Mechanised and automated welding —a structured approach

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1. Introduction

Mechanised and automated welding has traditionally been the province of processes such as submerged arc welding or machine controlled GMA welding. This is further underlined by the fact that the accepted name for manual (hand controlled) GMA welding is known as 'semi-automatic' welding. This mis-use of realistic and appropriate titles has only been effeftive in confusing new students to the profession or engineers from comparative technologies. The purists in our profession have often argued for a change in our approach to something like:-

Manual Welding :	Any welding operation carried out in a manner in which the welding torch, electrode or gun is manually held and controlled.
Mechanised Welding :	Any welding operation in which the welding gun is supported and driven mechanically but is manually supervised.
Automated Welding :	Any welding operation in which the welding gun is supported mechanically may be controlled by pre-set instructions and utilises in-process information to make correction during welding to maintain consistency.

Of course, the purists in our profession, like any other, do not dictate how the market views or describes the equipment or processes it uses, and quite rightly so! However, evolution has a habit of sorting things out in time and it is becoming apparent that developments are occuring within welding technology and they do appear to be gathering pace so we may be facing significant changes in our approach to modern welding processes.

We are now inextricably moving away from manually oriented welding processes. The welding consumables consumption figures clearly show a significant trend (Ref. 1) away from manual metal arc welding to the continuous wire processes.

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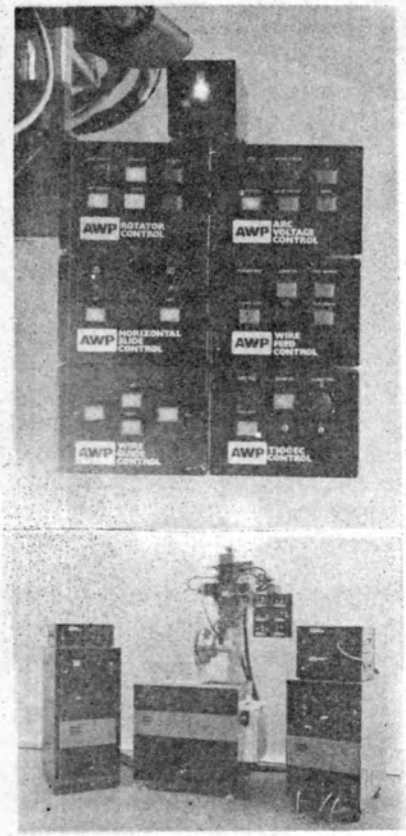
If the reason for this is to obtain an increase in weld productivity, and this appears to be the principle reason, then any more to 'semi-automatic' GMA and FCA welding will only be a temporary resting place. The real goal must be to achieve arc-on times of 50% and above, and the only way to achieve this is to continue the process of change into mechanised and on into genuine automated arc welding.

It is my intention to highlight the trends which can be detected in the progress of welding technology and suggest where these trends will take the industry.

2. Present Status

The phrases "mechanised and automated welding" usually brings up visions of column and boom, roller bed, rotator, seam welder and the use of submerged arc, electroslag and keyhole plasma welding processes. There has been changes in these equipments and processes such as more sophisticated controls being used to give better programming facilities. However, this type of equipment emerged when fabrication companies specialised in certain produce areas, when the purchase of a five meter longitudinal seam welding machines was both essential and fully justified. Today's market is different, companies can no longer afford the luxury of a single concentration on a particular product range or even a particular market. The development in mechanised and automated welding will have to reflect this changing approach by fabrication companies and customer requirements.

The second approach to mechanised welding has been the use of dedicated welding systems, usually designed and supplied to perform a limited variety of specified welds. Figure 1 shows such a dedicated welding system commissioned by Whessoe Heavy Engineering Ltd. for certain welds in their work on the Heysham II and Torness AGR power station (Ref. 2). These welding systems were highly successfull due, in no small measure, to the dedication of the engineers at Whessoe. They achieved better results than even they anticipated but they had to do it by pushing one the door of technology



Dedicated welding system designed for the site welding of AGR fuel standpipe closures. (Ref. 2)

and by significantly altering their working practices. However, the problem with this approach to automated welding is the same as that of the traditional column and boom. The welding system shown in Figure 1 was designed to perform a very narrow band of welds and requires significant engineering changes to the system to make it suitable for other welding tasks. Therefore the use of dedicated welding systems must be completely justified on the joints for which the system has been designed.

