



## Abstract

The ATOM Encoder Lights Out Manufacturing project explores the automation of the manufacturing process for ATOM encoders at Renishaw, a global engineering technology company. The project investigates the implementation of lights-out manufacturing, which enables processes to run 24/7 with minimal human intervention, focusing on two key segments: Index to Body and PCB to Body.

The literature review highlights the benefits and challenges of lights-out manufacturing across various industries. Methodology involves collecting and analysing production data to determine feasibility, with results showing that increased automation could improve efficiency and consistency. The design and implementation section outlines the technical requirements and integration of mechanical and electrical components, emphasizing safety and compliance.

Testing and validation confirm that the lights-out solution meets the desired outcomes, suggesting significant improvements in production efficiency and cost reduction. The study concludes that adopting lights-out manufacturing for ATOM encoders is both feasible and advantageous for Renishaw's manufacturing strategy.

## Background

At the forefront of Renishaw's innovations is the ATOM encoder. This optical encoder delivered in a miniature package gives customers high repeatability and stability throughout their position control applications. Throughout the ATOM manufacturing process, automation is utilised to achieve a high-quality product while minimising production costs. Another objective of using automation in this manufacturing process is to maximise production capabilities. Fully optimising manufacturing operations and extracting the full potential of process automation is key to creating a productive environment.



ATOM Coring Cell. This is a robotics system split into two segments, Index to Body and PCB to Body. The cells are connected via a belt conveyor which transfers trays of parts between the two platforms.

To improve production output developments to the system are required. Automation concepts, such as lights out manufacturing, could potentially be implemented which would help address the issues with material supply to the automated system. This report will investigate the advances in lights out manufacturing within industry and outline the implementation of a solution which utilises the concept. At the forefront of automated systems at Renishaw is the

## Methodology

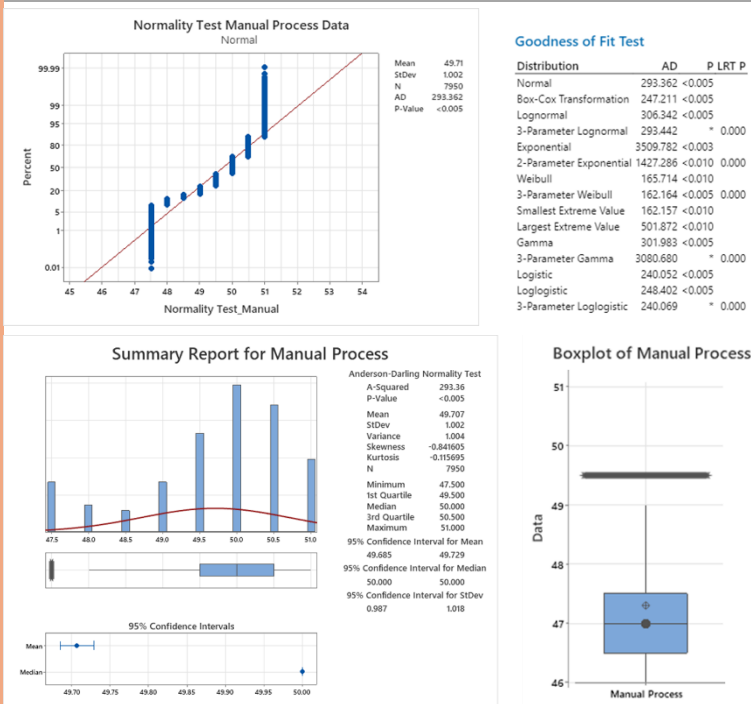
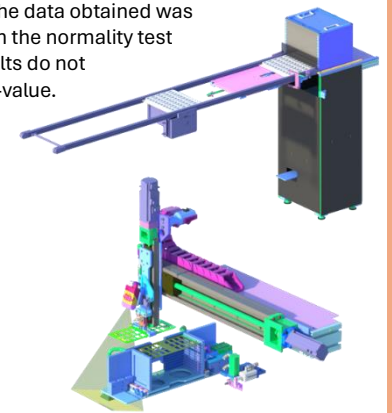
To justify the implementation, production metrics were compared with the expected metrics after a solution had been installed. Common practice for Renishaw's in house manufacturing systems is to record all production data for traceability purposes. Doing so also assists with identifying areas where a manufacturing process can be improved. Utilising the SQL Server Management tool, a simple query was used to manipulate the data and obtain the required information.

