CONSTRUCTIVE AND TECHNOLOGICAL ISSUES TO SOLVE FOR THE ALIGNMENT OF FIXTURES FOR THE WELDING OF THE CAR BODY ASSISTED BY ROBOTS

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Abstract: In this paper I wish to approach certain issues related to maintenance of the welding fixture and the 3D confirmation after de maintenance of the assembly line. One of the purposes of this paper is to present certain particularities of automated assembly lines that could be used to automate the 3D process of confirmation of the fixtures.

Introduction

To make parts with deviations to be within the permissible deviations set out from design, based on criteria in constructive way, functional and economically, is an indispensable request for quality assurance and product reliability. The checking of these limits of the deviation prescribed by the technical documentation are kept tight are performed by the measurement which are made in various stages of processing by the length measurement technique, which includes all processes for linear and angular measurements of the dimensions and geometrical characteristics of surfaces obtained by machining.

When we select the fixtures for mechanized welding, the engineer must evaluate considerations such as [3]:

- ✓ Production volume.
- ✓ Joint geometry.
- ✓ Movability of the welding gun (head).

Due to repeated and continuous use of welding devices, they should be checked regularly because of changes occurring in the production process. In general, these tests are done once a year when overall maintenance process lines - robots, welding stations, grippers, sensors, conveyors and other components of the technological line. But sometimes to be able to face a higher demand for body parts is necessary to increase the rate of work to produce a greater number of components per hour. This automatically leads to greater wear assemblies of flexible manufacturing systems which can result in a faulty component, then is necessary an inspection of geometrically more often.

In a picture below we have a fixture of assembly line for Jaguar made by a Romanian company in Oradea.