3. Emerging Trends

A number of emerging trends have been observed in the welding industry over the last five years which initially seem unrelated but almost certainly will all have significant impact on the future of welding technology. The principal trends observed are :

i) Continuous wire/cored wire consumables
ii) Power electronics
iii) Pulsed GMA welding
iv) Computer control systems.

3.1 Continuous Wire Consumables

The market has been showing a steady increase in the use of continuous wire consumables for some years and in approximately 1982 the sales of wire products exceeded that of the previous dominant product, that is the "stick" electrode. The principal reason for this is the requirement for increased duty cycle and hence improved productivity resulting in reduced costs in the completed joint.

A more recent change in this field has been the much wider range of cored wire products becoming available. This will greatly improve the lack of flexibility of the GMA process which is the main criticisms directed at the solid wire version of this process.

3.2 Power Electronics

Great strides have been made in the field of power electronics particularly for the control of welding power. The Welding Institute started this trend in the 1960's with the use of transistors in welding power sources. After a delay, various welding manufacturers took up the challenge and there emerged a variety of designs of electronic power supplies. The main advantage achieved by this trend is the achievement of flexible and repeatable welding power supplies. Power supplies became available, at an economic cost, which could be programmed to produce almost any welding condition and do so in consistent and repeatable form. So it has become possible to achieve flexibility and tight control from a wide range of welding power sources.

3.3 Pulsed GMA Welding

The developments described in Section (ii) have given rise to the re-emergence of the pulsed MIG welding process. It has been the ability of modern welding power sources to control pulses of current precisely, that has produced the basis for the surge of interest in the pulsed current GMA welding process. It has always been recognised that this welding process is potentially the most universal of all welding processes enabling virtually any metal to be welded in any position. Recent developments of using pulsed GMA welding in conjunction with cored wire consumables has further increased the improved flexibility of this process.

3.4 Computer Control

Welding and work piece manipulation are complex processes and when quality control requirements are added for monitoring and correction procedures it can become unacceptably complex for manual supervision. To ease this burden, certain of the more modern power sources are using micro-computers to control welding parameters such as pulse conditions and output slope control and for the storage of welding parameters.

Other more extensive examples of computer control have been developed which take into account not just the control of the power source, but also the control of other aspects of the welding operation such as wire feed control, arc length control, work piece manipulation etc. One such approach to total control of the welding process is described in reference 3 in which the circumstances of the application have dic - tated that, control of the welding system must be performed totally remotely. The engineering team turned to computer systems to completely control the total welding cell and this was successfully achieved. The basis of this approach to the welding system and others like it may well hold the key to the future of automated arc welding systems.

3.5 Summary

In this section on the emerging trends in welding technology, three things stand out as being critical to future welding systems :

Flexibility	: To allow fabricators to achieve a wide variety of customer requirements to meet varying market demands.
Control	: To enable every weld to be achieved satisfactorily and consistently such that the welding cell takes its equal place along with other high technology cells in a medium manufacturing facility.
Duty Cycle	: Consistent and sustained welding such that productivity can be maintained at a high level and that unit costs are kept to a minimum.

4. New Approaches

Like the emerging trends discussed in the previous section, future changes will evolve over a period of time. Some developments are already becoming obvious whereas others are still difficult to envisage as final products.

4.1 Short Term Developments

Two principal short term developments are obvious from present signs in the market.

i) Continuing moves to combine cored wire consumables and matching welding equipment to achieve maximum flexibility and productivity.

ii) Improvement in the approach to mechanised systems such that a similar controlled and flexible approach can be achieved from mechanical equipment.

This second development is the most interesting since it presents the welding equipment manufacturer with the greatest problems. SAF, the major French welding company, has been looking at this problem and has already developed a modular approach to flexible mechanised equipment for welding. Figures 2,3,4 and 5 show some of this equipment as a collection of individual units and then assembled into a typical welding equipment set-up. This modular equipment has been carefully thought out in terms of compatability and inter-linking but it is the enormous range of individual units and the detailed interfacing units which make the difference between a laboratory system and this genuine industrial approach to module mechanisation.

