

Vision Assisted Laser Marking Delivers Lean Manufacturing

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ABSTRACT

To achieve permanent, high quality, non-contact marking, automotive manufacturers use laser marking processes. But, the ability to accurately position small characters in a limited space, to recognize the proper parts before being marked, and the capability to repeatedly mark in a robust way without operator's adjustments still create challenges for those who attempt to achieve lean manufacturing.

Described in this paper is a high-speed vision based laser system capable of rapidly and accurately marking a large number of automotive parts of different shapes in a single pass. The vision based laser system has shown, that in a production environment, a reduction of waste, an increase in product throughput, and an improvement in the overall manufacturing cost can be achieved.

INTRODUCTION

In the arena of automotive control clusters, manufacturers using laser marketing technology, quickly realize that laser technology does what it is supposed to do and only what it is supposed to do. Laser marking systems are highly repeatable marking devices. They are very flexible at making complex graphics but lack the intelligence to handle production line variations associated with human errors or the physical placement of components before being marked [9].

To overcome operator errors, line process deviations or uncontrolled physical product variations, manufacturers rely on complex and accurate mechanical fixtures to achieve repeatable part placement. These fixtures provide means of significantly reducing errors during operation but are expensive and require significant setup time to align the part to the optical beam of the laser.

Unfortunately, with automotive manufacturers evolving toward higher acceptance standards and the push for lean manufacturing, suppliers are faced with delivering better products within tighter time constraints. As a result, suppliers are looking for new approaches to build and deliver more complex products within a shorter time frame [7, 10].

This paper explains, from a system design perspective, the cause and effect relationships between machine design and cost of production. It explains why current manufacturing processes cause plants to evolve into mass production systems and illustrate how technology based on vision has transformed these same processes into lean manufacturing practices.

MANUFACTURING CHALLENGES

Auto manufacturers have been outsourcing more of the added value vehicle components to their suppliers. They are looking for suppliers to produce not only components, but also complete systems such as radio and A/C control clusters which can be supplied directly to the assembly line.

Although suppliers are continually looking for business growth, they face the challenge to deliver a lower cost product within shorter cycle times and meet constantly increasing product performance. To meet automotive manufacturer's requirements, suppliers are then under pressure to set up production processes that allow them to rapidly and smoothly deliver products on schedule, and at the same time, cut costs without compromising on quality.



Figure 1: Types of parts marked using lasers

PRODUCTION PROCESS FOR LASER MARKING

Manufacturers of automotive control clusters that use lasers markers in their production processes, follow the following phases:

- A setup phase
- A production phase
- An inspection phase

Custom tooling

To meet the product technical specifications, component or system manufacturers use custom designed tooling that handles a unique component. The tooling holds only a few components placed in a specific orientation. The hardware is designed to a tight tolerance to minimize operator's errors and to ensure mark placement repeatability.

To guaranty continuous production, manufacturers keep these fixtures in close control and are monitored for tolerance periodically by the in-house QC group. It is common for manufacturers to have at least one extra fixture sitting in inventory in case the unit is damaged during production.

The cost of tooling per component may not be significant, but considering the number of fixtures necessary for all parts being produced, the cost quickly adds up. A product can have as many as 20 different components, each one requiring a unique fixture. In all cases, suppliers have to design new tooling for every new product. A breakdown of the cost is presented in table 1.

Processes	Accurate Tooling Per Part	
	Hours	Cost *
Design	60	\$6,000
Machining & Assembly	40	\$4,000
QC Inspection of tooling	16	\$1,600
Setup time	18	\$1,800
Total	134	\$13,400

*Based on a rate of \$100/hour

Table 1: Cost of tooling

Setup phase

The purpose of this step is to configure the laser marking equipment so the graphics align correctly on the part to meet the customer's specifications. This process is executed each time a different or an existing component is ready for production.

The operator marks a few components on the machine and, with the support of the Quality Control team, he tunes the machine parameters so markings meet the product specifications. The process, which requires metrology equipment, is generally repeated several times until the marking equipment is finely tuned (see figure 2). This procedure is time consuming, requires

human resources with specific expertise and halts production until the equipment is tuned.

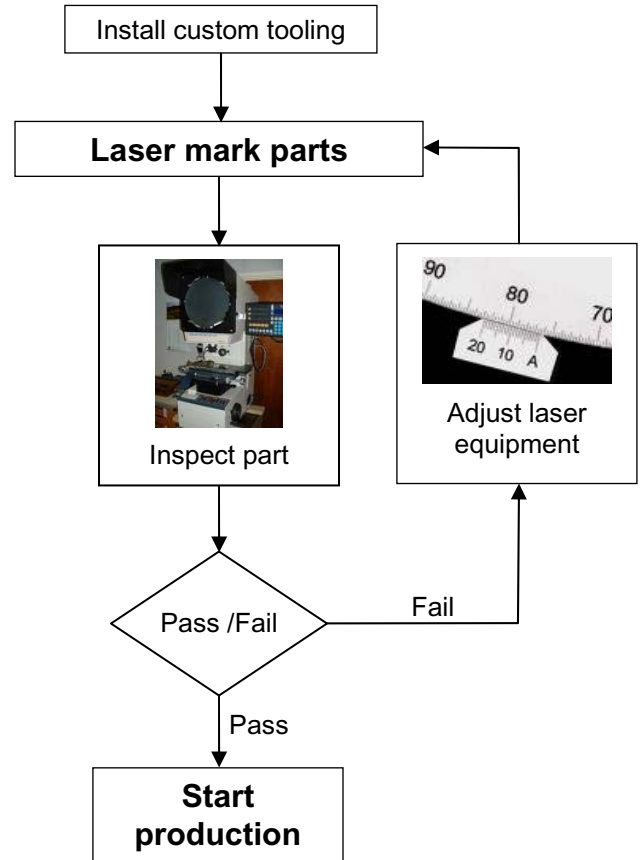


Figure 2: Typical setup procedure

Cost and mass production model

Traditionally the cost of production includes the cost of material, the setup cost, including tooling and setup, labor cost and the standard overhead cost. As presented below, the unit cost which is a measure of performance of a production line is calculated as:

$$Uc = (Mc + Sc + Oc + DLc) / N$$

Mc: Material cost

Sc: Setup cost

Oc: Overhead cost

DLc: Direct labor cost

N: Number of parts produce.

Because of the high cost associated with custom tooling and the resources required to set the production process, today's manufacturers are driven to produce a large number (N) of parts to bring the unit cost down. Mass manufacturing has been dictated by the approach taken to meet the customer's requirement and to optimize the return on investment.

