KEY-NOTE ADDRESS

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"WELDING : IT'S PRODUCTIVITY, QUALITY CONTROL AND VALUE ENGINEERING"

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I am honoured to have been invited to deliver the Key-note address at this Silver Jubilee Seminar of IIW, Calcutta Branch, and I am thankful to the Institute for giving me an opportunity for sharing my thoughts with you on this very important occasion, on the subject of "Welding, It's Productivity, Quality Control & Value Engineering".

In our country, since the first indigenous commercial manufacture of welding electrodes in 1947, welding has played a very important role in the growth of the fabrication industries and has made significant contributions to the overall development of the Indian Industrial scene. We are self-sufficient in almost all conventional welding, cutting, repair and reclamation processes. The majority of consumables and equipment to support these are manufactured indigenously. But when we survey the current international status of technology, we find that certain distinct technological gaps exist in our country where it will be necessary for us to substantially augment the total area of Welding Development, not only in its qualitative content but also to the extent of its appreciable use in the industry to improve the productivity and quality of welded fabrication. Perhaps a time has now come to review the situation and we are here today to address ourselves to a few significant issues related to defining the tasks ahead and to achieve results within a reasonable time frame.

Welding Technology in the industrially developed countries strives in a highly competitive scenario with the ideas of quality and productivity becoming ever more important. The extensive use of welding mechanisation has helped the realisation that weld joints made with the precise and repeatable control obtainable require far less inspection than man-made welds. The use of large-scale integrated electronics has now taken over more and more manual functions, resulting in very accurate controls on the heating effect of the welding arc and on the traditional weld quality parameters. Coupled with this the increasing use of easily mechanisable welding processes using continuous consumables has helped in achieving very high productivity levels with almost negligible weld defects and these have now become the key areas of success in today's Welding Management.

In view of the serious challenges being faced today by our indigenous fabrication industry and particularly in our Eastern region, it is imperative for us to recognise that we must also bring about rapid changes in our fabrication technology to remain competitive.

Welding Technology is born out of a 'Synergism' of materials, fabrication process and design engineering. Synergism, by definition is "Mutually co-operating actions of separate substances which together produce an effect much greater than that of any component taken alone". Welding, being a multi-disciplinary technology, demands concentrated efforts of engineers of various fields in co-ordinating their expertise for achieving the ultimate result. Synergism is thus a key factor in progress of welding technology and we need to keep this requirement sharply in focus. I will now deal with the individual components of this synergism i.e. the Fabrication Processes, Materials, and Design, with a view to identifying the work areas where we need to move forward to meet the challenges ahead.

FABRICATION PROCESSES

Fabrication engineering evolves from the use of the various welding processes. It also demands that a fabricator is able to identify the design details which may cause difficulties in fabrication and at the same time appreciate the necessity of effective quality control to limit weld flaw severity.

When we look at the advanced nations we find that revolutionary changes have taken place in the transition from Manual Arc Welding to MIG/MAG Welding measured in terms of percentage of deposited weld metal.

The table below gives the comparative use of the different welding processes in India and the developed countries.

Welding Process	Percentage share in weld metal deposited	
	India	Developed Countries
Manual Metal Arc	79	20
Submerged Arc	7	8
Gas Metal Arc (MIG)	12	70
		50 - Solid Wire
		20 - Cored Wire
Gas Tungsten Arc (TIG)	2	2

Also the evolutionary advancement of the basic MIG, TIG and Submerged Arc Welding Processes has seen the advent and increasing use of Narrow Gap Welding, Single Sided Welding, Pulsed Synergic Control Systems, use of Seam Tracking and Arc Control Devices. These involve widespread use of solid state electronics and microprocessors. The other trend is the increasing use of Automated Welding and Welding Robots.

In the context of Gas Shielded Arc Welding processes it is not often realised how important a role the shielding gas can play in determining the quality and cost effectiveness of a welded joint. Today over 90% of the gas metal arc welding in developed countries is done using Argon based gas mixtures. More recently Helium based gas mixtures have been developed which give excellent results for GMAW & GTAW of stainless steel, aluminium and other nonferrous alloys.

These gases which are generally binary and ternary mixtures of Argon, Carbon Dioxide, Oxygen, Helium, Hydrogen etc. give reduced wire consumption due to reduction in spatter and less convex bead geometry. They improve weld productivity due to higher welding speeds and also the metallurgical quality of the weld due to higher alloy recovery. With the dramatic improvement in Argon availability in the country such gas mixtures are now readily available and Indian fabricators should exploit them to increase productivity and reduce costs.

