Applying Kaizen to Welding Operations

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Abstract

One of the major differences between the Japanese and Western management styles is the time-frames used to measure success. Japanese management has a long term perspective, while Western managers tend to look for quick results. Unless top management is committed to introduce Kaizen as a top priority and realize that it will take time, any effort to introduce Kaizen to the company will fade before it ever flourishes. Changing corporate culture is really the only way to nurture Kaizen.

Kaizen can be applied to many areas of welding. It requires the involvement of everyone from top management all the way to the level of the welder. It also requires the presence of in-process controls for continuous improvement. ISO 3834 welding quality standard provides a good working tool to this end. Part 6 of this standard explains well the need for process control and emphasises the involvement of top management in welding activities.

What is Kaizen?

Kaizen is a Japanese term that means continuous improvement, taken from words, *Kai,* which means continuous and *Zen* which means improvement. Kaizen is not a single event, but rather a continuous heart beat in an organization, embraced at all levels and applied to all aspects of the business. Kaizen is a philosophy of working!

In the Kaizen philosophy any change or suggestion that contributes to the following goals, are given priority for implementation:

- Making the job easier
- Removing nuisance and drudgery from the job
- Making the job safer
- Making the job more productive
- Improving product quality
- Saving time and reducing cost

Standards and measuring system

In any business, management creates standards that employees must follow to perform the job. Companies, who embrace Kaizen, generally require the business managers to maintain and improve standards. It is imperative that an objective means of measuring the performance is needed to know, at all times, if the standard is being met or being exceeded. Clearly, instituting a method to measure the performance and monitor it for continuous improvement, is a necessary criteria for the process to work.. Lasting

improvement is achieved only when people work to higher standards. For this reason, maintenance and improvement of standards go hand in hand!

In the welding business for example, estimating standards in a company may be based on technical data like deposition rate or historical data, where actual hours can be compared to the standard welding hours to know if the contract is making or loosing money. If an accurate highly visible cost control system is not in place as the job progresses, experience has shown, that in most cases, the job will result in cost overruns, delays in delivery and loss of profits.

Those of us, who deal with managing welding man-hour over-runs, find that in most cases, the labor-hour statistics come in too late in the life of a contract to take any corrective measures. In some other instances, standard welding hours may be regularly revised upwards to absorb past inefficiencies, eventually forcing the cost of the product out of the market in a competitive environment.

Kaizen looks at problems as opportunities for improvement

The value of improvement is obvious. Whenever process improvements are made, these improvements eventually lead to better quality and productivity. Improvement is therefore a process. The process starts with recognizing a need and the need becomes apparent when you recognise a problem. Kaizen puts an emphasis on problem-awareness and will lead you to identify a problem.

The real issue is that the people who create the problem are often not directly inconvenienced by it, and often adopt a *laissez faire* attitude. They tend to take the inconvenience for granted. In day-to-day management situations, the first instinct is to hide or ignore the problem, rather than to correct it. This happens because a problem is an unwelcome event in a non-Kaizen organization. By nature nobody wants to be accused of having created a problem. However, if you think positive, you can turn every problem into a valuable opportunity for improvement. Simply put, when you identify a problem, you must solve it. Through continuous monitoring, if you can consistently avoid creating the problem, you in essence, surpass a previously set standard, improving the process to a new higher level standard of performance.

For the welder, if his weld has too much reinforcement or an undercut, generous use of grinding is never questioned!! Excessive grinding in a job shop is taken for granted. This is a very expensive inconvenience. The real corrective measure would be to avoid the discrepancy in the first place through adequate skill training, immediately when it first occurs! This is where responsible monitoring and supervision can pay off!

Kaizen requires a long term commitment

Kaizen managers are people oriented and understand that process improvement takes time. The results of Kaizen are not often immediately visible. It does not call for large investments to implement it, but it does call for a great deal of continuous effort and commitment. Often common sense and simple techniques are needed for improvement.

However, once the changes have been integrated in the day to day working, the improvements are permanent.

The non Kaizen organizations on the other hand are often obsessed by *innovation*. These organisations hope to reap the benefits before doing the homework of improving their operating processes. Innovation also requires investment in technology and often can be radical or disruptive. The middle managers in such organizations can usually obtain support for innovative projects because those projects offer a return on investment that is hard to resist on a short term time horizon. On the contrary when a lead hand wants to make a small change in the way his workers perform a task, obtaining management support can be difficult because the improvement in the process does not immediately show a large return on investment. If profit is the only measure of performance, then management will be reluctant to implement improvements that risk hurting short term profits, even if the long-term benefits of such change are obvious!

In a welding shop, if a foreman requests installation of a small jib-crane for making the assembly of welded parts easier, often, his demand will be ignored, and be considered unnecessary! However, management may look favourably to invest in an expensive machining center or a robot that may remain idle for long periods of time!

