A Multi-Disciplinary Approach to Optimizing the Resistance Welding Process

Abstract

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This paper introduces three innovative ideas of optimizing the resistance welding process. The first illustrates how accounting concepts can be used for comparison and contrast to highlight problems or unusual results; the second explores how looking at the process itself can bring a fresh approach, and the third is a result of carefully reviewing a simple consumable.

All three of these ideas are in production use around the world today, and their rapid adoption illustrates how new and imaginative approaches are still being used to encourage the use of the resistance welding process.

A Multi-Disciplinary Approach to Optimizing the Resistance Welding Process

Global competition continues to increase. As a result, companies around the world are seeking to reduce costs wherever and however they can. In the resistance welding field, many would argue that European and certain Asian countries are ahead of North America in reducing welding costs while maintaining and improving welding quality. They are achieving this through innovation and creativity.

This article provides three methods and examples of how innovative companies are saving money. Through extrapolation, these three specific approaches provide additional avenues for other, additional savings that can be explored in related applications. The first method discussed here uses ancillary skills to approach welding from a slightly different angle; the second looks at the overall field of resistance welding; and the third looks at specific components used in resistance welding. Thus the aim here is to provide a spark, or a beginning point, for those companies looking to minimize their resistance welding costs with innovative thinking.

Unfortunately, many methods and systems to save money, (much like anti-aging creams for women's skin and gels for covering men's greying hair), are replete with gimmicks and buzzwords that sound good but achieve little in practice. This article, however, will illustrate actual methods and systematic approaches used by successful companies employing resistance welding. There are no copyright catch phrases here.

In general, the success of these productivity improvements is based upon utilizing the skills of more than welding engineers alone. The article will highlight the types of companies that have been able to successfully innovate the most have drawn upon the skills of other employees and other disciplines within their organization. It will be the point of the article that the most successful net productivity increases will come from an open mind to consider new ideas; well organized; focused and formatted; drawn from a variety of informed sources. And, most importantly, the article will suggest that the lessons that can be learned from resistance welding can be applied to other welding processes and procedures, and, in fact, other fields and endeavours.

I - Coming at a Problem from a Different Angle

The first method uses accounting concepts as a tool of analysis to tackle welding issues. Many years ago, automakers realized they could bring cars to market sooner and more successfully if marketing and engineering worked together. Unfortunately, this idea of using a variety of disciplines to seek ways of reducing welding costs has not developed in North America. Generally, in Europe and in Asia, cost accounting for welding is more developed and taken more seriously than it is here. Specifically in Germany and Japan, cost accounting is used to a much greater extent than in North America to gather detailed costs associated with welding and then aggregated to provide useful information to management. This analysis can be called the 'cost per weld' or 'cost per foot (metre)' method. It is actually easy to understand and implement. Figures 1 and 2 below chart a simplified grouping of costs.

Cost per weld approach

This method accumulates direct and indirect costs and allocates them to specific welds. For example:

Direct labour	$100
Direct material	100
Indirect costs	100
Other costs	100
	$400
welds performed	5,000
cost per weld ($400/5,000)	$0.08

Cost per square foot approach

This method accumulates direct and indirect costs and allocates them to a specific area of the factory.

Factory costs	$100
Labour costs	100
Consumables	100
Other costs	100
	$400
square feet	2,000
cost per square foot ($400/2,000)	$0.20

Figs. 1 & 2, a simplified illustration of costs allocated to a specific weld or area of the factory

Often, in North America, total welding costs are not even known. While the absolute cost and number of consumables maybe known, intelligible knowledge of how capital, running, and maintenance costs affect overall resistance welding costs is neither tracked nor even considered.

Let me explain. Assume an objective is to reduce welding costs by 5% without affecting quality. Where do costs come from? It isn't just from consumables. It encompasses everything from labour to utility and depreciation costs. Obviously, some costs are harder to change than others. If factories are located in a number of different locations, some of these differences will already be known. If different equipment is employed, their performance will be different. Interestingly, even similar equipment performs differently in different locations, and generally North Americans keep poor records of how they are doing at different locations with specific different equipment. This is a weakness.

