

Project Proposal - ACCA6020 - Ethan Longley

by Ethan Longley

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Automating End-of-Line Quality Checks to Reduce Rework and Improve Production Efficiency

PROJECT PROPOSAL - INDEPENDENT PROJECT (ACCA6020)

ETHAN LONGLEY (2318473)
BEng Electrical & Electronic Engineering

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Introduction

Automation is a crucial part of modern manufacturing, with more processes adopting automation to enhance efficiency and product reliability. As automation technologies advance, complex products can now be assembled automatically, reducing human error and improving overall quality [1]. Quality-controlled production detects defective or incorrect items early, minimizing waste and rework while increasing efficiency. As product demand grows, manual processes become less reliable and resource-intensive, reinforcing the need for automated end-of-line (EOL) inspection [2].

Modern manufacturing typically follows a process flow from sub-assembly to main assembly and finally packing. Without effective EOL testing, damaged or incorrect parts can progress through stages, increasing product value and wasted assembly time. Each undetected defect raises rework or scrap costs, resulting in higher company losses [3].

This project aims to develop an automated process that ensures all devices undergo a quality EOL test before advancing. Industry 4.0 innovations, such as automated inspection, IoT-based data capture, and Manufacturing Execution Systems (MES), have revolutionized quality control by improving traceability and reducing human error through automated validation and real-time monitoring [4].

Problem Statement

As a world leader in manufacturing Intense Pulsed Light (IPL) products, producing over four million units annually, CyDen continuously strives to improve its manufacturing processes [5]. With such high production demand, a higher failure rate is common. Since CyDen produces a range of products with varying complexity, having an effective testing procedure is crucial to minimize failures and maintain quality. One of the highest volume production lines at CyDen is the Autoline, responsible for manufacturing the Victoria 2 Handset.



Figure 1 - Victoria 2 IPL Device [6]

Despite the name “Autoline,” the EOL testing process is performed manually. Operators conduct several tests and scan the etched QR code to store testing and calibration results in the CyDen database [7]. However, missed scans are a common issue, causing problems during packing when records are incomplete, leading to rework and scrapped components.

Cost Saving

Following the DMAIC (Define, Measure, Analyse, Improve, and Control) framework, a key Six Sigma step in this project will involve measuring current failure rates and their impact [8]. DMAIC provides a data-driven, structured approach to problem-solving and continuous improvement in manufacturing. It enables teams to identify root causes, implement and sustain solutions, and achieve better quality, efficiency, and cost savings [9].

Shown below is the average data taken from the current manufacturing process for a month period.