The metric which would support the implementation of a lights out running solution is the 'Cycle Time'. This is recorded in seconds, and is rounded to a whole number, which makes it a continuous data type. Conducting a normality test on the data would assist with identifying what kind of distribution the results conform to. Minitab is a statistical software package which can be used for data analysis and is what will be used to analyse the data set.

## Analysis, Results & Discussion

Following the methodology being outlined in the previous section, the data obtained was then analysed utilising the statistical methods mentioned. Based on the normality test performed on the data collected, it can be determined that the results do not conform to a normal distribution. This is due to the extremely low p-value. Consequently, non-parametric tests that do not assume normality should be employed since they are equipped to deal with normality deviations. Performing a Goodness of Fit Test on the data also supports the conclusion that the data conforms to a non-normal distribution, therefore we reject the null hypothesis.

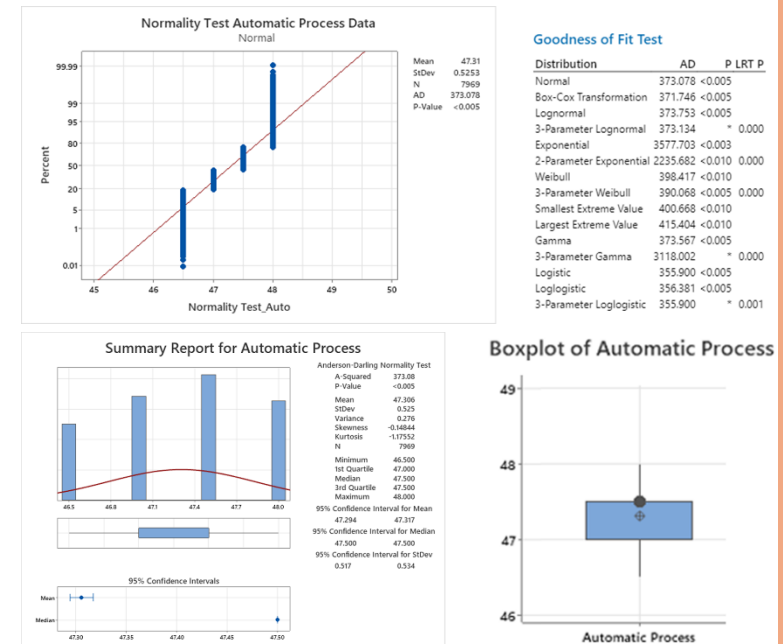
The histogram displayed in the analysis shows a skewed distribution, hence the p-value being non-normal. A more prominent bell curve would suggest a normal distribution however, this is not the case. There are multiple factors which potentially cause the distribution to be skewed, ultimately this is caused by the increased cycle time for many of the units manufactured.



Based on the Requirements Specification the following solution was implemented, which enables the automatic loading of PCBs and unloading of completed part trays. The same statistical analysis tools were utilised to assess the effectiveness of the systems post introduction into the production environment.

After conducting a normality test on the data captured post implementation of the lights-out running system, the results still did not conform to a normal distribution. Even though this was the case, it was clear that there was less variation in the results, compared to before the system was introduced. This is supported by the Goodness of Fit Test, performed on the lights-out production data.

The Box and Whisker Plot, using the data captured following the implementation of the lights-out system shows that tighter cycle times have been achieved with the implementation of the lights-out running, along with the elimination of outliers identified in the original analysis. It was determined originally that the cause of the outliers in the Box and Whisker Plot were increased cycle times due to slow panel changes by operators. With the removal of this process, the outliers have also been eliminated.



## Conclusions

After thorough analysis and implementation, it was determined that the introduction of a lights-out manufacturing solution to the ATOM Encoder Coring process significantly improved production efficiency.

The automation of PCB loading, and tray unloading has reduced the need for manual intervention, resulting in more consistent cycle times. This consistency in cycle times has minimised the variability in production, leading to higher throughput and reduced production costs. By implementing lights-out manufacturing, labour costs have been reduced due to decreased dependency on operators for routine tasks.

## Future Recommendations

Further Automation could ensure that materials are fed into the system without manual handling. This could include automated guided vehicles (AGVs) or conveyor systems that deliver materials directly to the production cells. Implementing a robust monitoring system to track the performance of the automated processes in real-time can help identify any bottlenecks or issues promptly. This would also be a useful tool for Production Engineering personnel.

Ensure that operators and maintenance personnel are thoroughly trained on the new automated systems to handle any issues efficiently. Regular maintenance schedules should be established to keep the equipment in optimal condition, preventing unexpected downtimes.

## References

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