Optimization and Automation of Visual Inspection of an Injection Molded Part in Jabil Healthcare

Glorimaris Collazo Acevedo
Master in Engineering Management
Héctor J. Cruzado, PhD, PE
Graduate School
Polytechnic University of Puerto Rico

Abstract *— In Jabil Healthcare an injection molded part requires a 100% inspection at 10X of magnification to comply with the visual criteria of no embedded particles and contamination. Jabil's current process uses two operators to comply with the requirement. This process is impacting Jabil since it has high operational costs and is entirely dependent on people. Two options were technically and financially compared to verify effectiveness and compliance in the product quality. The approved option guarantees a reduction of cost per unit from $0.1198 to $0.1103 after covering the amortization cost after three years. The selection option provides a reduction of cost of $38,000 per year in savings which is equivalent of 8% of savings per year after covering the amortization costs.*

Key Terms *— Cost Reduction, Plastic Components, Product Quality, Visual Inspection*

INTRODUCTION

Jabil Healthcare Puerto Rico provides manufacturing solutions to a wide range of healthcare customers around the world since 1973. One of the biggest assets of the company is the expertise of injection molding capabilities. Injection molding is one of the most often used processes for creating plastic parts. It can be defined as the action of shaping plastic material into a certain shape based on customer requirements.

A product in Jabil has as a specification of an injection molded part that requires performing a 100% inspection at magnification of 10X to comply with the visual criteria of no embedded particles and contamination. This product is considered a critical one since it's one subcomponent of a preloaded delivery system for ocular surgeries. The product has been manufactured in Jabil and the 100% inspection has been performed by two operators using a microscope to comply with the 10X magnification requirement. This process is impacting Jabil since it has high operational costs and its completely human dependent.

To guarantee the best customer service, which is one of the major goals of Jabil Healthcare, optimization and automation of the visual inspection process was required. To ensure the effectiveness of this new process in Jabil, it needed to comply to be a cost-effective vision system and to ensure that it complies with the requirements and quality attributes as per the customer specification. The benefits of automated vision inspection process are that:

- It will mean minimum operator intervention, since its will be dependent vision system.
- It will guarantee lower operational costs, since the operation will lower the operators used to one operator.
- It will increase the operational output since it will lower the scrap and customer complaints.

LITERATURE REVIEW

Quality is understood as meeting the customer requirements and productivity is defined as creating production with the optimal quantity of resources [1]-[2]. Quality and productivity are two very important things in any manufacturing process including the injection molding process [3]. Injection molding is a technique for the mass production of plastic components with advantages of low cost, high efficiency, and versatility [1].

Attributes of injection molded parts are an important feature of the product since it is the basis for customer decision on the product quality and functionality [4]. An essential step in the injection

molding process is quality inspection, which is the most common and conventional quality control [5]. Quality control is crucial in the injection molding process and the main purpose is to have a high yield and low production costs [6].

To reduce and eliminate non-value added time, an effective quality inspection tool and automation of processes must be used. The demanded increase in productivity with improve quality of the products has let to innovations and these innovations has transformed traditional manufacturing to advanced manufacturing [7]. With a short time of return of investment, the benefit of automation to comply with quality and productivity will multiply the benefit of automation which will result in more competitiveness on the market, due the decrease of production cost and minimizing human dependency [8].

When an operator manually performs a quality inspection in the manufacturing process, their eyes become fatigued with time and a sustainable quality control cannot be maintained [9]. Conventional methods rely on the operator's expertise and defect detection techniques are ineffective in reducing defects [10]. With the development of a vision technology system, many manufacturing companies use this technique to identify product defects in real life due to the advantages of high accuracy, low cost, and non-destructive testing [9]. The key components of a development of a vision system machine are illumination, camera, cost, enhancement, and recognition to detect defects on plastic components [11]. An automated inspection system reduces the labor cost and time, which increases the detection accuracy of the injection molded part defect [12]. A vision system defect inspection is the solution to the manual inspection because machine vision significantly improves the efficiency, quality, and reliability of defect detection [13].

METHODOLOGY

To comply with the customer requirements, the Plan-Do-Check-Act (PDCA) methodology was followed. An opportunity was found on the visual inspections of the Jabil Healthcare product to comply with the customer requirement of performing 100% inspection of the parts produced. A plan was generated to comply with the customer requirement, assuring a cost reduction and effectiveness of the visual inspection. Figure 1 shows the planned timeline created following the PDCA methodology that was followed to comply with the purpose stated previously.

