00	£ -	8	£ 16,000.00	£ 480.00	£ 16,600.00	Failure
Brush Linear Bearings	Station 7	Part: KLM25-80-SHS (x4)	Replacement for bearings damaged by water leaks.	£ 2,500.00	£ -	12	£ -	£ 720.00	£ 3,220.00	CBM
Earth Bonding Cable	Station 8	8m x 16mm cable	Entire length replaced in energy chain (vac frame to gantry).	£ 15.00	£ -	3	£ -	£ 180.00	£ 195.00	CBM
Nylon Wear Guides	Station 11	4 x 30 x 2390mm	Replacement guides manufactured by the Toolroom.	£ 16.00	£ 240.00	3.5	£ -	£ 210.00	£ 466.00	Scheduled
Water Couplings	Robot Head	N/A	Identified as regularly failing 2-3 times per year.	£ 6.50	£ -	3	£ 3,000.00	£ 180.00	£ 3,186.50	CBM
Robot Weld Tips	Robot Tool-head	N/A	Have a 10,000-weld lifespan; replaced at failure.	£ 10.00	£ -	4	£ 4,000.00	£ 240.00	£ 4,250.00	CBM
Unscheduled Total									£ 28,335.00	
Sceduled Total									£ 14,107.50	
Total: £ 42,442.50										

Table 4 Estimated Costs of Component Maintenance under Improvements from June 2025

Based on these assumptions, this change would save £2,125.50/month. With an upfront cost of £8,007.00, and a running cost of £103.5/month, we can say it would take approximately 3¹/₂ months to repay the investment. To implement this, it's crucial to secure management buy-in, which is driven by a clear ROI of 3.5 months. To be successful, these changes require ownership of responsibility going forward within the teams responsible for carrying them out, and a formal agreement on the timeframe for implementation. This often takes the form of a road map to guide the change in a consistent, controlled direction (Haouel & Nemeslaki, 2023). It's important that the new digital system is less bureaucratic and simpler to increase the likelihood it's adopted willingly and naturally.

6 Conclusions

The RC04 robotic welding cell's current Planned Preventive Maintenance (PPM) system is inefficient for a fluctuating production environment. Data fragmentation—caused by relying on paper-based workflows and separate spreadsheets—results in costly unscheduled failures and maintenance-induced issues.

Short-term, the RC04 Worklist and operator daily logs should be integrated into the central Shire System to provide a unified view of asset status. In doing this, replace the paper technician worksheets with a portable digital interface to allow for real-time updates and increased process flexibility. Implement software-based counters for high-wear items with known cycle lifespans. Medium-term, there are many areas where CBM hardware can be connected to fill out the information environment of this system. Install electronic pressure gauges, voltmeters, and vibration monitors to transition to the Condition-Based Monitoring status quo. It's crucial to involve maintenance staff with the expertise to select the correct monitoring equipment, which they are confident in deploying.

Finally, the long-term improvement of this maintenance system involves fully shifting the strategy from time-based overhauls and PPM to prevent unnecessary parts replacement and maintenance-induced failures by fully combining the previous steps. This is the regular use of accumulated digital data to inform long-term expenditure on maintaining asset condition and planning for asset retirement.

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