

BODY ASSEMBLY PROCESS IMPROVEMENT FOR AUTOMOTIVE  
INDUSTRY

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## **ABSTRACT**

An automotive body assembly system consists of many individual sub-assemblies and sheet metal parts welded. The objective in this project is to identify the problem that always happens in line assembly. Then improve the problem in line assembly to overcome from the problem arise. Hence make a comparison and find a solution about body assembly to improve the problem from the data analysis. At body assembly process there are several problem could happen such as miss the spot part, dent or hump, scratch, spatter burr and hole to the body during assembly. But the major problem happen at line assembly is spot weld and men mistake. By using 4M method which includes machine, method, material and man, this problem can be identify easily and effected. As a result there are some problem that contributes to the problem happen such as logistic problem which involve the wrong part delivery and wrong shipment. Besides that, man power and workability also be the problem to the line assembly. Lack of discipline, behaviour and competency of worker give a worse impact to the company. Wrong workability involves many of tools, machine and man power and affected the production and flow in line assembly. Spot welding becomes a problem when the current voltage supply is not enough and it can work properly. Lastly jigs and fixture need to be right servicing schedule to make sure the machine and tools are in good condition and avoid the problem happen used it. The method were used to make the analysis data is by making study case at AMM factory which more focus at body assembly line and problem occur during the process. From the data collected, analysis data can be done and improve the problem that always happen in line assembly. Hence it gives benefit to the company either in productivity or working environment from the solution has done.

## **ABSTRAK**

Proses penyambungan badan kereta mempunyai banyak bahagian-bahagian individu dan kepingan besi yang perlu di sambung. Objektif untuk projek ini ialah untuk mengenal pasti masalah yang sering berlaku di dalam proses penyambungan. Selepas itu, penyelesaian yang paling sesuai akan di cadangkan dalam mengatasi masalah yang sering kali timbul. Justeru itu, perbandingan dan penyelesaian dapat di buat daripada analisis data. Di bahagian penyambungan badan kereta masalah yang selalu terjadi adalah seperti tersalah pateri bahagian badan, kemik, lekuk, calar dan lubang di bahagian badan kereta yang di sambung. Tetapi masalah utama ialah spot weld dan kecuaihan pekerja. Dengan menggunakan kaedah 4M yang merangkumi mesin, kaedah, bahan mentah dan pekerja dapat mengesan masalah dengan mudah dan cekap. Keputusan yang dapat di lihat ialah masalah pemindahan dan pengangkutan bahan yang di hantar dengan salah dan tempat yang tidak betul. Selain itu, pekerja dan kemahiran yang ada juga menjadi salah satu punca masalah yang sering berlaku. Kurangnya disiplin, perangai dan komitmen yang di berikan memberi impak yang besar kepada syarikat. Salah penggunaan alatan dan mesin akan menyebabkan masalah kepada produktiviti dan pengeluaran produk yang di hasilkan. Spot welding menjadi masalah apabila arus yang di bekalkan tidak mencukupi. Ini kerana ia tidak dapat berjalan dengan baik apabila arus tidak mencukupi. Langkah-langkah yang di buat dalam menghadapi masalah ini ialah dengan membuat kajian dan pemantauan di kilang AMM di mana pengkhususan lebih di berikan kepada tempat penyambungan badan kereta dan masalah yang sering berlaku ketika proses penyambungan. Dari data analisis yang di kumpul langkah-langkah untuk mengatasi masalah yang sering berlaku dapat di cadangkan. Dengan itu, ia akan member manfaat samaada dari segi produktiviti atau suasana pekerjaan hasil daripada langkah-langkah yang telah di cadangkan.

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### LIST OF SYMBOL

% Percentage

### LIST OF ABBREVIATION

4M	Man, machine, method and material
Assy	Assembly
AMM	Automotive Manufacture Malaysia
LHS	Left hand side
RHS	Right hand side
Comp	Compartment
MIG	Metal inert gas
BIW	Body in white
RSW	Resistance spot welding

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Project Background**

Assembly requirements of individual components going in the sub-assembly and accessibility of weld spots decide the numbers of stages required and weld gun style. Welding guns are generally available in standard configurations dependent on size and style. Special guns may be essential to meet specific requirement of body design. Numbers of fixtures and welding guns, man power engaged and their efficiency along with efficiency of the overall system such as maintenance, decide the production capacity of the line.