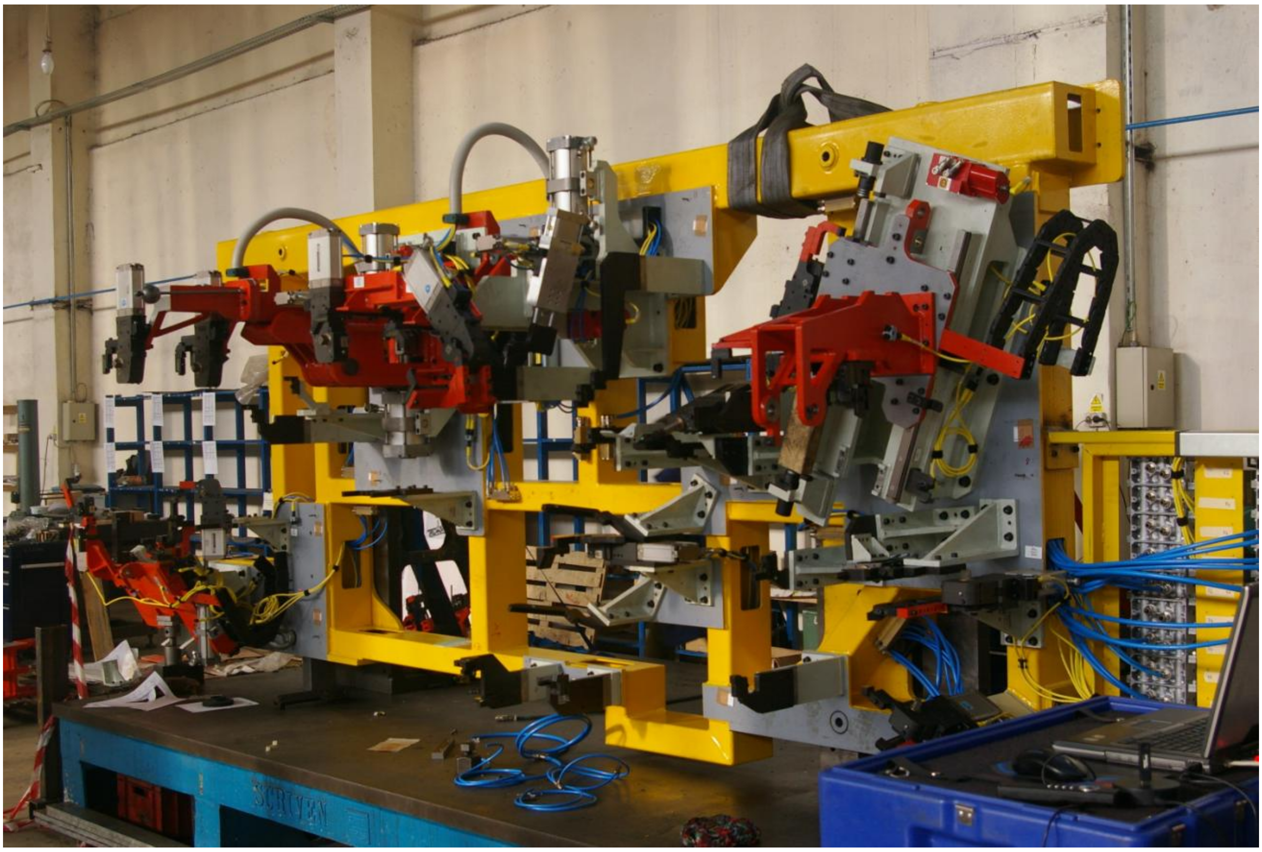

Figure 1 Fixture of assembly line for Jaguar

The concept of flexibility and the context of flexible manufacturing for body welding.

Industrial robot can be defined as a programmable automatic handling unit labor objects or means of labor.

Industrial robots are designed for flexible automation of production processes, replacing human operator in the operations taking place in harmful or hazardous environments, the activities difficult, exhausting the physical and intellectual effort (monotony) or deficient compartments skilled and specialized workforce.

Currently in the world are "active" hundreds of thousands of robots: in Japan, USA, UK, France, Sweden, Italy etc. In Romania there are few robots in service due to very low price of labor.

Advantages of industrial robots and their implementation in industrial technological processes:

(a). much of industrial robots are common components and therefore can be manufactured in large series, with a considerable reduction in costs and improve reliability;
(b). investments are not related to a specific application, different robots can be used simply for their programming;
(c). production preparation times are lower (often just restart)
(d). it is possible to complete automation of technological operations in the manufacture of parts or subassemblies in groups or in small series;
(e). using modular systems can run more tasks with the same arm by simply changing the tools or devices.

The movements made by a robot to join the parts with resistance spot welding are:

- ✓ positioning the extremity of an electrode next to a welding point;
- ✓ common axis orientation of the electrodes in a direction normal to the surfaces parts to be merged;
- ✓ moving extremity of an electrode in the next point;
- ✓ common axis shift of the electrodes if required;
- ✓ repeatability of each of these movements for many spot welds are in the group;
- ✓ local obstacle avoidance, where they are;
- ✓ the movement of position of the extremity of an electrode to a point in another group of points.

Some 250~300 pressed panels from in-house and vendor facilities are brought to different subassembly stations of Body Weld Shop. Subassemblies of pressed components are carried out mainly by resistance welding and other joining methods in a planned sequence at number of stations. Some subassemblies are done in off-line manufacturing cells and fed in at appropriate locations into the main assembly line. Figure 1 shows a layout of a typical Body Weld Shop. Front end, rear floor, and front floor, are transported to underbody body line, where all these are welded together in sequence to form the floor structure. Underbody is then transferred to main body welding station. Right hand and left hand body side panels are brought from two sides to main body weld station, after completion of all subassembly operations in separate lines. Preframing of body structure is carried out on special fixture. At same or next station, roof is added to form the body shell, figure 2. There after, rear doors, front fenders, hood and decklid/ tailgate fitments are carried out to complete the body-in-White. If necessary, a metal finish line may be added for minor repair of Body-in-White before it moves for painting. Figure 3 illustrates the sequences of subassemblies and the main body weld.

Typically, Body weld shop activities cover fixturing, welding, and transportation between the work stations, and the related support services.