The flexibility of this equipment can be demonstrated by showing that one set of modules can be formed into some ten different mechanised welding systems. In addition, by adding other key modules to a system which has already been working on a particular welded joint, the welding station can be completely transformed to perform completely different welds, e.g. a system designed to carry out vartical seam welding can be easily changed to act as a lathe-type welding machine. The systems shown in Figures 3 and 5 can be easily converted into a wide range of mechanised welding systems for GTA, plasma, GMA and submerged arc welding.

This approach introduces a high level of flexibility in the approach to the mechanised equipment required for welding. Fabricators are not limited by the traditional positioning equipment such as roller beds etc., but using such modular equipment the system can be easily re-configured to meet other applications. This provides the flexibility to enable fabricators to meet changing customer requirements.

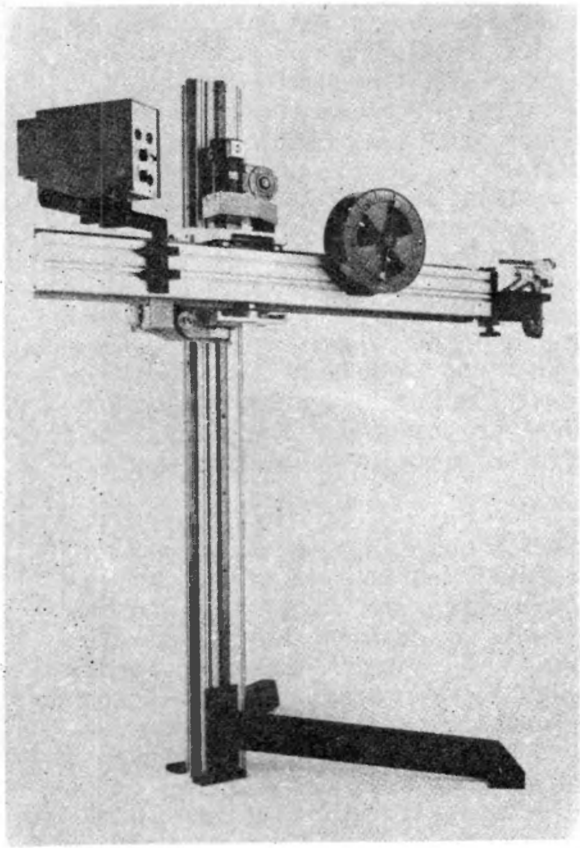
4.2 Long Term Developments

Two developments dominate the long term view of mechanised welding systems.

i) Guidance systems
ii) Modular computer control.