In the body assembly there several method were used such as laser weld, tailor welded blank and spot weld. For this report, spot weld will be taken as the main research and case study. Resistance spot welding (RSW) is used for the fabrication of sheet metal assemblies. The process is used extensively for joining low carbon steel components for the bodies and chassis of automobiles, trucks, trailers, buses, mobile homes, motor homes and recreational vehicles, and appliances and many other products.

#### **1.2 Problem Statement**

In the body assembly process there are several problem could happen. When this happen it could stuck the process in assembly line and disturb certain department. The major problem in the body assembly is spot weld gun and human mistake. Everyday

there are always have problems regarding this two factor such as miss the spot part, dent or hump, scratch, spatter burr and hole to the body during assembly. For analysis purpose, this problem will delay the time and production to recover it back. Hence, this research will help by making the analysis and case study at the body assembly by proposing a solution to avoid the problem or reduce it from happening.

### **1.3 Objective and Project Aim**

The aim of this project is to reduce the problem occurs during body assembly process and decrease the possibility that mistake could happen during work. The aim can be achieve by objective below:

- I. Identify the problem that always happen in line assembly
- II. Improve the problem in line assembly
- III. Make a comparison and find a solution in line assembly

### **1.4 Project Scope**

The scope of this project, more focus on E-class Mercedes car assembly at Automotive Manufacture Malaysia (AMM) factory at Pekan. Collecting the data have be done by visited the AMM factory for several time where all the data were recorded for used in this report. The report cover several scope:

- I. Make a analysis in the line assembly
- II. Study function of spot weld gun
- III. Improve the problem in line assembly

## CHAPTER 2

### LITERATURE REVIEW

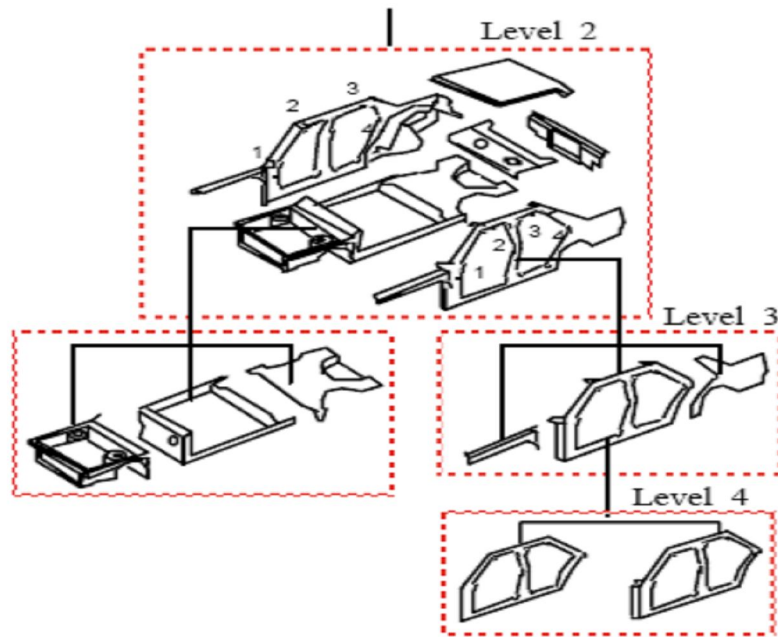
#### 2.1 Introduction

With increased competition in the automobile market, more attention has been given to managing variations in automobile body assembly processes. Dimensional variation affects fit quality and functionality. For example, variations in a body-in-white (BIW) can ultimately cause poor sealing, undue effort required for door closing, water leaks, excessive wind noise, prolonged time-to-market and added manufacturing costs. Typically, the automobile body assembly process comprises numerous steps, utilizing 300–500 compliant sheet metal parts, 50–120 assembly stations and 3000–6000 spot welds. Each step in the process is capable of contributing a degree of variation. Those variations in turn act on one another to compound distortion in the final BIW. The complexity of this interaction places severe demands on the existing methods of simulation, which currently fall far short of satisfaction. (Min Hu, Zhongqin Lina et.al, 2001)

