

## **Industry 4.0**

### **Assessment 1 – Written Report**

# **Automated Inflation and Sealing – Manual to Automated Process Technical Report**

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## Abstract

This report focuses on the fabrication of the Repose® Lite Cushion and specifically, the inflation and sealing process that is required to finish the product. The current manual process has been identified as a process that can be improved with ideologies of industry 4.0. The report highlights research which focuses on SMEs "Small and mid-size enterprises" and the barriers that prevents them for considering industry 4.0 techniques. The report also provides an outline of feasible recommendation on how SMEs can still consider such industry 4.0 ideologies without the need for changing their whole manufacturing systems.

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# 1 Introduction

The Repose® Lite Cushion is a unique reactive air, single cell, pre-inflated pressure relieving, and redistribution cushion indicated for the treatment of all categories of pressure ulcers (Frontier Medical Group, 2021). Developed as a pre-filled product, the internal development team at Frontier Medical ensured that existing manufacturing competencies were considered to manufacture the device internally (See Figure 1). With Frontier Medical's key competencies in welding, existing processes of using RF platen high frequency welder are currently used as the main manufacturing method to fabricate the product.



*Figure 1 Repose® Lite Cushion*

The most critical manufacturing process of the device is the requirement of inflating the product to a certain pre-filled pressure and sealing the air inside the product. The current process of inflating the device with air is currently performed manually using an automatic inflator machine and using an RF welder to seal the air inside the device. The inflation process for the product as well as the accuracy of the pressure required to be pre-filled on the device is the most critical requirement as the combination of the material and air pressure is what enables the device to perform clinically.

## 1.1 Purpose of the Report

The purpose of this report is to provide an efficient process solution to mitigate the current manual processes of inflating and sealing the Repose® Lite Cushion. The solution will focus on integrating industry 4.0 processes and ideologies to mitigate the current manual process of inflating the pre-filled device. The report explores:

- i. Current inefficiencies of the existing inflation and sealing processes
- ii. Identification of industry 4.0 ideologies that can improve the efficiency of the process

## 2 Aims & Objectives

### 2.1 Study Objectives

The objective of this report is to identify and propose an automated method of inflation and sealing which considers industry 4.0 ideologies, improves efficiency and throughput, and provides a solution to replace the current manual process currently in place for the fabrication of the device.

### 3 Implementation Methodology

Existing development activities surrounding the improvement of the inflation and sealing process for the Repose® Lite Cushion are underway due to the need of transitioning the method from a manual to an automated process. The existing process of inflation and sealing consist of a two-step process where an un-inflated product is inflated using an inflator machine which is connected to a mains air line: firstly, the machine is programmed to inflate the required internal pressure to the product (Step 1) (See Figure 2), and secondly, the inflated product is then sealed using an RF welder which is initiated manually as soon as the inflation method is completed (Step 2) (See Figure 2).



*Figure 2 Existing Inflation and Sealing Process*

Integrating both IoT and automation techniques as part of industry 4.0. The proposed solution incorporates a controller unit HMI "Human Interface" and a PLC "Programmable Logic Controller" programmed to control the sensors "Mass Flow Inflators", and "Pressure Transducers" which combined to inflate the product and to gather key dataset providing the company key manufacturing information (See Figure 3) that can track and assess inflation accuracies, production LOT "Finished Goods Batch Numbers" and manufacturing dates as top level data collection requirements (See Figure 4).