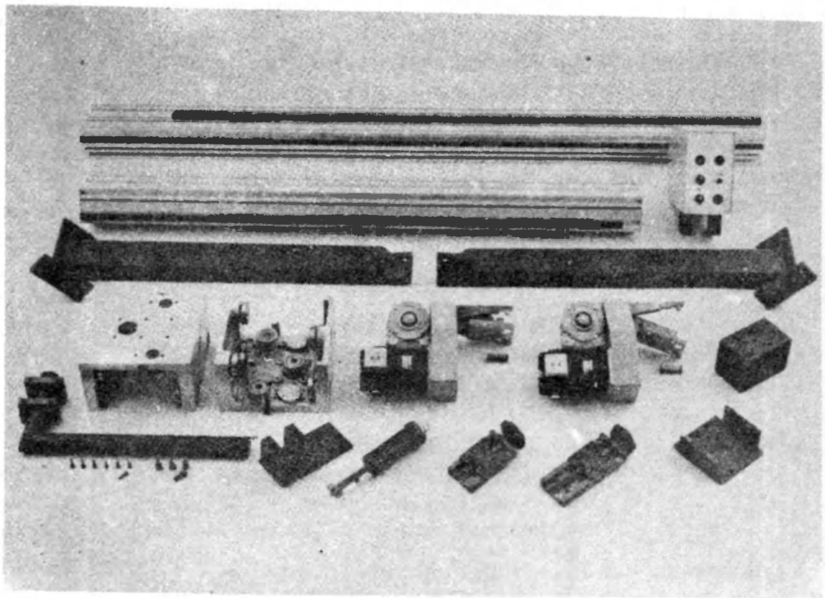
(i) Guidance Systems

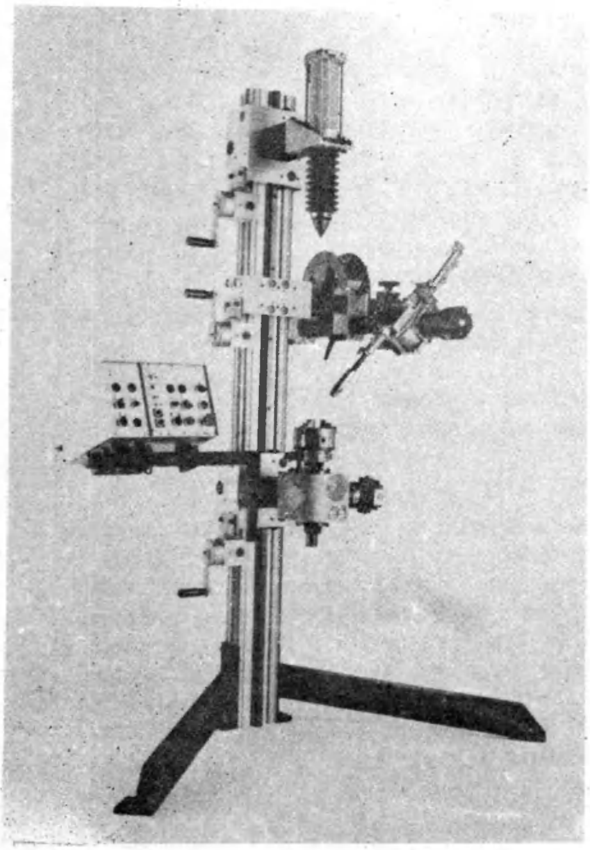
The continuing search for a genuine non contact universal guidance system is ongoing. Definite signs are emerging that progress is being made and such systems will undoubtedly be a commercial reality in the foreseeable future. The incentive to obtain this product lies in the ability to achieve potential duty cycle increases from 50% to 80/90% and as such has significant commercial advantages.



3. Components assembled into boom type welding system

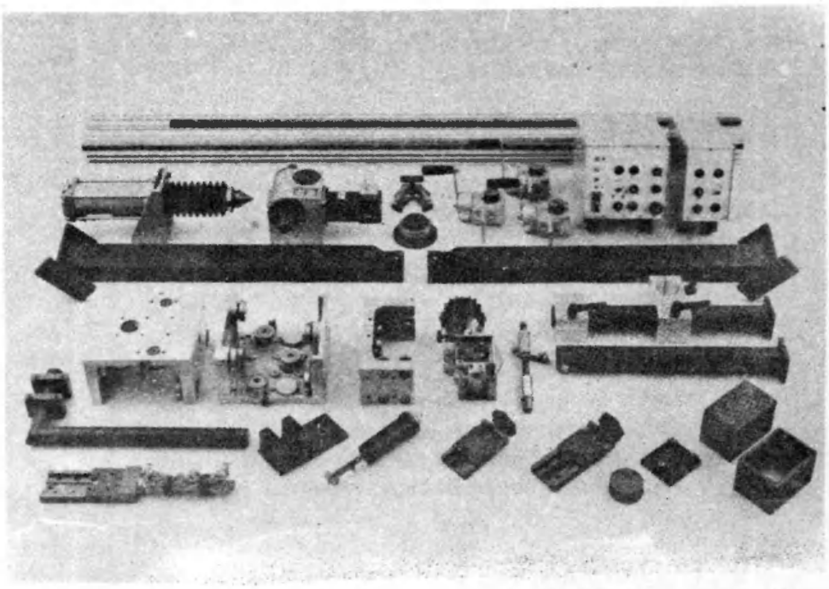
2. Components for mechanised welding system





5. Components assembled into system for rotational welds in the vetical axes.

4. Components for mechanised welding system



(ii) Computer Control Systems

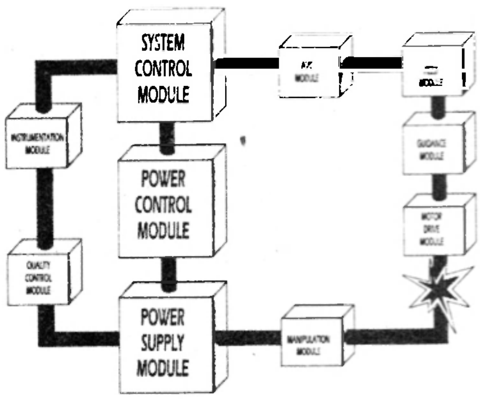
The second major change envisaged over the next five years will be a significant increase in the use of micro-computers to remove the complexity from welding systems. The majority of computer systems used at present tend to be complex at the operator interface requiring a welding engineer to programme and often to operate the equipment. The alternative approach appears to be that the computer control performs the same task as the hard wired control system but in a more updated fashion, hence used as a sales gimmick.