Kaizen, Innovation and business growth

In a slow-growth economy, Kaizen is often a better solution rather than uniquely relying on innovation for growth. When Kaizen is first introduced, many companies see productivity increase by 30 to 100%, all without any major capital investments. Kaizen helps lower costs and lets management become more attentive to customer needs as it creates an environment that takes customer requirements into account. Kaizen does not replace innovation. In an ideal situation, innovation takes off after Kaizen efforts have been exhausted, and kaizen begins again as soon as innovation is implemented. Kaizen and innovation, together make progress.

The example of the Toyota Motor company is perhaps the most revealing success stories of this decade. They pioneered the application of Kaizen and Lean concepts to automotive manufacturing! Their vehicles are competitively priced with unsurpassed quality. Once they had exhausted the Kaizen efforts, innovation took off to create a new standard - the hybrid vehicle. This shows the power of Kaizen!!

Kaizen applied to Welding operations:

It is indeed difficult to know where to start, as welding is a complex process. More over, welding being a *special process*, in-process controls are required, to ensure final quality of the weld. In other words, the finished weld may look good, and visually not show any non conformance, however, may contain a defect that can be revealed only through destructive testing or additional ultrasonic or radiographic testing..

To properly control welding, many in-process parameters must be verified. For example, limited to semiautomatic welding (processes like GMAW, FCAW & MCAW) there are more than 27 parameters! To name just a few:

> Choice of welding process, choice of weld joint, plate thickness, type of base and filler materials, weld size, weld pass and layer sequence, wire diameter, wire feed speed, welding speed, welding current and voltage, electrical polarity, shielding gas type, gas flow rate, welding technique and progression, preheat, post heat, inter-pass temperature, weld backing, back gouging, electrode stick-out, deposition rate, heat input, distortion, etc!

To put your mind at ease, most welders should have adequate training prior to performing production, and in most cases would have access to a well documented welding procedure, that would help choosing the correct parameters. Thus, for semiautomatic welding, what *are* the most important parameters, affecting quality and productivity? Kaizen should be applied to the following three parameters as a start:

- Wire feed speed
- Welding technique
- Welding speed

To illustrate how Kaizen can be applied to welding, let us review the results of a case study. Thirteen experienced welders, working for a structural steel bridge manufacturing contractor, were asked to weld 12 inch long, 5/16" fillet welds, using 1/16"diameter FCAW wire in the 2F position. The welders were asked to execute the test plates at their own work station, to reproduce the welding parameters used for production. These structural welders were experienced and were assumed to be optimized.

Table 1 shows the measured data and the results of the testing.

- Average wire feed speeds were measured at 229 ipm. An average wire feed speed of 350 ipm was attained after twelve months of monitoring.

- All the 13 welders were using the wrong welding technique. Several years ago, the welders had been transferred from a GMAW welding facility (where a push technique is recommended) to a structural steel FCAW facility (where a pull technique produces best results). The quality results were disastrous! 12 out of 13 welders failed to produce welds to the required specification and 9 out of 13 welders failed to produce acceptable penetrations! Changing the technique and increasing the wire feed speed, solved the penetration problems.

- The observed travel speed was measured at 8.8 inches per minute. This value is almost half of the optimized travel speed to deposit 5/16" fillets using the Flux Cored Arc Welding process. The average welding speed was increased to 14 ipm after twelve months of monitoring.

Role of the President and CEO for Kaizen as applied to welding

At the structural steel fabrication facility discussed above, there were many more welders than the 13 tested. Following the audit findings, several recommendations were implemented. The training of welders was specifically designed to give them a feedback on the quality of the macros. This was achieved over a period of 12 months. Initially there were many non believers. Over time, both quality and productivity improved. The President of the company was the most visible and eloquent supporter of this process, he had set the stage and created the environment for change! There were no more bridge components returning for repair!

A similar kaizen approach was followed with an agricultural manufacturer. Immediately after the audit, the CEO was ecstatic. He ordered standardization of the weld monitoring operation. Since the last 8 years, the average wire feed speed for GMAW, 0.035" diameter wire has increased from 420 ipm to 600 ipm. Over this time period, the welder population has also steadily increased from 90 to 150 welders, as the company now exports their products all over the world!

The ISO 3834 Welding Quality standard is an interesting standard. It describes many important process control parameters to ensure that welding remains under control. The newly introduced part 6 of the standard provides a useful guide for its application and shows several diagrams, one of which involves top management. This diagram has been reproduced in Figure 1.

Conclusion

Kaizen is an interesting process to apply to welding. It produces, in most cases spectacular results. It is not disruptive; however, it takes a commitment of the whole organization including the President or CEO. The two illustrated examples are a small sample of over 100 welding performance appraisals carried out in Canada over the last ten year period. The good new is that it works! It is truly an exciting journey in human engineering!

Table 1: Case history with Kaizen for FCAW structural 5/16” horizontal 2F fillet welds. After twelve months of monitoring, average welding speed increased to 14 ipm., wire feed speed to 350 ipm, over-welding reduced to 15% and all welds passed. The welding technique was changed to a pull technique.

