Quality and productivity in welding

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In the light of the tougher economic times, John du Plessis of the SAIW talks about the productivity gains that can be achieved by reviewing welding operations.

The global economic meltdown is impacting on the manufacturing and fabrication sectors worldwide resulting in a slowdown of industrial activity. Major projects have been halted or cancelled, spending has slowed, competition for projects and products has increased, jobs have been lost and some fabricators are working reduced hours – and South African industry has not been spared.

Manufacturers and fabricators are all challenged in some way by the decline in revenue. Traditionally, this has been countered by reducing labour and other costs through downsizing, working shorter hours and curbing all expenditure. Greater gains can be made, however, through a critical review of welding operations.

A number of research polls and papers have indicated that the most common welding related challenges that fabricators and manufacturers are faced with today are:

- Reducing welding costs.
- Improving productivity.
- Simplifying welding processes.
- Finding qualified and well trained welders.
- Reducing new equipment costs.
- Purchasing the correct equipment

The above factors are interrelated and providing a solution to one or more invariably results in improvements in the other areas.

The question is 'How can these factors be practically addressed in order to yield quality improvements and savings?' Some proposed methods and solutions to cost savings and increased efficiency of the welding operation are outlined below.

Reducing welding cost: There are numerous potential ways of reducing welding costs. The most common in most manufacturing/fabrication operations are:

- Reducing the weld metal volume through the prevention of over-welding.
- Minimising rejects, rework and scrap rates.
- Eliminating pre-weld preparation steps – the application of anti-spatter, for example.
- Eliminating post-weld cleaning and grinding of spatter and excess weld metal.
- Avoiding overtime.
- Reducing wasted effort, unnecessary handling and delays during fabrication.
- Reducing the arc time per unit length welded.

Labour is the biggest contributor to the cost of welding. Thus any action which will improve the efficiency in this area will have a major impact on the costs of welding.

As an example, the generous use of grinding is never really questioned, but just accepted. If you are spending time on grinding spatter, chipping slag, grinding welds down to final size or reworking/repairing parts, then you are compensating for the inefficiency of the welding operations, which will add to the overall cost of welding.

To reduce costs requires management commitment and involves everyone. It is a process consisting of both quick fixes and gradual sustained changes. The process requires in-process controls for continuous improvement and to ensure weld quality. With welding, the finished weld may look good but could contain internal defects. Thus to control welding and the weld quality, the in-process welding parameters have to be verified.

There are numerous variables including choice of the welding process, weld joint configuration, material type and thickness, filler material type and size, weld size, pass and layer sequence, welding speed, weld current and voltage, polarity, welding technique and progression, pre-heating, interpass temperature control, post-weld heat treatment and others which all influence the weld.

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So how does one deal with the complexity? A good working tool is to use ISO 3834 'Quality requirements for fusion welding of metallic materials'. In *Figure 1* a summary of typical welding system control measures are given as used in ISO 3834.

Production personnel should have adequate training prior to performing production. They should have access to well documented welding procedures and instructions. As the projects change, welders and supervisors must be constantly aware of their tasks to reduce the work effort required and time and motion delays.

It is important to have an objective means of measuring performance and that the measurement be available to everyone at all times to see if the standard is being met.

Often common sense and simple techniques are all that is needed for improvement. Some productivity improvements can be gained by:

- Reducing the weld cycle time and the arc-on time.
- Improving the weld operating factor (arc time, total labour time).
- Increasing the deposition rates and travel speeds.
- Eliminating the need for rework – welding it right the first time.
- Eliminating unplanned downtime.
- Eliminating the non value-adding activities.
- Implementing Kaizen and lean manufacturing techniques.

Simplification of the welding process: One of the easiest steps to improvement is to simplify the welding process through:

- The use of welding power sources that are easy to set-up and understand.
- Using well-maintained equipment capable of retaining optimal welding parameters.
- Training of welders and operators to improve skills and consistency.

Modern welding equipment, especially inverter-based technology, has evolved rapidly in the last couple of years to the point where they are virtually 'push button' machines that address the need for simplicity and high productivity. The settings can also be pre-set and locked-in so that the welder cannot make unauthorised adjustments. The main aim is to relieve the operator from fine-tuning welding parameters and allowing him to concentrate on the welding technique to produce a consistent quality weld. This technology has improved the ease of use, the optimisation of welding parameters and the control, measurement and recording of welding parameters for quality purposes. The time to train an operator has also been decreased significantly due to the simplification of the settings.