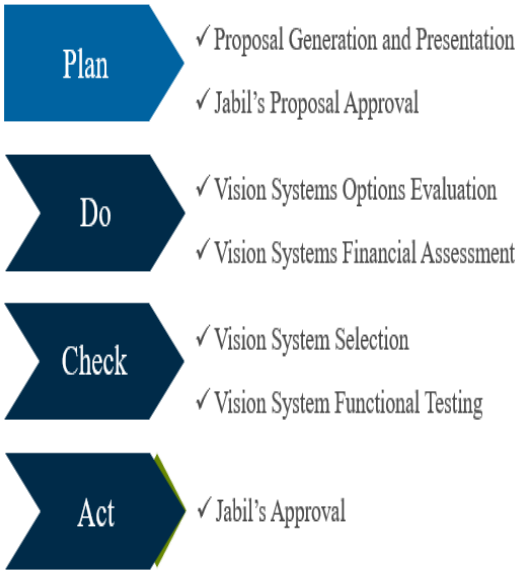

Figure 1
PDCA Methodology

Two options were proposed to be evaluated to see which one complied with the User Requirement Specification (URS) provided by the customer. The URS stated that the automated equipment shall execute the visual inspection and palletize the part with minimum operator involvement, except for loading the empty trays and unloading the full stacks of trays.

Two vision systems were compared to select the optimum choice to comply with the requirements provided by the customer. Table 1 presents the two vision systems, comparing their manufacturing cost, functional capabilities and operator that are required in each one of the options.

Table 1
Vision System Proposal Options

Description	Option A	Option B
Manufacturing Equipment Cost	$218,312	$423,044
Functional Capabilities	Load Trays with Plastic Components	Load Trays with Plastic Components
	Sampled Vision System	100% Vision System
Operators Required	2	1

Option B was the only option that complied with the URS provided by the customer since it provides a 100% inspection. However, to verify if it complies with the Jabil Healthcare scope of the cost reduction objective, a financial assessment and evaluation was performed.

RESULTS

Based on the comparison, the optimal choice needs to be one that complies with the URS, guarantees a cost reduction to Jabil and be a reliable decision to avoid customer complaints and mitigate high scrap. Table 2 shows the amortization cost and expected new cost and prices per each option if selected based on an annual demand of the product of 4,000,000 units, unit cost per 1,000 parts of $0.1198 and unit price per unit per 1,000 parts of $0.1294.

Table 2
Amortization Costs and Prices

Description	Option A	Option B
Manufacturing Equipment Cost	$218,312	$423,044
Demand of three (3) years	12,000,000 units	12,000,000 units
Amortization Cost	$0.0200	$0.0400
New Unit Cost / 1,000 units (3 years)	$0.1398	$1503
New Unit Cost / 1,000 units (3 years)	$0.1510	$0.1623

After performing the financial assessment, Option B was the only option that guaranteed Jabil's and the customer's needs. Figure 1 shows Option A, Option B and No Automation comparison with the unit cost covering the amortization of the equipment costs and the new cost per unit after covering these amortization costs. Only Option B guarantees a reduction of cost per unit from $0.1198 to $0.1103 after covering the amortization of the equipment cost after three years. These cost reductions are triggered due to labor cost since Option B only required one operator, a difference of the current process which requires two operators. Since Option B was the more feasible option of this project, the next step was to proceed with the functional testing to challenge the options and confirm the investment.

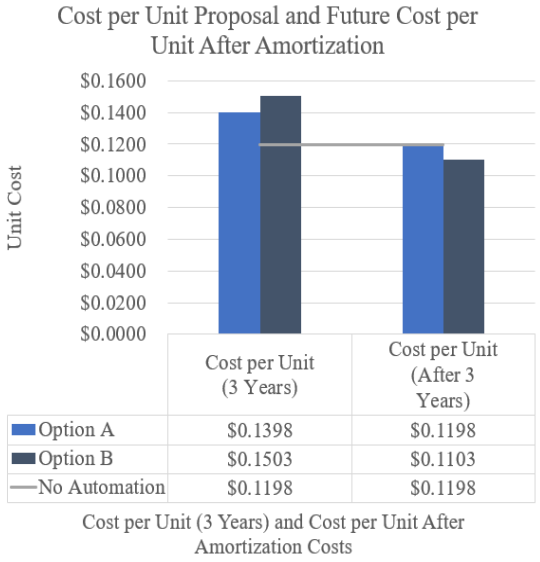

Figure 1
Cost per Unit Proposal and Future Cost per Unit After Amortization

As part of the functionality test, Option B could perform the operation with one operator with the only intervention of the operator to feed the machine with trays and unloading full trays with the plastic component already inspected. To verify if the system could detect the defects of contamination and embedded particles, an attribute agreement analysis was performed with acceptable results in the manufacturer. Finally, the Overall Equipment Efficiency (OEE) was calculated for a performance run of four hours with the results of

85% and a yield of 95% which was considered acceptable for the Jabil Team to officially proceed with Option B.

CONCLUSIONS

Three years after the implementation of the approved vision system Jabil Healthcare will guarantee the expected cost effectiveness. As an immediate benefit Jabil will have the advantage of producing a high-quality product with minimum operator intervention. The selected option provides a reduction of cost of $38,000 per year in savings. Comparing these savings with the cost of manufacturing without automatization, the improvement will provide an equivalent of 8% of savings per year. Option B provides Jabil customer satisfaction and a high-quality product in the injection molding capabilities. After the optimization, Jabil could offer the customer capacity of producing more components in compliance due to the benefits of automation.

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