In Germany, there is a developed interest in ***tracking costs per square metre*** of factory floor and by manufacturing operation and per machine. In their version, costs (including indirect costs) are gathered and allocated to the factory floor based upon its area. In Japan there is interest in ***tracking costs per actual weld*** performed. In this version, costs (including indirect costs) are gathered and divided by the actual number of welds performed. Information is power; once you know what your costs are – on a timely basis – it is easier to see if things are improving, getting worse, or staying the same.

The German standards are particularly useful in that they allow comparisons across an industry, different companies, and different welding processes – in different locations – to be easily compared. It has proved to be of great help in their transitioning of manufacturing plants out of highly automated and high labour cost Western Europe to lower cost Eastern Europe. Such moves to Eastern Europe is illustrative of major, long-term cost saving plans, and has been effective in that the labour force, generally speaking, is well educated, highly motivated, and very capable of managing and reporting change.

One notable case was the transfer of small welded assemblies (stamped and welded hinges and brackets) from Germany to Hungary. Simpler tooling from less automation and lower labour costs reduced indirect costs by 10% and direct labour costs by 30%. Detailed and accurate accounting records allowed for the rapid scaling of production and early realization – and reporting – of cost savings. Information is power. German welding engineers are not hesitant to use German accountants.

In Japan, the analysis of detailed costs and the allocation of indirect costs to individual welds per machine, or weld cell, or production line, reflects their underlying belief (well, a theoretical belief at least!) that every weld has to be a perfect weld. This is the concept of '*cost per weld,*' where all welding costs are allocated to individual welds. There is the famous example of a major Japanese automaker that has the same 'cost per weld' on the similar production lines in Japan, Argentina, and in Western Europe. Similar detailed costs around the world would certainly suggest that costs are controlled in a format that is comparable. Consistency has its own reward. How many North American plants of the same company have the same cost per weld? The point is clear; we don't even know what the costs are.

It has been proven that the introduction of whole new cars has been introduced faster, with fewer problems, and at less overall launch cost, when multi-disciplinary teams are brought together to execute the project. The same results can be expected if teams are introduced for cost saving initiatives in welding.

II – Reviewing Overall Processes

The second method of reducing welding costs generally requires a little more vision, risk, knowledge, and analysis. Those able to successfully manage these criteria are amongst the most successful of companies employing welding. They include the adoption of leading edge technologies, such as simulation software, to optimize welding parameters, 'active' welding controllers, and single-sided spot welders. Here the discussion will revolve around one such process, single-sided spot welders, and examine why it has been useful to some companies.

Japanese and Korean auto companies have successfully concentrated on reducing cycle times. The more cars you can produce from the given set of tooling in a day is something that makes any accountant excited. Single-sided spot welders are one such tool. Instead of the expensive and slow moving welding guns so common in North America, there has been a recent tendency in Asia to move toward single-sided guns that can more rapidly move from weld to weld, requiring simpler tooling and back-up bars. Why? They are quicker. They are simple.

Those readers with a long memory will remember that North Americans had pogo-style welders 30 years ago. Why would they appear to be so much more effective and better at generating quicker welds now? And why did North Americans abandon them? The older pogo-style welders tended to have less developed force and current controls. Despite the wealth and profits of the last 30 years, North America has been slow to adopt new technology in active weld controllers, the software to optimize welding parameters, slow to improve quality standards, and hesitant to implement new ideas.

Figure 3 below illustrates a manual single-sided spot welder. The second electrode is distant from the first electrode and the current path is more convoluted:

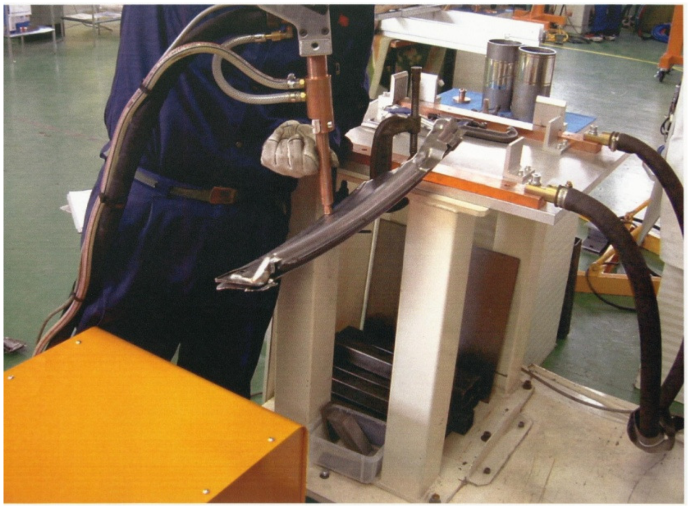
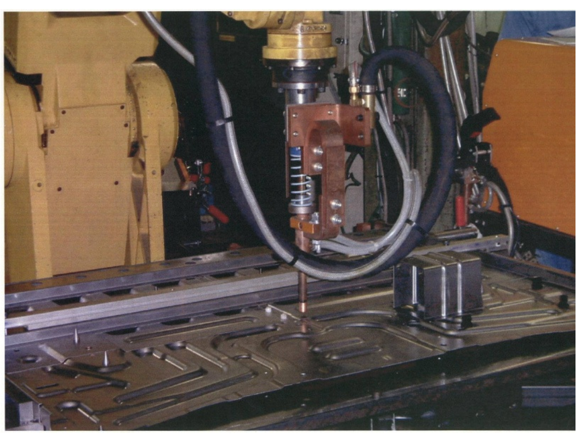


Fig. 3, a manual single-sided spot welder

Single-sided spot welding is being increasingly adopted as it can be a faster process (more 'welds per minute'), with cheaper tooling and, further, the process can also allow sheet to be welded to hydro formed tubes and other more complicated structures. This particular aspect has proven difficult to do with traditional spot welding guns, limiting the use of inexpensive resistance welding and requiring more expensive welding processes with shielding gases and filler metals.

Figures 4 and 5 below show a robotic application, with the left picture showing the part and the right the tooling back-up bars. The traditional robotic spot welding gun moves slowly through its programmed arc, carrying its weight and the twin clamps of its electrodes from spot welding position to spot welding position. The single-sided spot welder can literally jump from position to position, greatly decreasing cycle time and improving productivity.



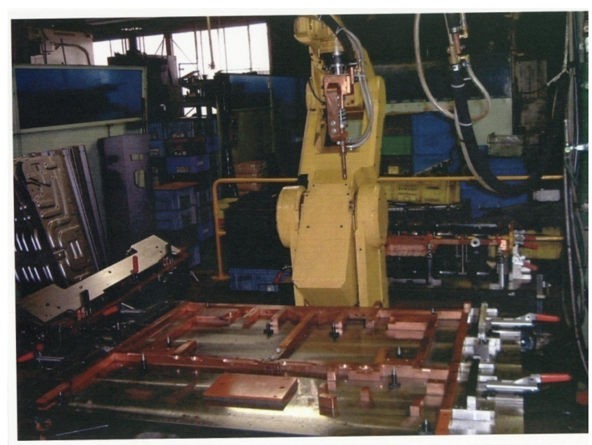


Fig. 4 & 5, a robotic single-sided spot welder with a part in the tooling (left) and revealing its tooling of back-up bars (right).

The trick, of course, is that the welding process must be well understood to be able to do this effectively. The typical innovator with single-sided spot welders has excellent maintenance programmes, good robotic programming, and an excellent understanding of optimizing welding parameters as well as superior weld parameter control. Having the correct weld parameters and a sophisticated weld controller are essential ingredients when using single-sided spot welders.

III - Reducing Costs from Specific Components

Consumable costs are large in the resistance welding process, and it is necessary to analyze and examine them. In this way, original and detailed examination of the standard North American tungsten-faced projection welding head has recently led to the replaceable modular head that is simple, easy to use, and inexpensive. Figure 6, below, shows a typical tungsten-faced projection welding head, while figures 7 and 8 show the modular projection welding head with its constituent screw-together parts.