An automotive body assembly system consists of many individual subassemblies and sheet metal parts welded at more than 200 stations. Dimensional variation in the final body is accumulated as sheet metal parts are assembled at each level of the system. In designing such a system, engineers are interested in predicting how variation propagates through the system so that process problems can be solved early. During the launch of the manufacturing system, engineers are interested in identifying the sources of variation quickly so that quality products can be produced in the shortest possible time. Traditional variation simulation techniques were developed mainly for simulation of product variations and are based on rigid body assumptions. They are not applicable for compliant sheet metal assembly because parts can deform, causing changes in

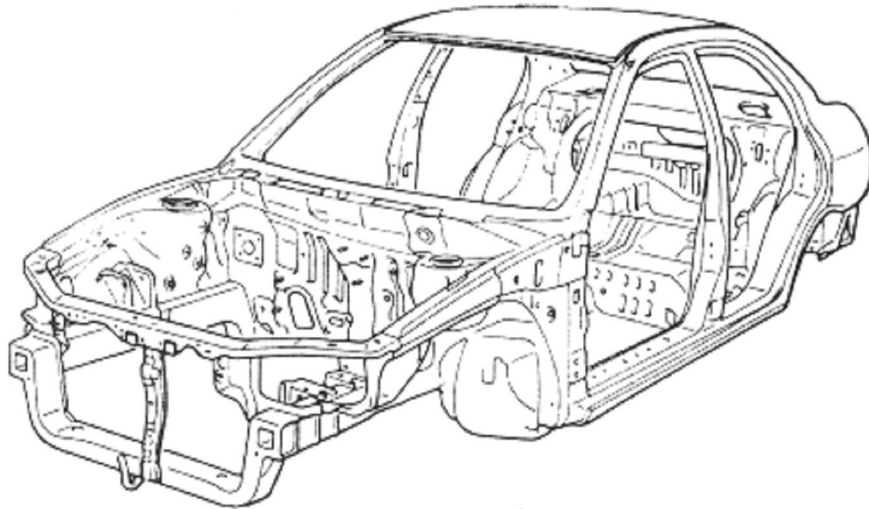
dimensions during assembling. In addition, existing diagnostic tools focus on single machines, rather than an entire multi-leveled manufacturing system.

An automotive body assembly system is a multi-leveled hierarchical system, in which sheet metal parts are joined together to form subassemblies, which in turn becomes the component to the next level of assembly. A simplified process is shown in Fig. 2.0. At Level 2, the body is framed by assembling the major subassemblies, such as the underbody, side frames, roof, shelves etc. At Level 3, the major subassemblies are formed. For example, the side frame is assembled by welding together the door ring, quarter panel, and motor rail. At Level 4, parts are welded together to form the components for the level 3 assembly, e.g., door ring inner and door ring outer are assembled to form the door ring. (S. J. Hu, 1997)