If our aim is to improve the weld quality and productivity while simultaneously achieving material and energy conservation at the National level we shall have to increasingly use Thyristor, Transistor and Inverter Power Sources with feed-back mechanisms which not only provide higher electrical efficiency with very stable output but also facilitate Pulsed Arc Techniques and advanced controls. The present connected load of welding machines taken together in our country comes to a staggering figure of around 2500 M.W., whereas the utilisation is very low, leading to high no-load losses as well as low power factor. This is a problem of national importance which can only be solved by use of large-scale power and control electronics. We should aim at least for a 15% saving in the energy consumption by using these improved power sources. At the same time, for quick adoption of such solid state power sources by the general industry, the equipment manufacturers should ensure that these do not become too expensive for use in our country.

Although considerable effort has been directed in our country by both the welding manufacturers and users to improve the percentage of weld metal deposit from Manual Metal Arc to other higher productive processes, we are yet to feel the impact of this transition in real terms of economic benefit. We have to assess the future needs of the user industry sectors like Power, Transport, Shipbuilding, Petrochemicals, Fertilizers, Earth Moving and Mining Industries and then identify the gaps in technology and input resources related to higher productivity processes which will have relevance and impact in the context of our own socio-economic situation.

With the exception of the Friction stir process for Longitudinal Welds in Aluminium and copper based alloys and extension of the Laser Beam process for cutting, heat treating and surfacing in the auto industry, the development of any new major welding processes is not foreseen in the near future, which could significantly overtake the existing ones at the international level. We can, therefore, consider certain action areas for our immediate attention, namely :

- Accelerate the conversion from Manual Metal Arc to semi-Automatic and Automatic Gas Metal Arc Welding Processes.
- Apart from the inherent lower productivity of the Manual Metal Arc processes, we are all aware that there is a substantial wastage in the use of stick electrodes by way of stub-end losses. This could be in the region of 12 - 13% of the deposited weld metal which in monetary terms is over Rs. 10 crores per year in India. We should, therefore, aim for conversion from manual metal arc to semi-automatic or automatic processes to reach a ratio of 60 : 40 in five years from the existing ratio of 80 : 20.
- Use of Argon/Helium based shielding gas mixtures.
- Increasing use of work handling devices, welding manipulators, positioners and so on.
- Increasing use of narrow gap joint geometries in heavy sections to achieve substantial economy and minimise distortions.
- Introduction and wider use of Solid State Power Sources and other electronic controls which will be required to support these processes.

MATERIALS

Welding in the ultimate analysis can be considered to be a branch of Materials Technology. Over the last two decades there has been a quiet revolution in the development of new materials, such as ultra high performance steels, composite materials, ceramics and plastics. Such developments have been driven by the ever increasing need for improving performance and at the same time reducing costs and in turn hold the potential for improving the quality and competitiveness of fabricated products.

In the automobile sector, sea changes have taken place, where several aluminium alloys and MMCs are tending to replace steel not only for the body but engine blocks, crankshafts, leaf springs etc. In fact, Opel have brought out an all aluminium car with extensive use of Aluminium - Lithium alloys. The steel makers on the other hand are investing heavily to develop newer steels and cost competitive steel designs.

All these developments are leading to extensive application of laser systems, adhesive bonding, friction stir welding and robotisation. For non-metallic materials eg. ceramics, diffusion bonding, electron beam and laser welding and vacuum brazing have been successful. In fact, successful commercial utilisation of any new engineering material will largely depend on its amenability for joining with itself and with other materials, without losing its special properties.

In India, the use of high strength low alloy steels in general fabrication has gained momentum and the steel mills are investing large amounts in changing their product mix and improving their casting and rolling technologies specially for flat products. Use of these steels has the potential for considerable materials saving and cost reduction. The Nuclear and Aerospace industries are already weldng Titanium and zirconium and have started working with Ceramics and Composites. In the field of Defence there is a considerable requirement for welding of a range of ultra high strength steels. All these are adding further dimension to the demands on welding fabrication.

The other area of materials engineering deals with the conservation of materials in use by weld surfacing technology which provides the means of protecting the surfaces of engineering components that are subjected to some kind of impact and wear stresses or chemical attack in service. Whereas the basic requirements to achieve these objectives are being met by indigenous industry there is still a need to promote faster and better methods of weld surfacing by using flux and metal cored continuous consumables and Plasma spraying techniques.