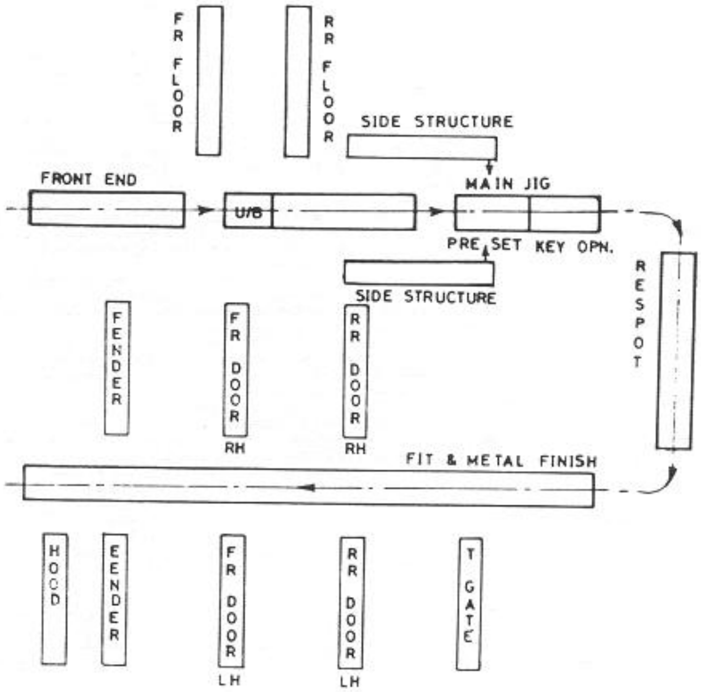

Figure 2 A Typical Body Welding Shop Layout

Over the years, the concept of building the fixturing for body shop has undergone changes. In earlier concept small unit parts used to grow to large ones by sequential welding in jigs/fixtures. For better rigidity and to avoid distortion causing dimensional inaccuracy of structures, the parts were clamped on dedicated and complicated fixtures with manual toggle clamps or through an integrated pneumatic clamping system. All possible welding was carried out at each station before moving to the next station. The accuracy of each of these preprocesses was deciding the accuracy of the final assembly of body-in-white in line. At final line, the accuracy could not be affected. The new concept now limits welding points to minimum at dedicated fixtures for subassemblies. It leaves finish welding as much as possible for the final welding line to ensure quality. However, the finish welding is done, necessarily, after making necessary adjustment for the position errors.

Trends for body welding have changed from individual spot welding guns, to special purpose multi-welding machines, and then to application of robots for welding and other joining processes in cells and lines.