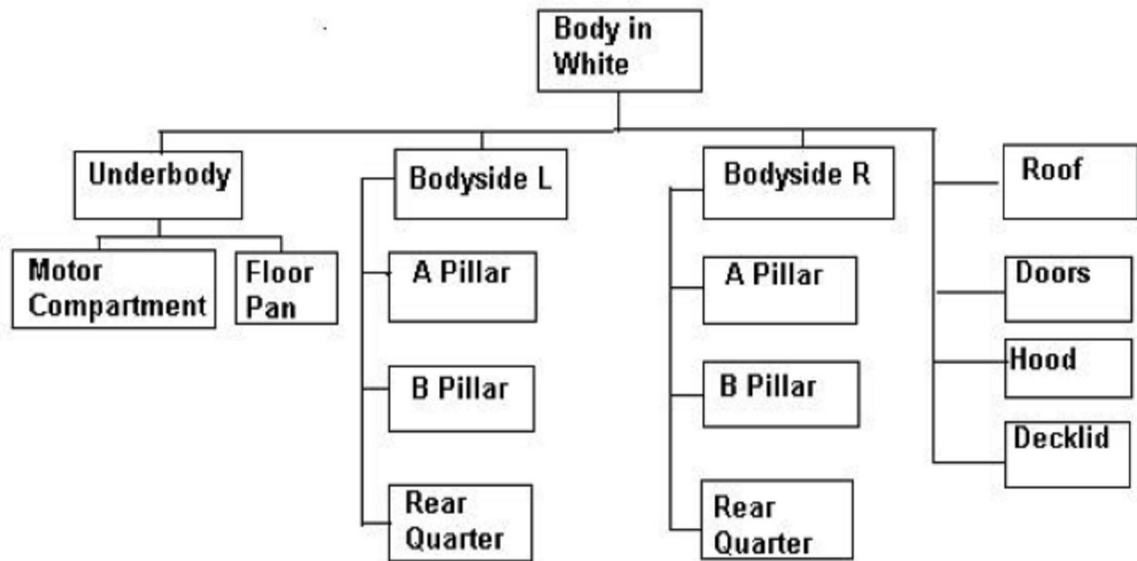


**Figure 2.0:** An auto body assembly process

In the Body in White assembly process, a hierarchy of in process measuring stations can be established, as shown in the following block diagram. The number of these stations that is actually implemented in a given process is dependent upon several factors that shown in figure 2.1 and figure 2.2.



**Figure 2.1:** Body in white



**Figure 2.2 :** Possible Measuring Station Locations

One very serious factor to consider when determining how many measuring stations that there will be is of course cost. This leads to the minimum number that should be considered, namely four: Body in White, Under body, Left Body side, and Right Body side. Going beyond this minimum will of course lead to a more capable measuring regime that will lead to better and tighter process control. (Omer L Hageniers, 2001 )

Below is the overall flow chart of how the process in assembly line for body assembly. All the activity and the process along the line assembly were mention in the Table 2.0 start from beginning the process until finish. From the chart, process and information of the car that will assemble can be analyzed.

**Table 2.0:** Activity Process in Line Assembly

PROCESS FLOW	ACTIVITY
<pre> graph TD     A((A)) --&gt; Z2.1[Main Jig Z2.1]     Z2.1 --&gt; Respot[Main Jig Z2.1 Respot]     Respot --&gt; Z2.2[Main Jig Z2.2]     Z2.2 --&gt; Z2.3[Main Jig Z2.3]     Z2.3 --&gt; B((B))             </pre>	<p><u>Main Jig Z2.1</u></p> <ol style="list-style-type: none"> <li>Spot Welding for :- <ul style="list-style-type: none"> <li>Inner Side Wall to Assy Z1 RH/LH</li> </ul> </li> <li>Apply Glue at Inner Side Wall</li> <li>Rivet Inner Side Wall to Assy Z1 RH/LH</li> <li>Spot Welding Condition check</li> </ol> <p><u>Main Jig Z2.1 Respot</u></p> <ol style="list-style-type: none"> <li>Spot Welding for :- <ul style="list-style-type: none"> <li>C pillar RH/LH to Inner S/Wall Top</li> <li>C pillar RH/LH to Inner S/W Bottom</li> <li>Front Open reinforcement</li> </ul> </li> <li>Foam Part attachment</li> <li>Spot Welding Condition check</li> </ol> <p><u>Main Jig Z2.2</u></p> <ol style="list-style-type: none"> <li>Spot Welding for :- <ul style="list-style-type: none"> <li>Side Wall Outer to Assy Z2.1</li> <li>Roof Bow to side wall outer (E200K)</li> <li>Roof Panel to Side Wall (E200K)</li> </ul> </li> <li>Apply Glue to Side Wall Outer</li> <li>Foam Part Attachment to Side Wall Outer</li> <li>Spot Welding Condition check</li> </ol> <p><u>Main Jig Z2.3</u></p> <ol style="list-style-type: none"> <li>Spot Welding for :- <ul style="list-style-type: none"> <li>Roof</li> <li>Rocker Panel</li> </ul> </li> <li>Folding Rear Wheel Arch</li> <li>MIG Welding</li> <li>Drilling Front Wheel House RH/LH</li> <li>Spot Welding Condition check</li> </ol>