The principle advance in using computers must be to substantially reduce the complexity of the process. This can be done by using memory systems containing extensive pre-programmed welding conditions such that only alterations of conditions are necessary to refine parameters to meet the requirement of particular jobs. Operator interfaces will be simple to understand and operate, such that technician skills similar to that of machine tool operators will be the main requirement. This allows operators the time to carry out the principle role of the skilled welder which is to act as a quality controller by consistently monitoring the quality of the on-going weld.

A modern computer controlled welding system will be laid out as in figure 6. The central system will control and monitor all functioning modules and will know which modules are connected and which are not and will adjust the information paths accordingly. The operator interface will be simple to use, such that operators need not have any previous experience of computer control systems. Welding systems must become tightly controlled cells linked to other manufacturing cells and automatically programmed by an overall factory communication system. All the technology now exists, the fabricators who use the latest technology to advantage, who learn about the latest developments and can correctly specify the equipment most appropriate to their applications will emerge as the leaders in their field. Those who shun advance in technology will only have a limited future.

5. Summary

A group of initially unrelated developments in welding technology show the emerging trends in the future of welding as a fabrication technique. Increased flexibility, better control and high productivity are the continuing requirements for the future. Short term developments such as greater flixibility and cost effectiveness in continuous wire consumables and equipment for mechanised welding are necessary to enable fabricators to meet changing customer requirements. In the longer term we look to universal guidance systems to gain significant increase in productivity and to computer control systems to provide the overall control and high level of supervision required to ensure the productivity and the high level of joint success rate required by an advanced manufacturing facility.



6. Schematic layout of typical computer controlled welding system

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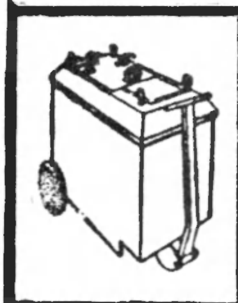
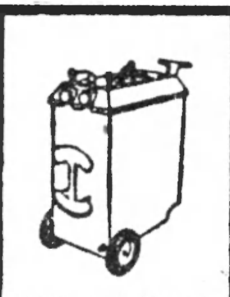
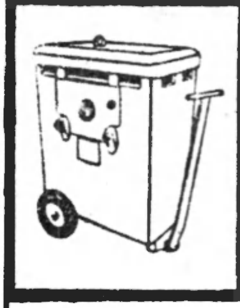
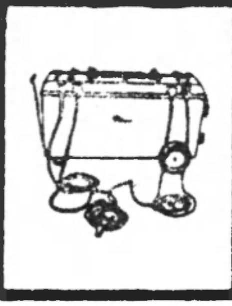

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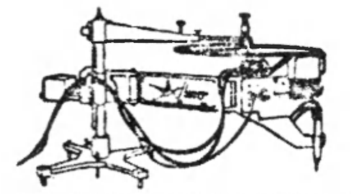
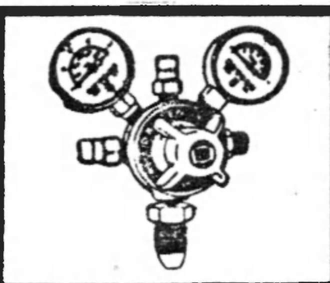
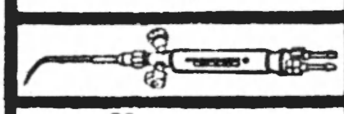
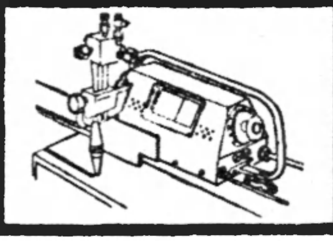

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