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THE EFFECTS OF A POSITIONING PALLET REDESIGN ON THE QUALITY AND PRODUCTION PROBLEMS OF A MANUFACTURING CELL

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THESIS

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ABSTRACT

The purpose of this thesis was to determine the cause of the quality and production problems that Delphi Packard Electric Systems was having with its Resistor Relay Module (RRM). The RRM had a total reject rate of 32%, half of which came from solder defects. It was discovered that the soldering defects were caused by the pallets used to place the parts in the soldering robots. The problem with the pallets was their inability to accurately position the part in the robot's workspace. The pallet was redesigned such that the number of parts were reduced and a linear thruster was utilized for the purpose of positioning the part precisely and consistently in the same coordinates. Changes in the product itself allowed for the use of three robots instead of seven and reduced the total time required to solder each part from 250 to 50 seconds. The RRM was observed for several months after the design changes were implemented and all the production data was recorded. The total reject rate was reduced to 12% and the total scrap rate was reduced from 19% to 8%. The most significant change was in the solder rejects which was reduced from 16% to 4%.

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Chapter 1

INTRODUCTION

1.1 Overview of the Problems with the RRM

There are three factors that will determine a company's success: quality, the relation of product value to price, and the making of the product to meet the consumer's needs [1]. This has never been more true than in today's era of global markets and economies. Manufacturers strive to make a product of low cost, high quality, and often in high volumes. With quality and production being so intertwined, having a problem with quality will affect the total production rate. More importantly, the cost of the product will increase and cause a drop in sales.

Delphi Packard Electric Systems' Resistor Relay Module (RRM) is produced in a manufacturing cell with some production and quality problems. The main problem with the quality of the Resistor Relay was due to defective soldering of the components onto the ceramic board. The manufacturing cell was producing a total of 32% rejects. Half of the defects, 16%, occurred in the soldering operation where bridges, missing and excess solder required that the part be reworked or scrapped. After a study of the soldering process was conducted, it was determined that the soldering

defects were caused by the pallets used to position the part in the soldering robots.

1.2 Why Fix Quality and Production Problems

Automotive Power and Signal Distribution Systems (PASDS) or wiring harnesses is a big industry with sales in the billions of dollars. With advances in technology, automobiles are becoming more high-tech and require more electrical components. Delphi Packard Electric Systems (Delphi-P) supplied wiring sets for 12.7 million vehicles in 1995 alone. Delphi-P is the top manufacturer of PASDS in the world and has the largest market share of 25.1%. Improving the quality of the Resistor Relay can increase that percentage since quality is one factor that drives market share. With superior quality and a large market share, profitability is virtually guaranteed [1,4].

1.3 Background on the RRM

The RRM is a control module for the fan speed in a Heating, Ventilation, Air Conditioning (HVAC) system. The original control module consisted of wound metal coils that acted as resistors to control the fan speeds. The old module is shown in Figure 1.1. The figure does not include

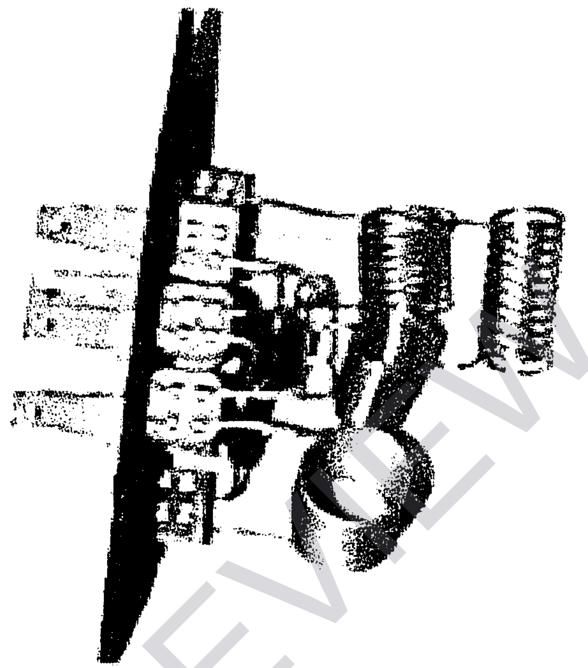

Figure 1.1 Original Control Module

the relay that switched between resistances. What made this design difficult was that the connections to the relay terminals and the blower motor still had to be soldered to the module. There were safety concerns with the module, mainly that it had no thermal fuses and soldering the

connections was difficult. This design had remained unchanged for nearly 50 years before Delphi-P introduced an updated module. The updated module consists of a ceramic board with resistor traces, a relay, a jumper assembly, and housing. The cell that produces the RRM has been in operation for nearly two years at the Rio Bravo Electricos X-A plant in Cd. Juarez, Mexico. The Resistor Relay was produced in a U-shaped manufacturing cell consisting of 17 stations. The engineering work is done in conjunction with two groups, one at the headquarters in Warren, Ohio, and the other at the plant site.