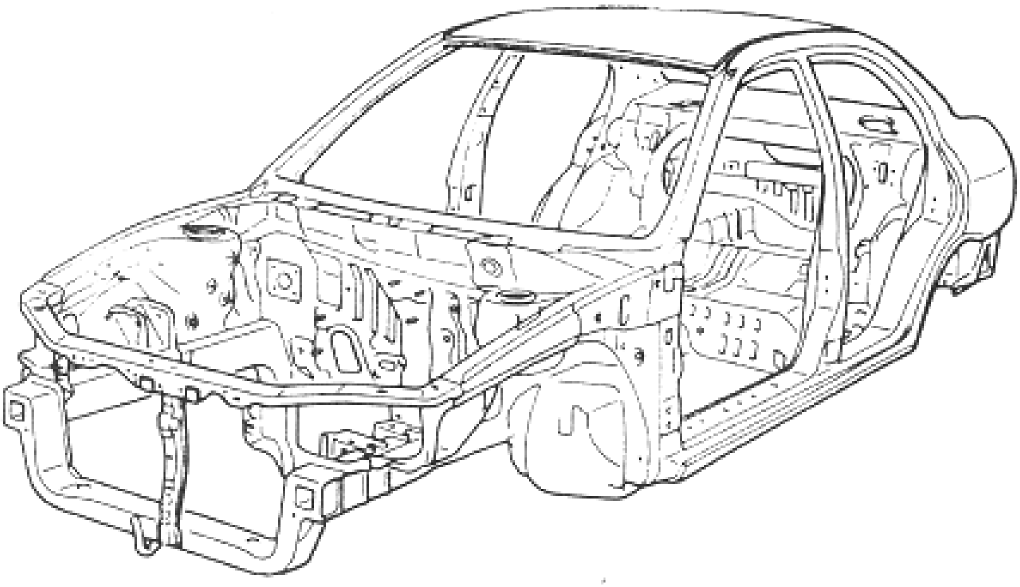

Figure 2. A Typical Body Shell Construction

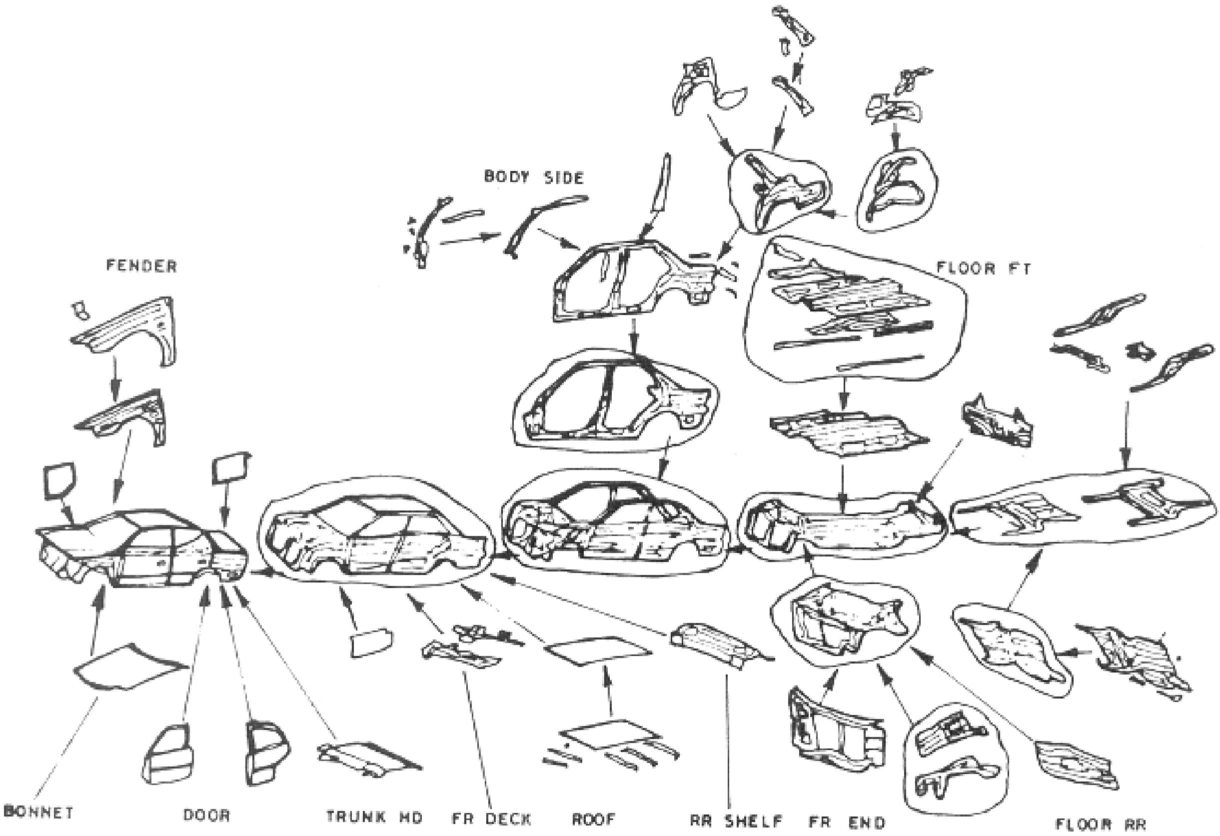

Figure 3. Sequences of Sub-Assemblies and Main Body Welding

Theoretical aspect of body measurement systems.

To evaluate automotive body quality, North American manufacturers are incorporating more data-based decisions instead of subjective opinions.

In the assembly of body line, the role of the measurement systems of the fixtures are critical because from an poor design and misinterpretation of data can produce lose of time and lots of money. The most common technology used for measurements are the coordinate measuring machines, which can be machanical CMM with stylus or optical-CMM (laser trackers, interferometers) used for process validation. The first prior step of using the measurement system is to verify its repeatability and reproducibility, in some cases, to estimate accuracy.

The measurement system plays a critical role in any dimensional evaluation process. In the case of the automotive body, its role is particularly influential. Body manufacturers measure most part features in absolute space (X, Y, and Z coordinates) rather than as relative distances between points [1]. Absolute space measurements are more complex, particularly for angled surfaces (i.e., not on measurement axis). They also are heavily dependent on the part locating system (i.e., datum scheme), which often is difficult for parts lacking rigidity.

One of the main components in a measurement system is the part reference or locating system. Regardless of the measurement technology, nearly all part measurements are relative to a part datum scheme described on Geometric Dimensioning and Tolerancing drawings. These datum schemes provide a reference system for all part surfaces and features using body coordinates. Figure 4 below illustrates a typical body coordinate system. This system replaces the traditional X, Y, and Z directional designations with fore/aft (X), in/out (Y), and up/down or high/low (Z). The 0,0,0 point of the car is the front, lower, and center position [1].