PROCESS FLOW	ACTIVITY
<pre> graph TD     B((B)) --&gt; A[Turn Over Jig]     A --&gt; B[Brazing &amp; Clinching]     B --&gt; C[Fitting &amp; Adjustment]     C --&gt; D[Metal Finish]     D --&gt; E{Quality Gate}     E --&gt; F{BPA (Random)}     E --&gt; D     F --&gt; Exit(( )) </pre>	<p><u>Turn Over Jig</u></p> <ol style="list-style-type: none"> <li>1. Spot Welding Rear Panel</li> <li>2. Complete Stud Welding</li> <li>3. Spot Welding Condition check</li> <li>4. Stud Welding Start Up Check</li> </ol> <p><u>Brazing &amp; Clinching</u></p> <ol style="list-style-type: none"> <li>1. Apply Glue for Parcel Tray</li> <li>2. Clinching Parcel Tray to Rear End</li> <li>3. Roof Drilling</li> <li>4. Brazing &amp; Grinding Rear End Joint</li> <li>5. Sealant Apply to Rear End</li> </ol> <p><u>Fitting &amp; Adjustment</u></p> <ol style="list-style-type: none"> <li>1. Fitting Bonnet, Trunk Lid, LH/RH Doors.</li> <li>2. Adjustment Gap &amp; Flushness &amp; confirm Torque</li> </ol> <p><u>Metal Finish</u></p> <ol style="list-style-type: none"> <li>1. Sanding body surface if required.</li> <li>2. Repair body surface if required</li> </ol> <p><u>Quality Gate</u></p>

## 2.2 Spot Welding

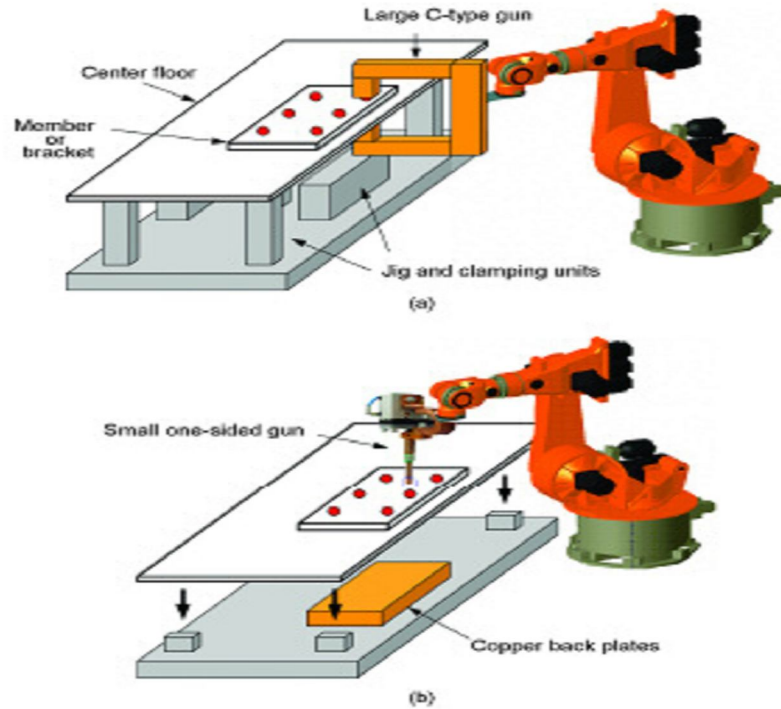
Resistance spot welding (RSW) is used for the fabrication of sheet metal previous term assemblies. The process next term is used extensively for joining low carbon steel components for the previous term bodies next term and chassis of automobiles, trucks, trailers, buses, mobile homes, motor homes and recreational vehicles, and railroad passenger cars, as well as cabinets, office furniture, appliances and many other products. High-strength low-alloy steel, stainless steel, nickel-, aluminum-, titanium and copper alloys are also spot welded commercially.