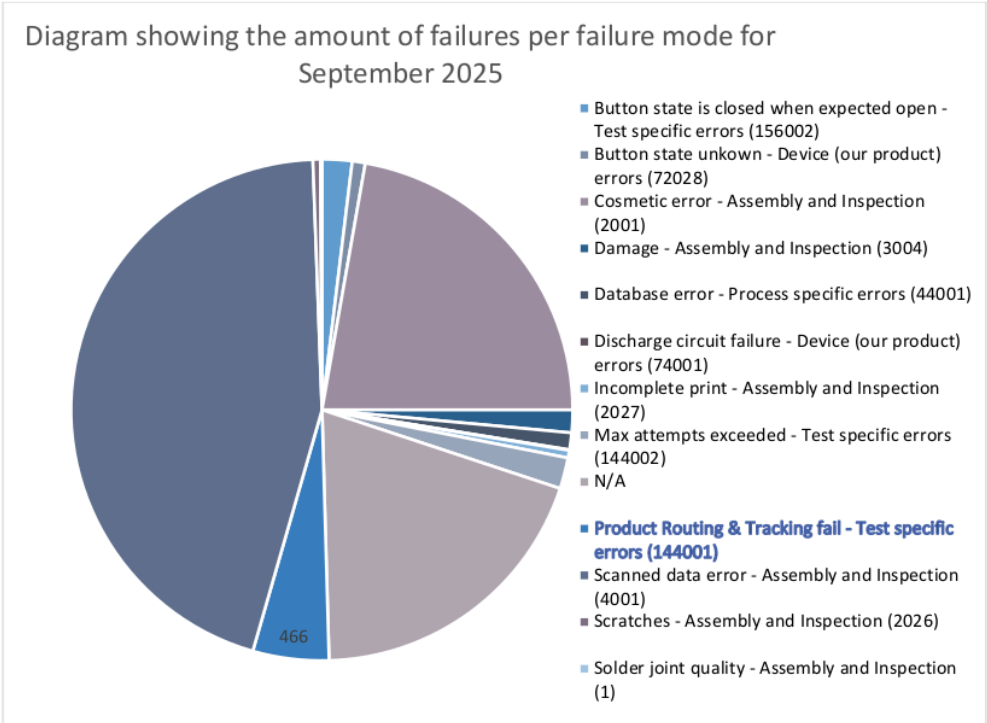


Figure 2 - Diagram showing the number of failures per failure mode

Figure 2 shows a pie chart of failure types, with the Product Routing and Tracking (R&T) errors highlighted in the legend. These account for 5% of issues during the packing stage. While small compared to data errors (45%) or cosmetic damage (22%), this 5% causes significant problems when products return to the assembly line for rework.

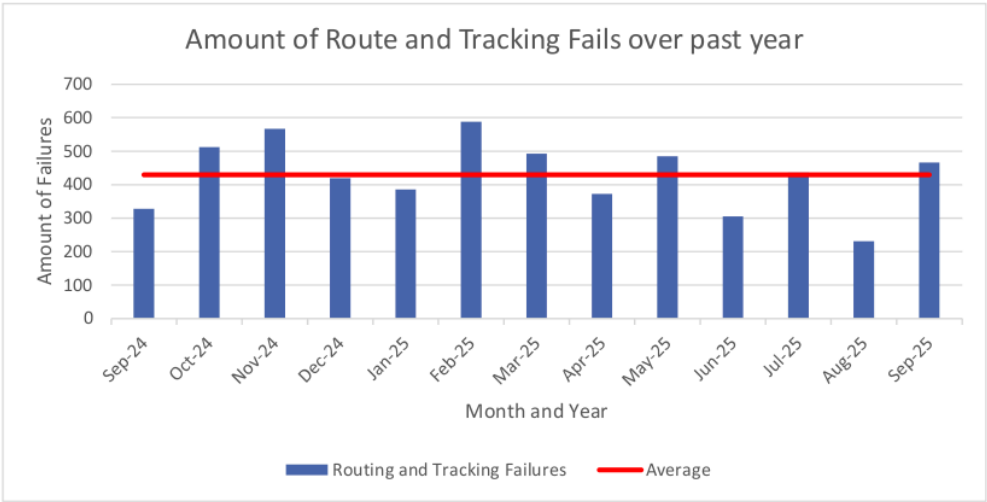


Figure 3 - Graph showing amount of Routing and Tracking Failures over past year

The average amount of R&T failures over the past year has been 430 per month, as shown in Figure 3.