VALUE ENGINEERING OR DESIGN

The best definition of value, for any product, would be fitness of purpose at the lowest cost. In this context we must appreciate, that it is the designer who holds the key to economic and high quality fabrication by selecting the most cost effective material which can meet the service requirements and the most reliable and highest productive process for joining it. The new high performance materials and high energy welding and brazing processes give tremendous scope for reducing section thickness, simplifying joint geometry and reducing weld metal. At the same time improvements in weld joint quality and reliability achieved by the mechanised processes using solid state power sources and feed back controls allows one to reduce the factor of safety in designing for a particular stress level.

In our country, we tend to use rather high factor of safeties of 4 or 5 whereas in the advanced countries this has been brought down to 2.5 to 3, thus achieving considerable economies in materials. If we have to attempt this we must be absolutely certain about the quality of the welds and joint efficiencies so as to take advantage of this aspect. I feel much more attention should be given to the area of 'Structural Analysis' in weld design.

In the area of "Value Engineering' the success of the design engineer very largely depends on his ability to innovatively use new materials and processes and at the same time to study and understand the failure mechanisms in the welds so that he can derive the economic gains by management of the "Risks of Failure". A designer cannot work in a vacuum : to over-design is a wasteful solution and to be ignorant of materials engineering and fabrication process and parameters is to face catastrophic failures or develop uneconomic welded designs and procedures which makes the industry uncompetitive.

One of the important issues one has to face while upgrading or changing Technology is the extent to which indigenous design and development should be encouraged seen against importing state-of-the-art technology. I feel, there is a role and need for both and we have to judiciously decide which technologies to import and which should be developed in India and this must be based on an assessment of investments involved and the time frame of development.

If one glances through the Welding Journals and Research Reports, one comes across numerous technological advancements, refinements and modifications taking place in various welding processes. But in real life only a few mature into significant processes which find appreciable application. The measure of our ability will be to pick and choose the right materials, processes and designs for their development and promotion in the Indian context.

WELDING EDUCATION

We have so far discussed certain areas of Welding Technology based on the Synergism of Materials, Fabrication and Design. Perhaps one of the most important issues that cuts across the boundaries of these constituent sections is the availability of suitably qualified and trained manpower at all levels of the Industry.

The explosion of knowledge and information particularly in the areas of science and technology, makes the learning a person receives during his formal study programme obsolete in an incredibly short span of time. Any professional is affected by obsolescence of knowledge. The half-life of knowledge in the fields of sciences and engineering is said to be about 5 years. It seems that a vigorous effort has to be made to keep the knowledge base updated.

Welding education is a key area where we need to concentrate on more than one level, since welding technology has not only become highly sophisticated but also extremely specialised in nature and has now reached a stage where it can claim to be a separate discipline of engineering. Welding engineers now-a-days are using experts systems as a part of artificial intelligence of the machines, image processing techniques and neutral networks for better and better performance, repeatability and reliability.

Whereas stress should be given on the availability of suitably structured courses and training for welding engineers, I feel an even higher priority needs to be given to augmenting facilities for education of front line shop supervisors, welders, quality control inspectors and maintenance personnel. All these people need to appreciate to some extent the theoretical concept of the process he is dealing with and his role in ensuring its successful application.

In this context, given our present situation, continuing education courses appear to be the best strategy and it is necessary to have a close interaction between the industry and academic institutions to develop proper course curricula to meet the industries' needs. There should also be exchange of personnel to provide for an experienced faculty.

I would like to commend here the excellent work done by the Jadavpur University, Metallurgy Department for organising such courses for the first time in the Eastern region. I think your Institute should continue to promote provision of more such continuing education opportunities in association with such I.I.Ts/ engineering colleges who already have Welding as a distinct academic discipline.

Gentlemen, I have attempted to underline certain broad directions in striving towards improvement in the areas of Welding Productivity, Quality and Value engineering. I don't think anybody would venture to provide a simple and ready prescription on any technology upgradation in as complex an area as welding. We must appreciate that any technological change is driven by market forces. In India today we are seeing an increasingly open and competitive market. This is a healthy trend and it will be the fabricators' need for having high productivity and at the same time cheaper and better quality welds which will act as the main catalyst for this technological change. Our overall success on moving towards higher technology will very largely depend on how we collectively recognise this need, get ourselves genuinely committed, and accept developmental challenges for achieving our objectives. Here I return to the theme of Synergism. Let us be very clear in our minds, Gentlemen, that no technological change or advancement in welding will take place unless all the related aspects of process materials, fabrication, design, inspection, testing, and manpower move forward in a well co-ordinated manner to achieve the quantum jump in productivity and quality that we are aiming for.

I am sure that this Silver Jubilee Seminar will provide the right forum for working towards this integration which will lead to enriching our knowledge towards our pursuit for excellence.

I wish this Seminar a great success.