ROBOTIC WELDING CELL

This project was part of a £1.0M investment in manufacturing facilities and equipment with the following overall objectives:

- Reduce manufacturing costs.
- Significantly increase production capacity.
- Improve operating flexibility.
- Replace old and obsolete technology.

For details of the other parts of the investment, please click on **£1.0M Investment in Metal Manufacturing** or **Pre-treatment & Powder Coating Plant** or **Metal Cutting & De-burring Cell** as required.

The company in question manufactured products using wood composite panels, plastic mouldings and metal components. A significant proportion of the metal components were welded assemblies fabricated in-house from lengths of hollow section mild steel. Two of the product ranges contributed more than 50% of the company's turnover through either sales of standard product, or specials derived from the standard ranges.

An analysis of the market place for these products had shown a significant change in recent years moving from high volume orders with low variety, to low volume orders with high variety. Some standard welded assemblies from the two main product ranges were produced using an in-house robotic welding cell, but many were produced manually using simple weld jigs.

The existing in-house robotic welding cell consisted of two weld stations one for each main product range. The equipment was 15 years old and this had been causing significant process problems because:

- The Operating System was now obsolete.
- Excessive wear was causing an increase in reject rates, due to incorrect positioning of the weld torch.
- Spare parts were difficult to obtain.

This situation was brought to a head when the cell suffered a catastrophic failure, resulting in a fire inside the extraction system. This event added considerable weight to the business proposal to replace the equipment which was under preparation at the time!

When planning the replacement cell the following operating requirements were identified in order to meet both current and future business needs:

- Initially the cell would consist of two weld stations, one for each of the main product ranges.
- Each station to be capable of producing ANY combination of standard assemblies for that product range during a single weld cycle.
- Ability for rapid change to accommodate the introduction of new product ranges.
- Both weld stations to be operated by one person, with loading and unloading of one station carried out while the other station is in the weld cycle.
- Single station operation if required.
- Capability for on-site upgrade to three or four station operation within two weeks.

Like many areas of the machine tool industry the supply of robotic welding equipment is hugely competitive. However, the specification of equipment is largely down to selecting the right items from a standard range of products to meet a given set of requirements. This, of course, needs to be done with care but the area which will contribute most to the success of the project is the design of the weld jigs and associated sensing. Getting this right will have a fundamental effect on:

- The productivity improvements to be achieved in terms of the range of components to be produced and the weld cycle time.
- The dimensional accuracy and general quality of the finished components.
- The reliability of the cell in terms of minimising downtime during production.

Sensing is used to detect the presence of components in the jigs and is used to:

- Tell the machine which component assemblies are required and hence which weld programme to select.
- Prevent the cell operating if any piece parts required for a particular component assembly are missing.

The trick here is to get the right balance in terms of functionally versus complexity.

ROBOTIC WELDING CELL

When designing the functionality of the sensing system the temptation is to add more sensors with the aim of (hopefully) reducing the number of rejects produced. However, every sensor will increase the complexity of the system and, inevitably, reduce its reliability. This will result in increased downtime as a result of erroneous sensor signals preventing the cell running. By any standards the environment inside a welding cell is hostile, so it makes sense (no pun intended) to minimise the number of relatively vulnerable components and any associated wiring. The better approach is to eliminate possible errors through the design of the jigging and/or the components themselves.

The operating requirements and projected production volumes were given to three potential suppliers who provided outline solutions for discussion. In view of the emphasis to be placed on jigging and related sensing systems, in each case these discussions included representatives from the jig designer and/or manufacturer. These initial discussions eliminated two of the suppliers because they could not provide the required functionality.

The third option was then subjected to a rigorous evaluation consisting of:

- A visit to the supplier's manufacturing facility.
- Visits to existing customers who had purchased similar equipment.

These activities included the involvement of the people who would eventually operate and maintain the equipment. In this particular case, the existing customers included component manufacturers who successfully supplied the car industry. This last point was given considerable weight during the decision process leading to selection of this particular supplier.

As the cell would effectively be a bespoke design, the development phase included several meetings with the supplier to confirm the requirements. As before, in view of the emphasis to be placed on jigging and related sensing systems, most time was spent on the design aspects of these items. These discussions resulted in several component design changes aimed at improving the quality of the finished assemblies.

The resulting cell can be seen in the photograph below.