1.4 Objectives of the Thesis

The objectives of this thesis are the following:

1. To improve the overall quality of the Resistor Relay Module manufactured by Delphi-P. The improvement in quality means the reduction of the total solder defects, the total scrap produced, and the need for rework.

2. To redesign the pallet used in the soldering operation of the RRM. The new pallet will allow for a more precise positioning of the ceramic board in the soldering robot's

workspace. This critical improvement will allow the quality requirement of 1-2% total rejects to be more attainable.

3. To increase the production rate of the manufacturing cell. The improvement in quality will automatically increase the production. Changes in the product itself eliminates the need for certain stations, thus reducing the total time required to produce each part.

4. To reuse as much of the existing material as possible to reduce the costs of these changes to the manufacturing cell. A great effort was made to utilize the high cost nest material that was used in the old pallets. Some machines used in the cell were modified to adjust to the changes that were made to the pallet, but no entirely new machines were added.

1.5 Scope of the Thesis

The scope of this thesis is to describe the improvements made to the manufacturing cell. It begins with a description of the old Resistor Relay Module, the layout of the old process, and the old pallet. Then it describes the changes made to the RRM, the layout, and most

importantly, the pallet. The thesis ends with the results, conclusions, and recommendations.

Chapter 2

DESCRIPTION OF THE PRODUCT

2.1 Introduction

This chapter will describe the Relay Resistor Module manufactured by Delphi-P. The module is comprised of a ceramic board, solder traces, a relay, a jumper assembly, a connector with a TPA, terminals, and a housing (See Figure 2.1). Each component will be discussed briefly.

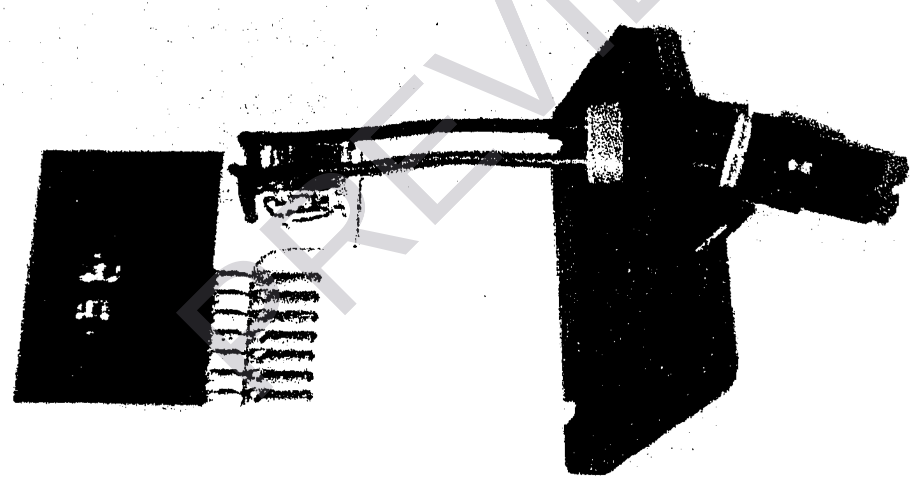

Figure 2.1 An Unassembled Relay Resistor Module

2.2 Components of the RRM

The jumper assembly consists of two wire cables which lead to the ceramic board on one end and have a connector on the other end. The connector interfaces with the blower motor and the TPA aids in locking the connector. The plastic injection molded housing contains the relay and part of the ceramic board, wire cables, and terminals (when assembled). The housing provides a way for the RRM to connect to the main wiring harness. Two seals, a gasket and Mastic putty, protect the RRM from any humidity that may be present in an automobile engine compartment.

The main component of the RRM is the ceramic board (See Figure 2.2). The ceramic board contains solder pads on its surface that connect the different electrical components together. Thick solder traces were added to these pads to help carry the large currents that pass through the circuitry. A black protective overcoat covered the different resistor traces needed to control the different fan speeds. A relay is used to allow switching between these speeds. The terminals on the ceramic board are used for connecting the main wiring harness to the RRM. Six or seven terminals are used depending on the product number. The wire cables, the relay, the terminals, and the circuits connecting these components were all soldered by the robots.

Figure 2.2 Ceramic Board With the Old Solder Traces

2.3 Problems with the RRM

There were two major problems with the product. The first was the number of points that required soldering on the ceramic board. Each RRM required 31 points to be soldered. The terminals required 12 to 14 solder points, depending on the part number. A set of four points resulted in a thick solder trace that ran along most of the width of the ceramic board. It was discovered that the thick trace was creating a microcrack in the ceramic. The crack followed the path of the thick trace and could eventually

propagate and break the electric circuit. The second problem was the function of the housing. The housing did not hold the ceramic board securely within its cavity. A thermoset glue was added in between the ceramic and housing to compensate.