The major advantages of spot welding are high speed and adaptability for automation in high-volume and/or high-rate production. Despite these advantages, RSW suffers from a major problem of inconsistent quality from weld to weld. This problem results from both the complexity of the basic previous term process next term as well as from numerous sources of variability, noise, and errors. Any or all of these complicate automation, reduce weld quality, demand over-welding (i.e., the production of more welds than are structurally needed, if each were perfect), and drive up production costs. For this reason, ensuring weld quality has been and remains a major challenge and goal. ( Min Jou, 2003)

Resistance spot welding uses the surface resistance of the materials to be joined to generate an intense localized heat under pressure with a short passage of a high current. Use of coated sheet in vehicles for corrosion resistance has presented problems related to the electrode life. The electrode life may get reduced to 50~500 welds before maintenance (tip dressing) as against 3000~6000 welds in case of uncoated plain steels. With introduction of HSLA steels, the need for reliability of weld quality has become much more demanding. Suitable shop floor quality tests are vitally important. ( Cho, Y., and Rhee, S. 2003)

### 2.2.1 Large Panel with Members and Brackets

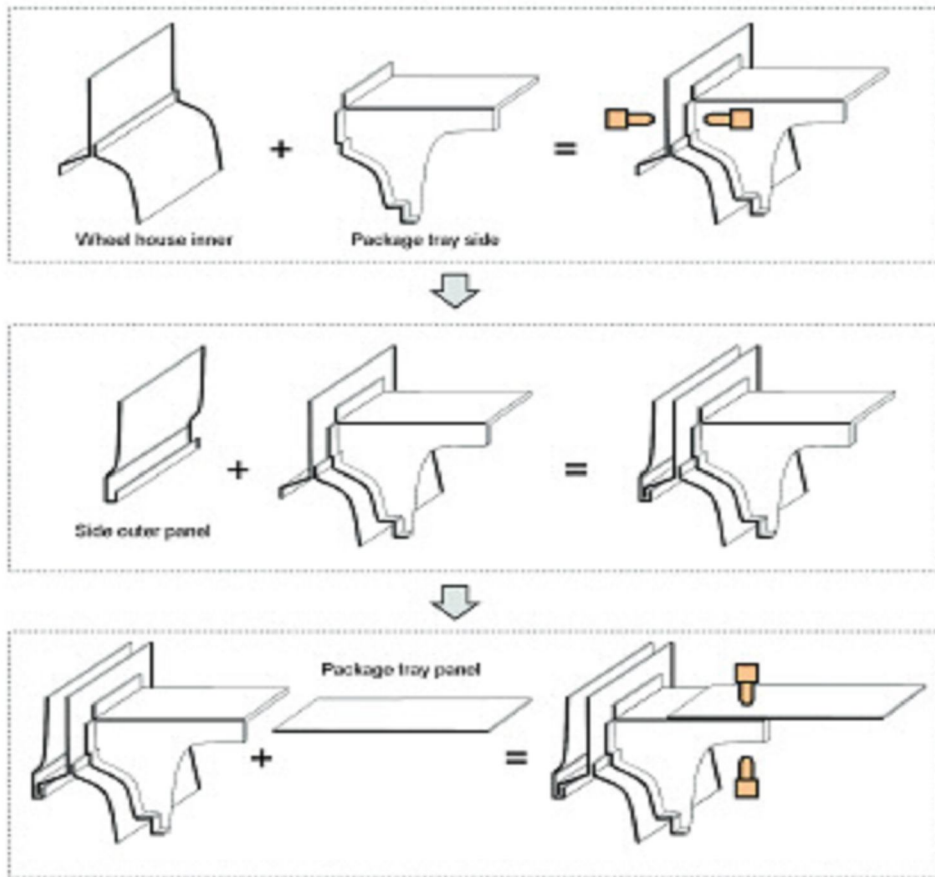
In order to make a weld with members and brackets on the large panel, such as the center floor of the auto body, a large C-type gun is needed to access in the middle of the panel. Since complicated jig fixtures and clamping devices are located underneath the panel, it is very hard to teach the robot the right position with proper cycle time - Fig. 2.2A. Once the single sided RSW system is adopted for this application, fixture and clamping units can be dramatically reduced -Fig. 2.2B. Thanks to the easy access to the weld spots, cycle time also can be decreased.