The new generation of inverter-based power sources is more energy efficient – averaging 85% compared to the 60-70% for older power sources. They are also better at managing power fluctuations, which can affect weld quality when using a conventional power source. Consistent arc starts, smooth and stable arcs and improved weld puddle control also make them easier to use.

Pulsed gas metal arc welding (GMAW) has proven to be better suited than conventional gas metal arc welding in terms of problems such as lack of fusion, burn through, spatter, poor bead appearance and the management of distortion. Pulsed GMAW used to require expert knowledge to fine tune and implement but most modern pulsed GMAW power sources now come with built-in programs. Thus the operator only needs to choose the correct program for the wire size, base material and gas being used.

Welding equipment must be routinely maintained and the performance checked. Too often the welding equipment is used until it breaks down or suffers a serious malfunction. Education of the operator together with daily and weekly checks and maintenance routines will result in improved equipment up-time, less frequent unplanned down-time and more consistent quality welds.

Non value-adding activities: Time wasting and non value-adding activities can be drastically reduced. One of the common findings is that the welding consumables and welding equipment accessories are not readily available at the welding work station. The consumables have to be drawn from central stores when needed, resulting in significant amounts of unproductive time.

In the gas metal arc welding process the use of bulk consumable packs instead of spools results in improved efficiency due to fewer wire changeovers. In fact 'endless wire packs' are now available so that no welding station need ever be without wire.

Increased welding speed, arc time and weld quality: In the majority of South African welding operations, the welding parameters are not optimised. The result is that there are some productivity gains that can be achieved without any additional capital costs. Welding parameters are often set by the operators and differ significantly from one operator to the next, even on identical components. In some cases the welding parameters are set by maintenance personnel who do not have any welding knowledge. Through the development and qualification of welding procedure specifications and training to correct operator welding technique, significant productivity gains can be achieved.

Automation: There are many reasons for automation; the shortage of qualified welders, quality improvement and to increase productivity. Robotic welding is generally faster than manual welding, resulting in increased productivity – and robots do not suffer from attention deficit or bad days. An automated system can consistently produce the same weld at the same speed. The weld size control is much more precise, which reduces the amount of over- and under-welding.

An automated system, however, needs to weld in the same place every time. If the tolerance of a part cannot be maintained or there is variance in part fit-up, the company will simply be automating a broken process leading to increased rework and scrap. This is one of the biggest problems we encounter with automated applications. If one relies on the welding operators to compensate for fit-up issues, one needs to look at the upstream manufacturing process to ensure consistency.

Conclusion: In the tough economic times we are facing it is important to achieve substantial cost savings and increased productivity through the optimisation of welding operations. This can easily be achieved by focusing on and improving a few selected areas.

The implementation of ISO 3834: 'Quality requirements for fusion welding of metallic materials' is one of the most powerful tools available to drive increases in welding productivity.

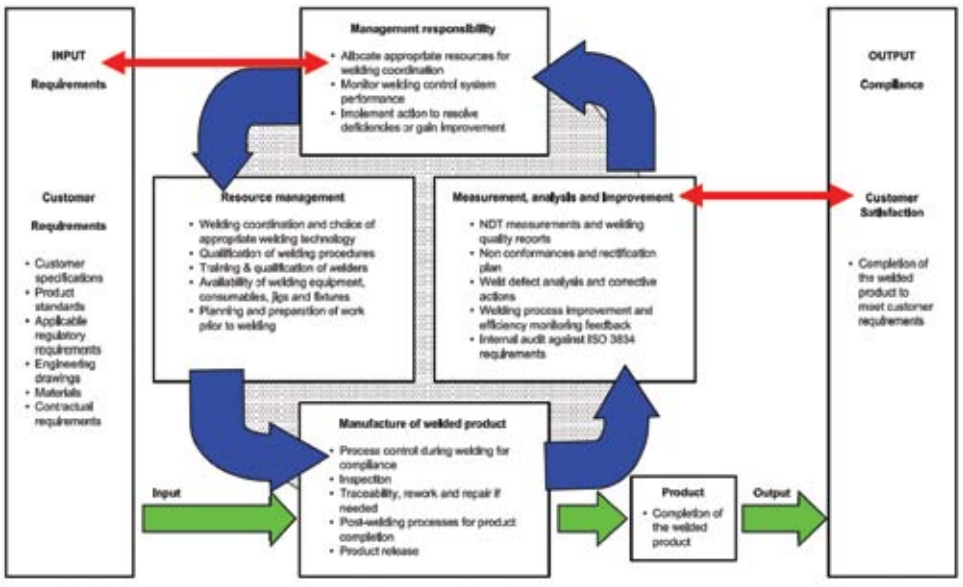

Figure 1: Summary of welding system control measurements.