Team	Sample number	Required size (inches)	Wire feed speed (in/min)	Technique Push/pull	Welding speed (in/min)	% over welding	Visual evaluation Acc./Rej.	Penetration evaluation Acc./Rej.	Global evaluation Acc./Rej.
Night	1	5/16	235	45 push 15-30	11.8	-20	Acc.	Acc.	Rej.
Night	2	5/16	212	40 push 0-5	7.9	10	Acc.	Acc.	Acc.
Night	3	5/16	236	40 push 0-5	9.5	68	Acc.	Rej.	Rej.
Night	4	5/16	220	40 push 15	10.6	40	Acc.	Rej.	Rej.
Night	5	5/16	211	40 push 0	10.9	-10	Acc.	Acc.	Rej.
Day	6	5/16	222	40 push 0-10	10.1	40	Acc.	Rej.	Rej.
Day	7	5/16	259	35 push 5	9.2	44	Acc.	Rej.	Rej.
Day	8	5/16	302	40-45 push 5	9.6	68	Acc.	Rej.	Rej.
Day	9	5/16	219	45 push 15	7.6	20	Rej.	Rej.	Rej.
Day	10	5/16	241	45 push 0-5	7.2	44	Acc.	Rej.	Rej.
Day	11	5/16	200	45-50 push 10	10.0	-10	Acc.	Acc.	Rej.
Day	12	5/16	210	45 push 15	7.2	44	Acc.	Rej.	Rej.
Day	13	5/16	210	45 push 25	6.4	44	Acc.	Rej.	Rej.
			Average		Average	Average	Accept	Rej.	Rej.
1/16" diameter FCAW wire, 100% CO2			229		8.8	29.4%	12	9	12

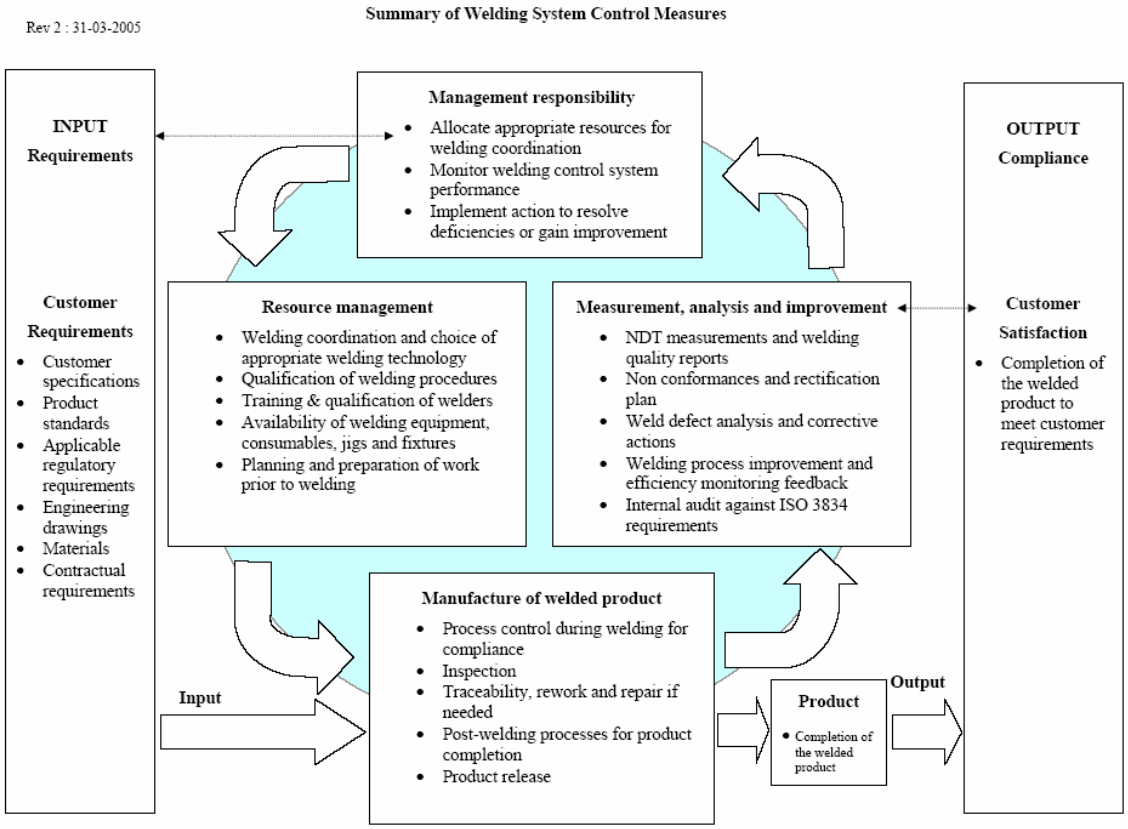

Fig. 1: Summary of welding system control measures from ISO 3834 part 6 proposed diagram