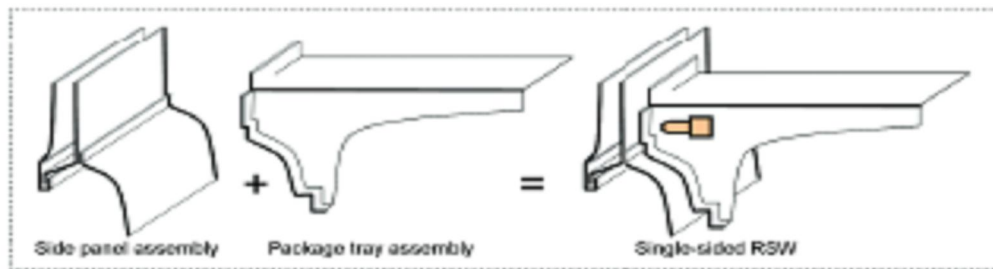
**Figure 2.3:** Single-sided RSW of a large panel. A - Large C-type gun with jig and clamping units; and B - single-sided gun with backing plates.

### **2.2.2 Preassembled Parts**

Usually, large parts are assembled at original equipment manufacturers (OEMs). This means the OEMs need large facilities with complicated manufacturing processes. Once parts are provided as a preassembled unit, lean assembly line manufacturing can be achieved with a minimum number of production cells. As shown in Fig. 2.3, package tray panels are assembled with three stages. In this case, the package tray side panel has to be welded in the first stage and then the side outer panel is assembled, resulting in body side complete. After that, this complete is built together with a package tray at a later assembly station. However, if the package tray assembly is preassembled (Figure. 2.4), the manufacturing process can be reduced to two stages; body side complete stage and its joining stage with package tray assembly. In order to assemble package tray panels on the body side complete, a single-sided welding technique is needed. While arc or laser beam welding may not be a perfect solution due to the gap issue of the end of the panel edge, single- sided RSW has sufficient electrode force to control the gap. (Dickinson, D. W., Franklin, J. E., and Stanya, A, 1980)



**Figure 2.4:** Conventional way to build package tray panels.



**Figure 2.5:** Proposed way to build preassembled package tray panels.

Spot weld quality is ensured through control of four principal parameters:

- Current
- Weld Force
- Weld time
- Electrode configuration

Automotive manufacturing system emphasized first on constant current in resistant welding for its practical advantages:

- Automatic compensation for power variation of mains.
- Correction for welding gun impedance change when welding across large sections of body panel.
- Less program changes
- Compensation allows different number of thickness to be welded on one setting in many applications.

Weld timers provide the ability to monitor each spot weld so that its peak current level is within predetermined limits. Dynamic resistance principle measuring the variation of resistance over time during the weld is also used to ensure a higher level of guaranteed quality. A sophisticated dynamic resistance system may incorporate an adaptive control feature that varies the weld settings within certain limits to achieve correct weld quality. The system also includes a weld current stepper function linked to the counting of welds executed. The parameter limits are established for the specific application and programmed for control. With capability of microprocessor based controls, the constant current system could easily be attained for ensuring weld quality.

The weld time variation is unlikely with electronic controls. Welding forces is applied pneumatically through line supply and hardly require a more rigid control attained for ensuring weld quality. Tips of electrodes are to be maintained for consistent current density. Either an individual weld count or an interface with the robot (if used) is applied to make electrode dressing compulsory after an established number of cycles.

Pneumatic or electrically driven tip dressers shape both electrodes simultaneously to ensure established geometry and decontaminated condition of the tip surfaces.

For quality of spot welding of automotive body, in addition to accurate panels and jigs, tightly controlled position, sequence and direction of spot welding as well as attitude of welding gun are necessary. Spot welding was basically manual operation. Dedicated multi weld machines are used for high volume production in totally automatic mode. The application of robots provided the appropriate human solution with much higher precision in positioning and repeatability as shown Table 2.1.

With increased acceleration and deceleration of robots, spots can be applied at high rate: a 50 mm step takes less than 0.3 seconds and a 300 mm one can be traversed in under 0.7 second. Welding robots are generally supplied as a complete system including gun transformer, air, water and electrical power supply, and all controls.

**TABLE 2.1:** Dimensional Accuracy in Body Assembly

FEATURES	DEVIATION OF HUMAN WORKER	DEVIATION OF ROBOT
Welding position	+/- 20~30 mm	+/- 0.5~1.0 mm
Number of welding points	Stipulated points +/- 0~2%	Stipulated points +/- 0%
Attitude of welding guns	Perpendicular to surface within +/- 10~20 degrees	Perpendicular to surface within +/- 1 degree