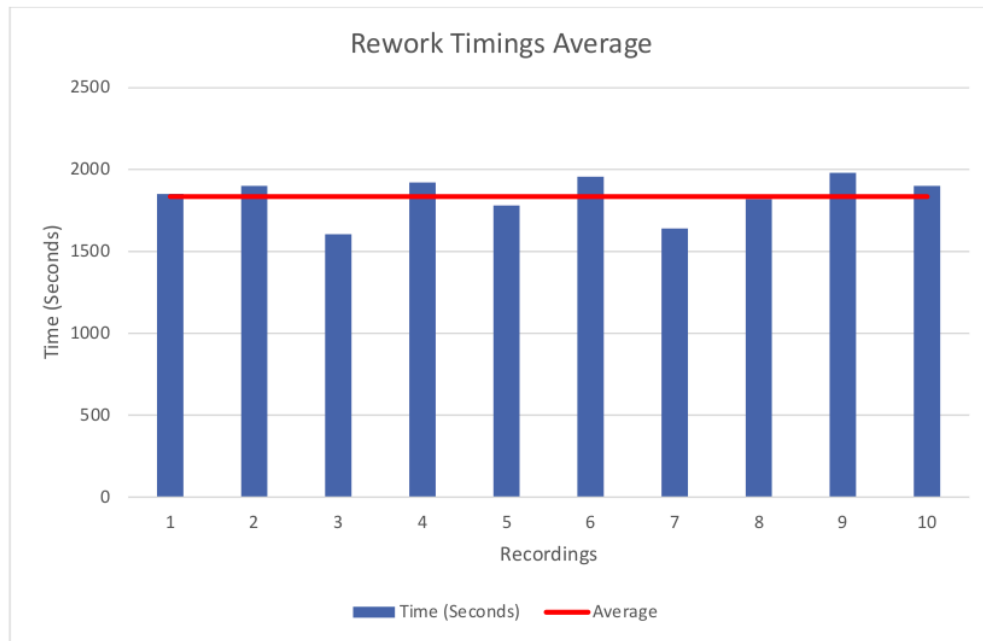


Figure 4 - Rework Timing Recordings and Average

The average amount of time taken to rework each handset is shown in Figure 4 as 1835 seconds or 30 minutes and 35 seconds. CyDen uses a Labour Cost of £15.11 an hour, therefore using the following equations, the total cost saving can be calculated.

$$\frac{1835 \text{ seconds}}{3600} = 0.5097 \text{ hours}$$

$$0.5097 \text{ hours} \times £15.11 = £7.70$$

Therefore, each unit costs £7.70 to rework.

$$0.5097 \times 430 \text{ units} = 219.18 \text{ hours per month}$$

$$£7.70 \times 430 = £3,311.82 \text{ a month}$$

Therefore, each month a total of 219.18 hours is spent reworking handsets and an additional cost of £3,311.82 is spent.

$$219.18 \times 12 = 2,630.16 \text{ hours a year}$$

$$£3,311.82 \times 12 = £39,741.84 \text{ a year}$$

In total, this project has the scope to provide CyDen with an annual cost saving of £39,741.84.

Continuous Improvement

This project also allows for a great continuous improvement opportunity. The current time taken to manually carry out the EOL test is displayed below.

