ROBOTIC WELDING – STEP TOWARDS SIX SIGMA IN WELDING

BY

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Improving the quality of welded component, without sacrificing the productivity is a great challenge. The defects in the welded component include welding defects as well as the dimensional variances which ensue as a result of welding. Eradication of these defects consumes a lot of time and loss of overall productivity. Deployment of robots for welding invariably results in a vast improvement. A typical welding system consists of the welding robots, the welding machines and the fixtures holding, handling and clamping the components during welding. Such a system is custom designed after a thorough study of the component and the simultaneous design of the system starts. The synergic performance of the various constituents of the system results in the benefits. Large volume of repetitive jobs lend themselves as the most suitable candidates for robotic automation. In these cases the benefits are quickly realized. It is because of this that the robotic system are commonly seen in automobile industry.

There are several differences between automatic / semiautomatic welding (GMAW process) and Robotic GMAW welding . The typical heat input in the former case is around 1400 Joules / mm while in the latter the heat input is 300 – 400 Joules/ mm by virtue of the welding speeds of 900 to 1200 mm / min. Many parameters usually ignored in manual or semiautomatic or low end automation assume great significance as they have a telling effect. The high welding speed warrants a very high level of process control. Consistency and repeatability become all important particularly in face of component to component variations.

The stress analysis of the component gives clues to decide the locations where clamping is necessary and accordingly the fixture is designed. The locations of clamps and the fixture, in general, impose some restrictions on freedom of parameter and sequence design. Situation is further complicated if multiple robots work at one station. In such a situation, care has to be taken to avoid the path crossing of robots. Thus, invariably, the best desired set of operational functions cannot be set and one has to be content with the feasible optimum solution. This requires a high level of vertical domain knowledge.

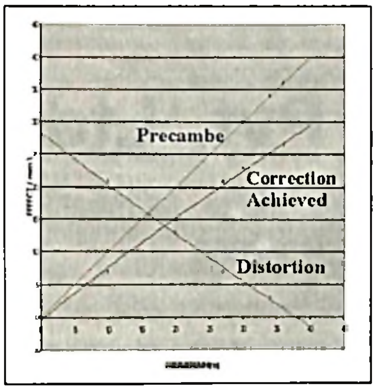
Distortion control is another facet of robotic welding. The user of robotic system expects the output component from robotic station to be in ready–to–use condition. Hence the need to maintain dimensions within their respective tolerances. The technique to be adopted for controlling distortion is highly job specific and in many cases novel methods have to be used to supplement the weld sequencing method.

Two cases from Indian automobile industry, where robotic systems were deployed, are discussed to bring out the welding engineering aspects of robotic welding.

Robotic Welding of Chassis Of A Multi Utility Vehicle

A welding line was set-up, in suburbs of Mumbai, for manufacture of chassis for a 4 – wheeler multi utility vehicle. The line consisted of eight stations with

totally 9 robots. The chassis, which consists of the left and right long members with necessary number of cross members in between them, was of complex shape with so close dimensional tolerances that the dimensions were required to be measured on a CMM (co-ordinate measuring machine). The long member of the chassis was a box section, of approximate length of 3.5 meters, fabricated out of two pressed channels welded together by ~ 3.5 meter long weld. The location of the two joints between channels forming the box section, were on same side of the neutral axis of the box section. As a result, while the distortion could be controlled by weld sequencing only along one axis that along the other axis would take place irrespective of the sequence.



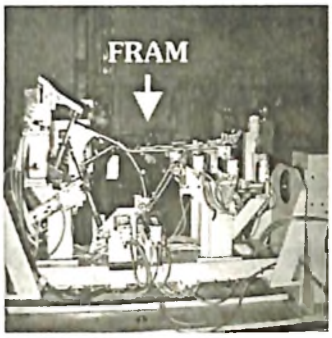
As expected, the distortion was within limits in the direction where sequencing helped but in the other direction, it was as much as 28 mm. Pre-cambering was adopted to control distortion in this direction. Several trials were done and a relationship was evolved to determine the required precambering. Distortion was measured on a Co-ordinate Measuring Machine. It was consistently found to be below 1.5mm against a tolerance of $\pm$ 3 mm specified by the customer. As a result, the long members could be taken for further operations without any correction thus saving the line production time.

Welding engineering at other stations was also carried out with precision. The final chassis produced required no correction. This line has been commissioned and is now operating as desired for the last two years.

Robotic Welding of Frame Of A 2-Wheeler

The SPM for welding the two wheeler frame was required by an auto ancillary unit in South India. This SPM was a short one in length. Four robots were required to operate in this small space. Thus in addition to the aspects seen above, additionally a time relation was required to be developed between the four robots to avoid clash of robots or infringement. Further, the distribution of welding had to be done to minimize the overall station time.

Analysis had revealed the central tube to be stressed. The clamping was suitably provided taking into consideration the location of components to be welded. Welding sequence was optimized managing factors like maximizing robot utilization , minimizing robot air time, choosing proper welding parameters etc. The most important requirement was to obtain engine mounting locations within 1.0 mm through distortion control techniques.



The normal distortion experienced by the customer was 8-10 mm. The use of SPM brought this down to 3 mm. It was still not within acceptable limit of 1.0 mm. A novel method of deploying compensating weld was used. This involved a bead deposition of right length and at right location to nullify the stresses causing the distortion. The right length was worked out from the bead – on – plate distortion data. After this bead was deposited on the frame, the distortion was controlled within the desired limits on a consistent basis. This was established by welding over 25 frames and checking this dimension on CMM. This robotic system has been manufacturing frames at the rate of about 1600 frames per day for over one year now.

The two cases cited bring out the salient features of how a robotic system could be advantageously used to get a product of good quality at increased productivity levels. The robotic welding is easily seen to be a different cup of tea altogether , requiring a level of insight into the behaviour of welding process in question.

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