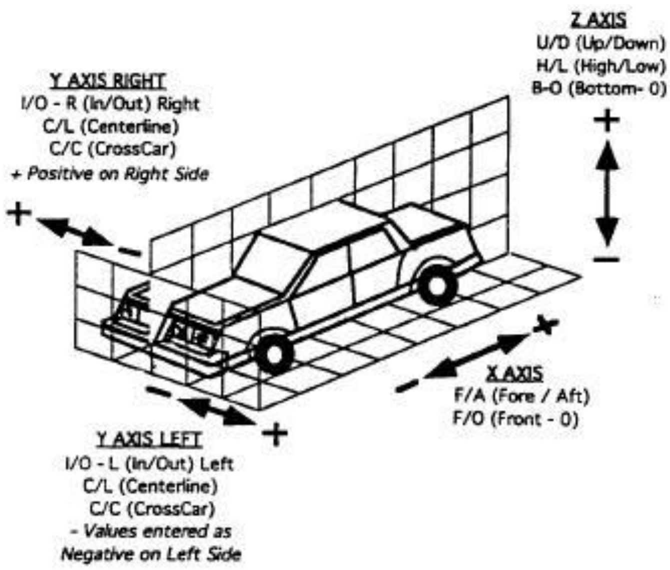

Figure 4. Body Coordinate System [1].

Holding fixtures used in measuring systems and assembly operations often follow a 3-2-1 locating scheme to position parts. Under this scheme, three locators position a part in a primary plane or direction (e.g., high/low). Two locators then position the part in a secondary direction (e.g., in/out), leaving one locator for the tertiary direction (e.g., fore/aft). This approach fixes the part in 3-dimensional space and satisfies the six degrees of freedom constraint. For some product designs, manufacturers replace the three locators for the secondary and tertiary directions using two round pins, one fitting a circular hole and the other a slot. The pin locates the part in two directions (e.g., in/out and fore/aft). The slot then becomes the other locator for the secondary direction (e.g., in/out). Figure 5 provides a schematic representation of the 3-2-1 principle using the hole/slot combination.

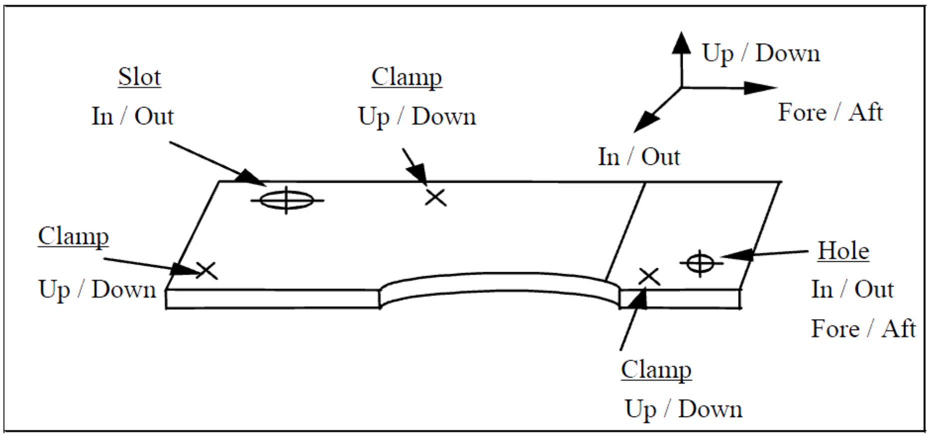

Figure 5. The 3-2-1 Locating Scheme [1]

CONCLUSIONS

Due to different requirements of fixtures alignments, by the manufacturers of cars, is hard to make a rule to align them. At first glance confirmation geometry is usually done using the 3-2-1 alignment system, i.e. using three reference centers to block axes. But there are cases where alignment is made by grinding and milling a starting point, making the subsequent alignment of the assembly line is not the same type of alignment. In these cases the alignment is done after other reference points are given to the 0 car.

It is very important for the designer to provide reference points visible from any position to be able to make further adjustments, both for commissioning and for maintenance.

Technological lines which are using robots for welding body lines are almost entirely automated. Given this and because all welding fixtures are in range of at least one robot, then I will try to automatize the process of geometrical validation using a robot. This could allow an immediate verification of a fixture that not gives the geometry of the part. This would avoid the stop of the entire assembly line, but only to the cell where the defect occurred.

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