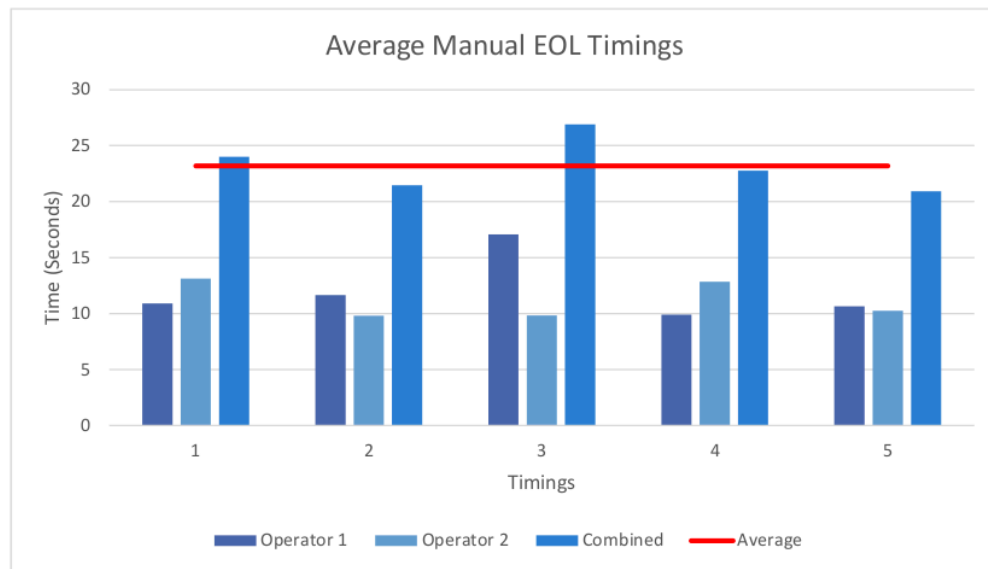


Figure 5 - Manual EOL Timings

Shown in Figure 5 is a graph showing the average time taken to manually carry out the EOL testing on the Autoline. As shown, on average over 5 timings taken, the time taken to carry out the test is 23.2 seconds. By reducing the time taken to carry out this test, it will increase the production volume for the company.

From the recorded timings in Figure 5, the expected volume of devices per hour can be calculated.

$$\frac{3600}{23.2} = 155.17$$

Meaning that the EOL testing can currently complete 155 units per hour. By speeding up this process with an automation system, it will also allow for higher production rates and therefore a reduction in hourly labour costs to meet customer order quantities and increase profit margins.

Project Outcomes

Project Aim

The aim of this project is to successfully design, test, implement and verify an automated EOL test procedure to increase company cost savings and improve overall efficiency of CyDen's Autoline. This project will cover the use of various automation systems and components such as conveyors and PLCs to carry out effective testing on the Victoria 2 Handsets. By implementing this system, the aim is to eliminate any possibility of a handset reaching the packing line with a R&T failure and reduce the EOL testing time to 15 seconds.

Project Objectives

Objective 1 - Analyse the current testing process. Identify bottlenecks, unnecessary manual tasks, and key sources of failures in the EOL test.

Objective 2 – Design an automated testing system. Develop and model an automated EOL test station, refining the layout based on test results and feedback.

Objective 3 – Implement PLC. Program and integrate the PLC to manage conveyors, initiate tests and record data.

Objective 4 – Integrate data monitoring and feedback. Ensure test results and failures are automatically logged to the database for traceability and analysis.

Objective 5 – Test and validate the system. Conduct trials to confirm reliability, repeatability and compliance with CyDens performance requirements.

Objective 6 – Evaluate Efficiency and Cost Benefits. Assess improvements in cycle time, accuracy, and overall cost savings to confirm project success.

Project Design

As the EOL automation will need to be integrated into an already automated process, it will be important to standardise the equipment. Currently at CyDen, Beckhoff PLCs are used to control their processes.



Figure 6 - Beckhoff PLC

Beckhoff PLCs, shown in Figure 6, use TwinCAT software to deliver fast and powerful control. They can also write data directly to SQL databases, ensuring secure storage and easy retrieval during the packing stage. CyDen standardises on the Structured Text programming language, which will be used for this project [10].

The PLC will control all EOL test operations and record relevant data. As each device moves along the conveyor, it will complete a 'Fire-in-Air' test to confirm lamp operation, followed by two power inspections and a serial number scan to ensure full traceability.

Automation will require a standard conveyor for device transport and a Thermopile Optical Power Sensor to measure IPL output [11]. The sensor setup will be adjusted for high and low power modes, triggered by the device's Skin Tone Sensor (STS) readings, ensuring accurate power validation [12].

Planning

To ensure that the project deadlines can be achieved, it is important to break it down into smaller tasks and milestones. Shown below in Figure 7 is a Gantt Chart highlighting the project milestones and tasks.