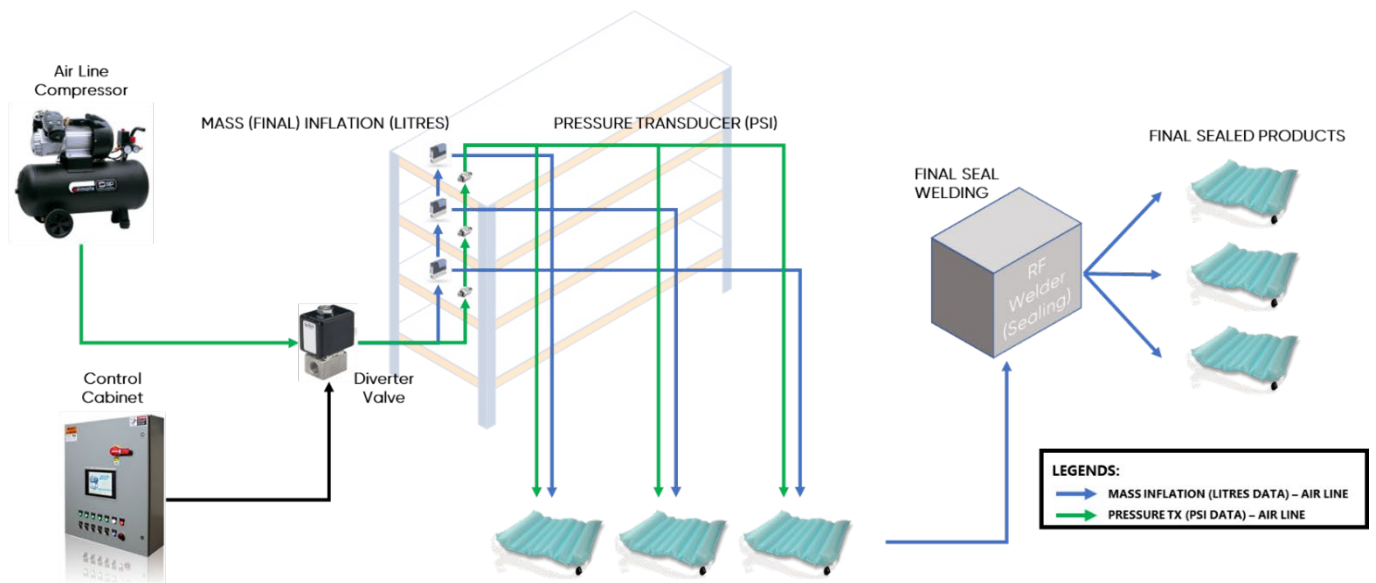


Figure 3 Automated Inflation and Sealing Setup

Such data collection is required to provide the benefits of being able to trace the product's fabrication process and capturing key machine, and environment data that can identify reasons behind defected products and returns (See Figure 4).

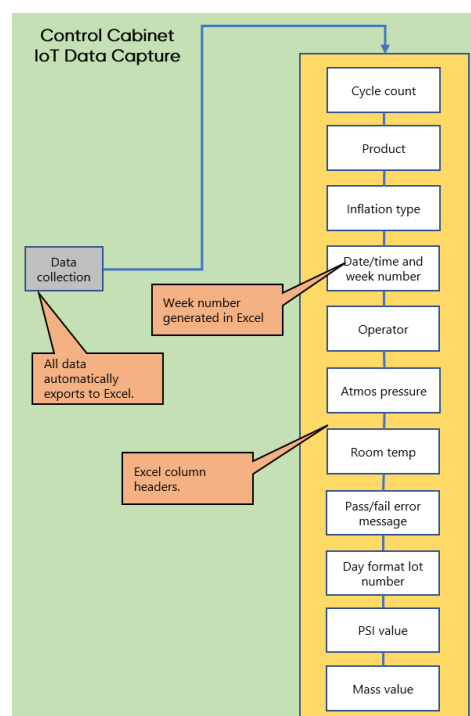


Figure 4 Control Cabinet IoT Data Capture

Process automation of the inflation and sealing of the device will require gantry welders to be sourced and controlled by the PLC cabinet at the point of initiating the system to start its process. The proposed solution also includes a three-system setup which requires three of each sensor to be installed and controlled by the control cabinet. Each of the sensors will capture and provide data which will be easily accessible and traceable. Systems such as a light indicator will also be required to provide an indication to the cell workers to identify successful initiation of the process, and if one sensor fails during the procedure.