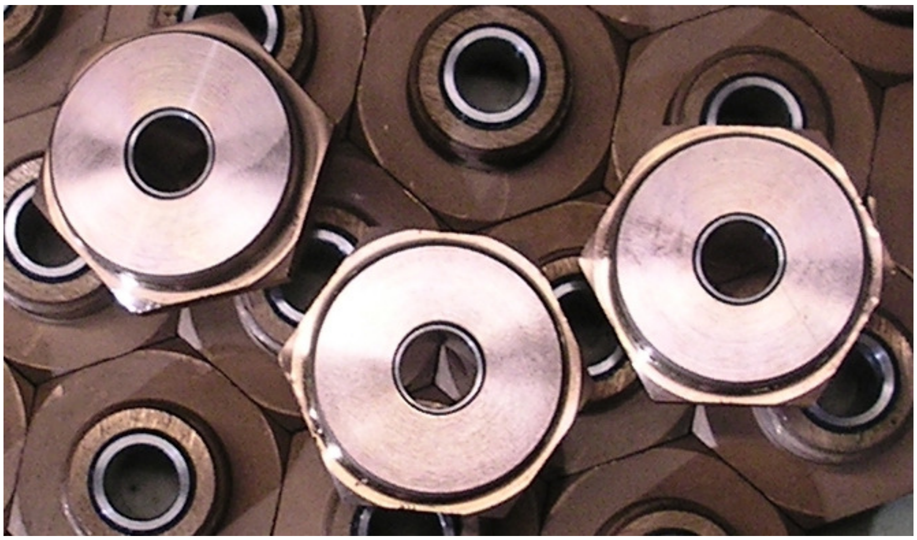
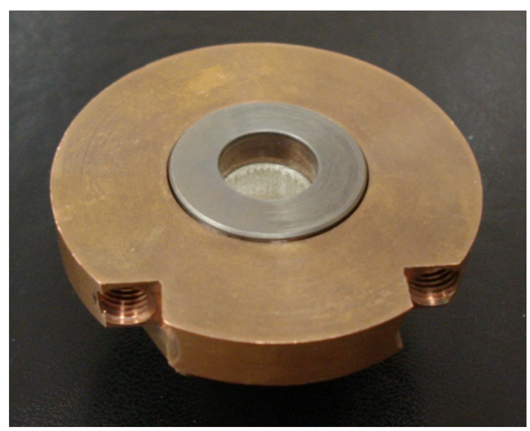


Fig. 6, a number of expensive, welded, tungsten-faced projection welding heads.



Figs. 7 & 8, the modular projection welding head with its inexpensive and replaceable components

This simple idea has saved one major North American OEM over $100,000 in six months at the first facility it was introduced. The modular head parts can be standardized; it is easily cooled; it lasts as long; it can be made of different materials: and the conversion from the old fashioned expensive tungsten-faced head is easily implemented. Not surprisingly, it is being adopted across the company. It came about through an awareness that things cannot, need not, and in fact must not, stay the same. This same OEM, and others, have also started to follow Japanese and European automakers to replace coated chemical vapour deposition (CVD) locating pins with solid ceramic pins that have infinitely superior wear characteristics. Figure 9, below, illustrates a composite stainless zirconium oxide locating pin. The strength and dimensional accuracy of materials such as solid zirconium oxide more than offset their cost when the full life of a project is considered. Unfortunately, many companies do not know their full costs! They are not set up to recognize that the daily cost of replacing of a $5 pin is more expensive than replacing a $50 pin – once.

Fig. 9, a composite steel and zirconium oxide pin

Conclusions

This paper has reviewed three approaches to minimizing welding costs – from a different angle, with accounting information; from the process itself, by exploring single-sided welding guns as an innovative way of speeding the production lines; and from examining the basic assumption of what a consumable should look like – the replaceable modular projection welding head.

Successful companies that minimize their welding costs have a clear direction. They have a focus and know where they are going. They do not hide behind buzzwords and half-understood concepts. They don't worry solely about "carbon imprints," "just in time inventory" or "lean manufacturing", or whatever is the fashion of the month. It is not that the carbon imprint is not important; it is rather that a company's welding process is a "whole" issue, and a confusion of passing gimmicks and catch phrases distracts rather than focuses the company.

Companies that are able to minimize and optimize their welding costs are comfortable with the risks they are taking, as they understand these risks. They understand the importance of correct welding parameters, good maintenance, accurate robotic programming, and generally have clear, long term planning. They

1. know what their objectives are, and have achievable goals,
2. have a desire to succeed and beat their competitors,
3. have a desire to learn from their competitors,
4. have a realization that the way it was done yesterday is not good enough,
5. have a desire to innovate and consider something new, and

6. have a desire to understand the problem deeply and from new angles – to consider the how and why of a welding process.

Less than five years ago, a certain vice president of manufacturing of a very large company said to me that his company "didn't need to know about welding, it was their suppliers' concern." Such short sightedness is a recipe for failure. To beat your competitors you must understand all aspects of your product and of how it is made.