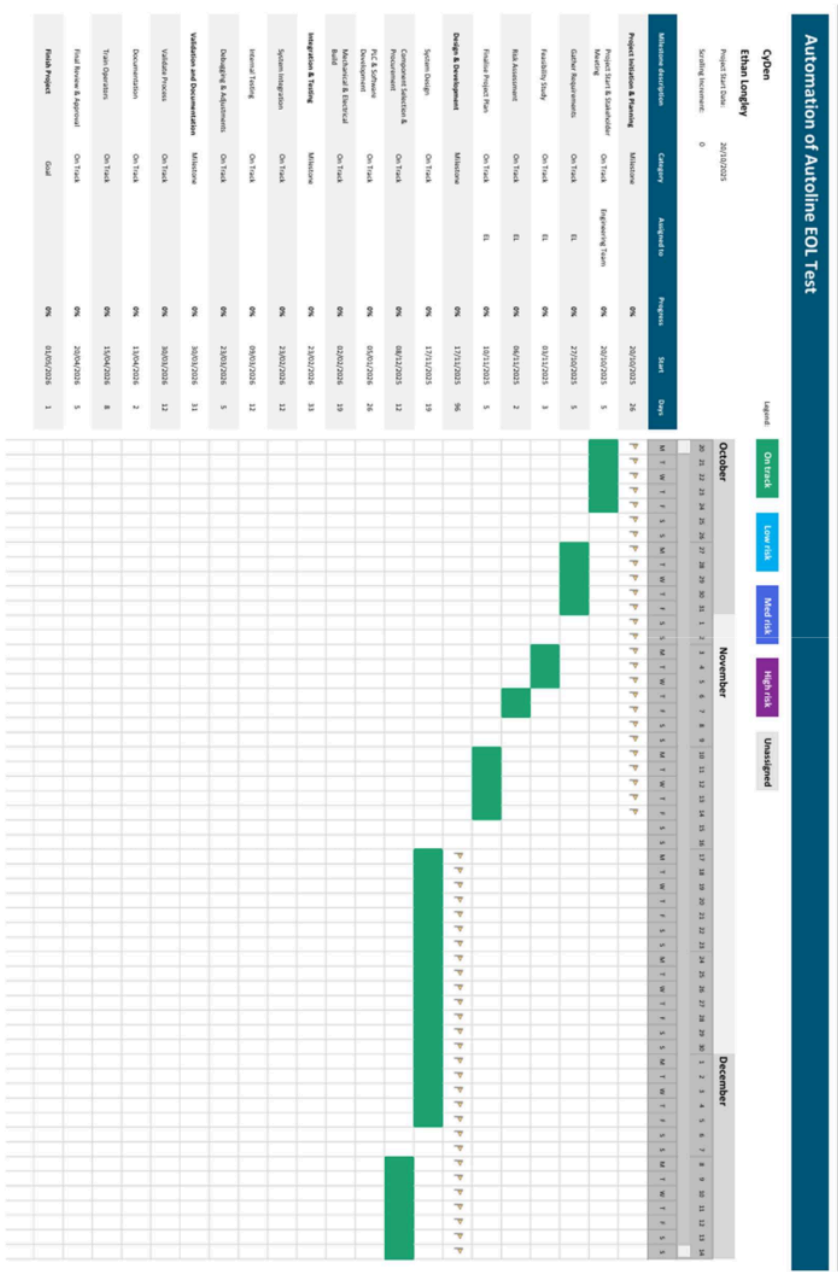


Figure 7 - Autoline EOL Automation Project Gantt Chart

From breaking down the requirements for the EOL Automation project into smaller tasks and Milestones, the planning has been set out to begin on the 20/10/2025 and end on the 01/05/2026.

Using the Gantt Chart, a Critical Path Analysis can be formed to determine which project deadlines will be more critical than the rest.