## 4 Background Research

Industry 4.0 provides benefits to an organization when executed as part of a company's aim of implementing automation, and IoT considerations within their manufacturing processes (Contrino, et al., 2020). Such application of industry 4.0 ideologies can provide cost reductions, improvements in product quality, more efficient manufacturing processes, fabrication flexibilities, and competitive advantages within their manufacturing competencies (Masood & Sonntag, 2020). SMEs like Frontier Medical Group have no prior experiences or knowledge within industry 4.0 techniques which makes it difficult to consider and adopt as part of their manufacturing processes (Masood & Sonntag, 2020). Contrino, et al., 2020 justifies that SMEs have been facing tremendous challenges from the emerging industry 4.0 technologies and their applications due to the pace in which technologies are constantly developing.

Barriers that inhibit Frontier Medical Group to adopt industry 4.0 practices coincides with (Masood & Sonntag, 2020) findings on SMEs challenges with adopting industry 4.0 techniques. These include:

- 1) Frontier Medicals size as a company as well as product turnover may not provide a clear benefit to the implementation of automative manufacturing techniques.
- 2) The company's attitude towards industry 4.0 techniques affects the benefits of such technology and processes.
- 3) The size of the company can provide doubts on whether implementation of such practices is even beneficial.
- 4) Manufacturing complexities that may arise with such industry 4.0 techniques can provide challenges in adopting new processes outside of existing machine competencies.

Industry 4.0 methodologies within intelligent manufacturing processes provides improvement within manufacturing workstations which focuses on efficiencies within the cell worker's interaction with such machinery (Golan, et al., 2020) which ties in with the proposal of improving the inflation and sealing process of the Repose® Lite Cushion. Smart HMI's and

PLC's can allow operators to choose the correct settings to run on the machinery, capture key data such as production LOT, manufacturing dates, internal pressure of each product LOTs, and the environment ambient temperature. A compilation of such data provides detailed information which can support quality assurance on the manufacture device and be able to trace any discrepancies, and errors via smart computerised systems which integrates information from various sources, utilising the capabilities of IoT (Golan, et al., 2020).

Another factor for consideration is the increase in productivity that automation can provide a particular manufacturing process. Automation aims to remove, where possible, any human interaction from such production processes (Gildchrist, 2016), which in turn allows for system controllers, and machinery to process and action such tasks. An advantage that automation can provide the existing inflation and sealing process of the Repose® Lite Cushion is the increase in product throughput which can enable double the quantity of products produced, making the process more efficient to run.

Lepasepp & Hurest, 2021 alluded that a significant advantage of smart manufacturing is the level of transparency it introduces to a process, the benefits of developing such techniques as part of industry 4.0 can provide absolute customisation of products to constantly improve their performance as well as manufacturing feasibilities and being able to create new operating models which can increase productivity and throughputs (Schwab, 2016).

## 5 Conclusion

The benefits of implementing industry 4.0 ideologies can provide advantages to companies and organisations willing to adapt to such manufacturing technological advancements. The proposed mitigation and solution highlighted in this report can provide huge benefits within the current process of inflating and sealing processes of the Repose® Lite Cushion. Implementing such system and developing automated manufacturing cells when executed correctly can lead to increased production efficiency and improved traceability of products.

This report has further indicated that simple system improvements within manufacturing cell is still possible to consider especially within SMEs. There is no need to completely overhaul an existing manufacturing facility to fully consider industry 4.0 methodologies – focused improvements on certain cells can still provide benefits and improve proficiencies within product manufacturing.

## 6 Recommendation

Based on the above, it is recommended to consider the proposal illustrated in Figure 3 due to the improvement that the new system can bring. The current manual process currently in place is very inefficient and time consuming to conduct. Thereby the proposed system can mitigate such manual process by overriding the existing process to provide an automated system that can be controlled by a cell worker which can be initiated at the start of each shift. As previously mentioned, the research conducted in this report all cited the fact that SMEs are behind with considering industry 4.0 ideologies due to knowledge gaps and cost of such systems. The recommendation from this report addresses that implementing industry ideologies within SMEs is achievable by focusing on one cell to begin with and see its improvements within efficiencies and throughputs.

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