Chapter 3

DESCRIPTION OF THE OLD LAYOUT

3.1 Introduction

The following chapter will describe the production flow of the manufacturing cell before any of the changes were made. A short description of the stations and their functions will be given.

3.2 The Stations in the Old Layout

The cell produces three part numbers and contained two lines as shown in Figure 3.1. One line had six robots and the other had seven. Each line had 17 operators. The product went through a total of 17 stations for complete assembly and inspection. Assembly of the module was done in the following order:

<u>Jumper Assembly</u> (1)- In this station, wire leads were built to a connector and a TPA was added. The wire leads were wrung through a seal and the housing. The continuity of the wire leads and connector was checked.

<u>Terminal Inserter</u> (2)- Terminals were inserted into position on the ceramic board. Six or seven terminals were

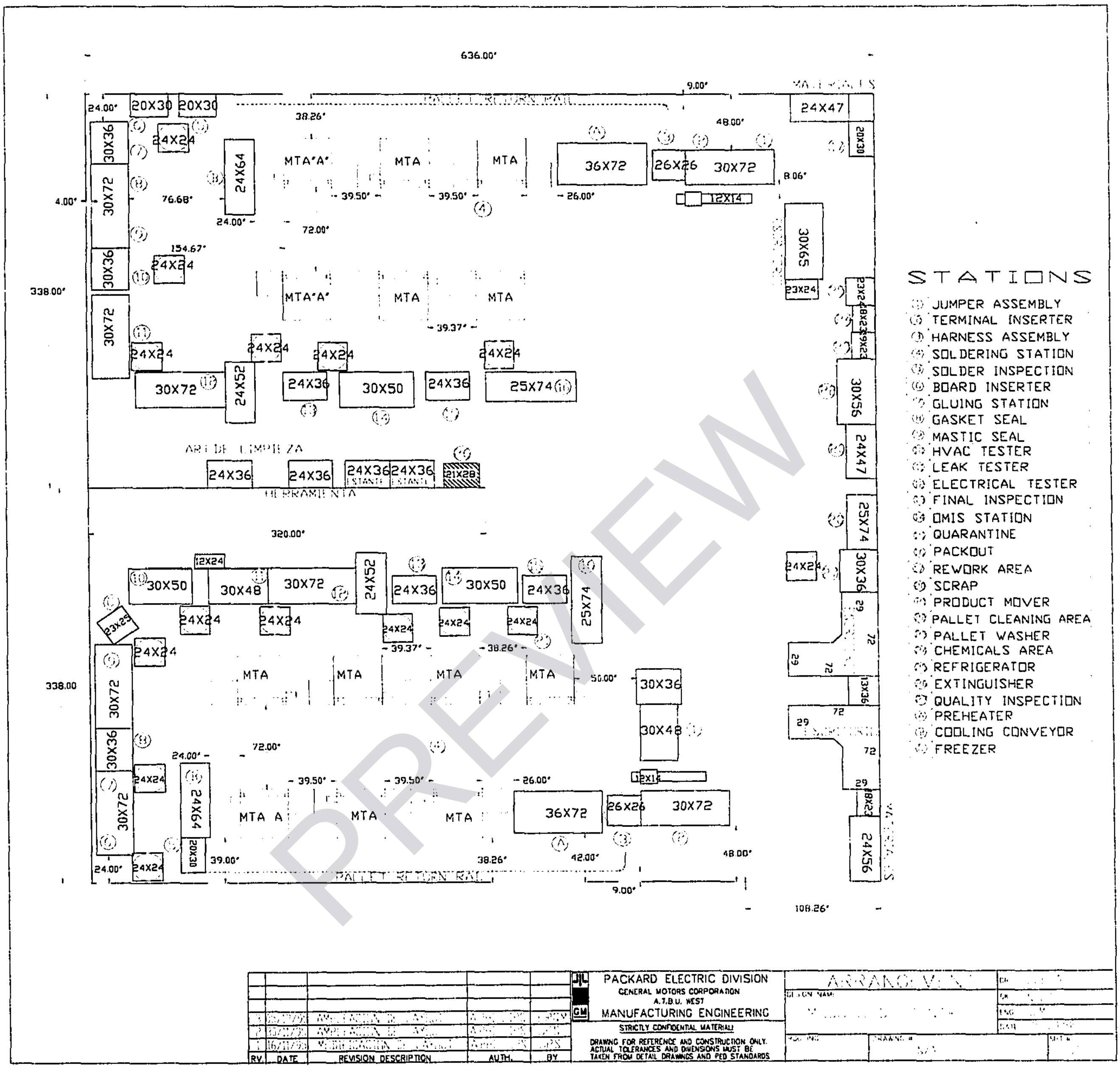

Figure 3.1 Stations in the Old Layout