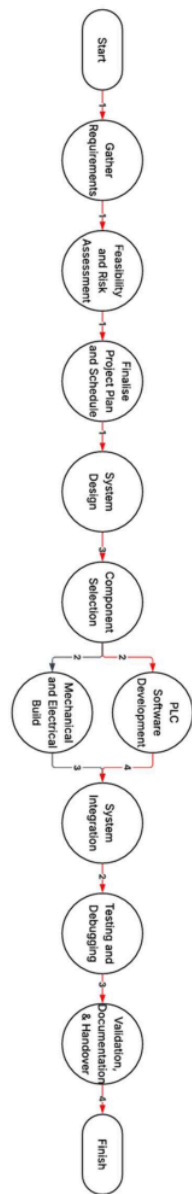


Figure 8 - Autoline EOL Automation Project Critical Path Analysis

Figure 8 shows the critical path analysis for the project. Shown in red is the critical path, the lines indicate the number of weeks required to complete each aspect of the project. It is visible from the critical path analysis that the mechanical and electrical build can be done at the same time as the PLC software development. This will allow for the build aspect to have an additional week if required before it begins to affect the overall deadline of the project.

Project Considerations

Risks

Every project carries risks. The main technical risk is that new components may not integrate correctly with existing systems; using familiar hardware will minimise this. Operationally, installation could interrupt production, causing downtime and supply chain delays. Project management risks include scope creep, where additional stakeholder requests could extend timelines and increase costs. Safety is also critical during electrical installation, requiring strict adherence to lockout procedures and awareness of mechanical hazards such as conveyor pinch points. All safety measures will be identified and communicated before work begins.

Ethics

Ethical considerations focus on operator welfare, data integrity, environmental responsibility, and professional conduct. Operators must have realistic production targets that do not cause overexertion. Data from the EOL tests must remain accurate and traceable to support effective recalls and root cause analysis. All components will be RoHS compliant to protect users and the environment by limiting hazardous substances [13]. Professional conduct requires transparency with stakeholders and accurate documentation throughout validation to ensure the system meets its intended purpose.

Conclusion

To conclude the project proposal, there is currently a £39,741.84 annual discrepancy in CyDens device manufacturing process due to issues with the EOL test which is then noticed later during the packing stage as a R&T failure. To overcome these issues, by automating the EOL test, using Beckhoff PLCs and various other sensing equipment, it will allow for a more reliable process, removing all chance of operator error. With the aim of eliminating any chance of a device getting an R&T failure during the packing stage and reducing the EOL test time to 15 seconds, it will improve the overall efficiency of the manufacturing process. The project will aim to be completed by the 01/05/2026 however this can be completed sooner if following the 22 weeks proposed by the critical path analysis.

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GRADEMARK REPORT

FINAL GRADE

74/100

GENERAL COMMENTS

Introduction / A&O: (15/20 Marks)

The project title and problem identification are good and industry specific. The aim is well defined and directly addresses the identified problem. SMART objectives are relevant, measurable and achievable. Deliverables are mentioned. However, the proposal would be strengthened by briefly defining what project success looks like and outlining how this success will be verified.

Background to the Project / Literature Review: (16/20 Marks)

Good explanation of how the project relates to existing work in manual vs automated soldering and manufacturing automation. Demonstrates knowledge soldering defects, PLCs, and automation systems. Uses an appropriate range of sources, including textbooks and peer-reviewed journals. The literature review is sometimes descriptive rather than critical stronger comparison between sources would improve academic depth. Links between literature findings and your specific industrial case could be more explicit.

Project Design: (21/30 Marks)

The development methods and tools are described well. The description of data collection is good. Appropriate selection of tools such as PLC systems, CAD software, and automated soldering equipment. Strong alignment between objectives and design strategy. However, the section could be improved by describing the data analysis methods more explicitly. It would also have

been better to include a block diagram of the system architecture to enhance clarity.

**Resources /
Planning: (11/15
Marks)**

Listed the tools and deliverables. Good Gantt chart showing when each tasks to be completed. Ethics form completed. It would have been better if the planning section could describe resource dependencies in more detail.

**Document
Presentation: (11/15 Marks)**

The document is well structured and presented. The narrative flows logically, with sections transitioning smoothly from one topic to the next. It would have been better with consistent formatting and spacing. Proofread to find minor errors or inconsistencies.

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