1 – General view of the cell showing the initial weld stations with double sided jigging

ROBOTIC WELDING CELL

The initial cell configuration with two weld stations arranged side by side was chosen because it provides:

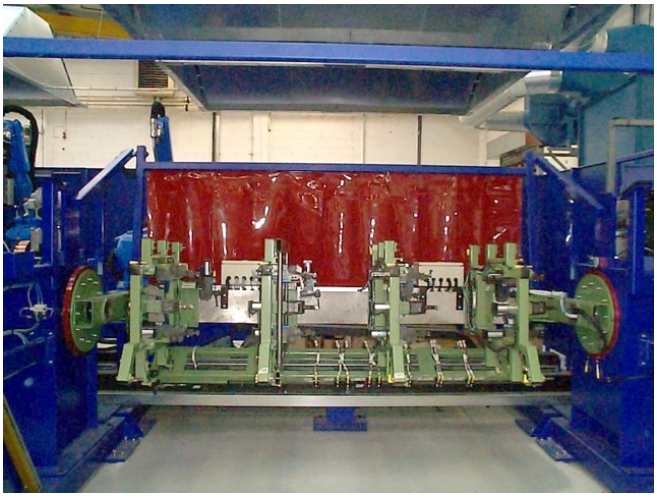
- A big footprint in front of both stations for storage of all the piece parts required for each product range.
- The ability to easily upgrade the cell by adding two further weld stations "back to back" with the first two, with all stations serviced by two robots mounted on a central track running between each pair of stations.

To be able to produce all the standard components with each product range the jigging needed to be double sided and mounted on manipulators positioned each side of the station. This arrangement allows the jigging to be rotated for loading and unloading, and repositioned as required during the weld cycle. Piece parts are clamped manually during loading with automatic unclamping to release the finished components. The sensing on the jigging allows any combination of standard assemblies to be produced during a single weld cycle.

The operator is protected from the glare of the welding arc and any flying debris by a curtain positioned in front of the station during the weld cycle. This curtain is made from strips of antiglare material fixed vertically to a horizontal beam. The strips are bolted together where they overlap to prevent accidental access by the operator during the weld cycle. The area underneath the curtain is protected by a light curtain which will stop the machine instantly if the light beams are broken.

The beam supporting the anti-glare curtain is mounted on arms which pivot vertically at each side of the station. This arrangement allows the curtain to be moved behind the jigging to provide access for the operator to load and unload the station. With the curtain in this position the operator will also be protected from glare and flying debris from the weld station opposite, once the cell has been expanded to four station operation.

In order to achieve the requirement for onsite upgrade to three or four station operation within two weeks, the initial cell specification included control cabinets sized to accommodate any additional equipment which would be required.



2 – Jigging mounted on manipulators

The double sided jigging for one of the two main product ranges mounted on manipulators at each side of the station. These manipulators rotate the jigs during loading, and also during the weld cycle. This arrangement allows production of any combination of standard assemblies during a single weld cycle.

3 – Twin robots mounted on central track

The two robots mounted on the central track which runs the length of the cell. This arrangement allows two more stations to be added later (opposite the first two). The arc glare curtain (shown positioned at the rear of the station to allow loading & unloading of the jigging) moves to the front of the station to protect the operator during the weld cycle.

ROBOTIC WELDING CELL

To remove the fumes generated during the welding process each station is fitted with an extraction hood which removes the air from around the work area. The effective volume of each station meant that a massive fan would be required to extract air from all four stations simultaneously.

The volume of air which needs to be removed from each station is reduced by baffles, which speed up the effective airflow along the front and rear edges of each hood. In addition, by linking the extraction system to the robot control system, the extraction for a given station is only operating during the weld cycle with some overrun to remove any fumes produced as a result of "after smoking".

Despite the above measures the volume of air removed during operation of the cell is considerable. As a result of this, the extraction system incorporates a filter which removes the fumes and impurities from the air and then returns it to the shop floor area. This eliminates any external emissions from the building, and reduces energy losses during Winter months by minimising the heat loss, which would have resulted from the heated shop floor air being extracted from the building into the external atmosphere.

As a result of the decision to link the extraction system to the robot control system, it was agreed that the extraction system would be provided by the supplier of the welding cell as part of the overall package. This simplified the contractual arrangements and reduced the potential for problems by keeping the lines of communication as short as possible.

Following an Acceptance Trial at the supplier's premises, the equipment was installed and commissioned into its designated area, where the cell guarding and extraction system had already been installed. This saved a considerable amount of time, and made the installation of the extraction system much easier by allowing uninhibited access underneath. Initial operator training completed the installation process.

The finished cell was entirely successful in achieving the operating requirements set out at the beginning of the project and provides the flexibility required to meet both existing, and future, business needs. In fact, the biggest challenge for the future will be the logistics of providing the variety and volume of piece parts required to keep the cell operating at full volume!

4 – Rear of the cell showing the blanked off stations and integral extraction system