An Approach to Best Welding Practice

S. K. Gupta - B.E., C.E., FIE, FIIW, MISNT, MAE, MITD

1.0 INTRODUCTION

Today product innovators and entrepreneurs want the designers, technologists and engineers involved in manufacturing and fabrication to produce the intended marketable product in the shortest possible time with superior quality and at the least cost.

Today Welding is the major and special process used by the Manufacturing and Fabrication industries producing wide range of products starting from nano components and assemblies to giant ships, bridges, tunnels etc. involving wide range of materials. In brief, meeting with the wide ranges of demands there is now a proliferation of welding processes, techniques, machinery and equipment, consumables and operators available in the market.

But ultimately what counts to the manufacturers are matching the growth of the demand, cutting down the cost of production and meet the customer satisfaction for quality products with almost an instant delivery schedule coupled with a financial stable bottom line.

It is therefore imperative that to meet the above mentioned critical criteria in the system and the process of manufacturing the Best Welding Practice has to be adopted and applied with efficiency and effectiveness.

The BEST PRACTICE in welding can be simply defined as the most EFFECTIVE and EFFICIENT method to weld a joint. The term "EFFECTIVE" refers to the method which utilizes the resources to the optimum extent and the term "EFFICIENT" refers to the method of Right First Time with minimum wastage. In addition an approach for Continuous Improvement will pave the way for adopting the BEST PRACTICE in Welding.

The GOAL of best practice in Welding :

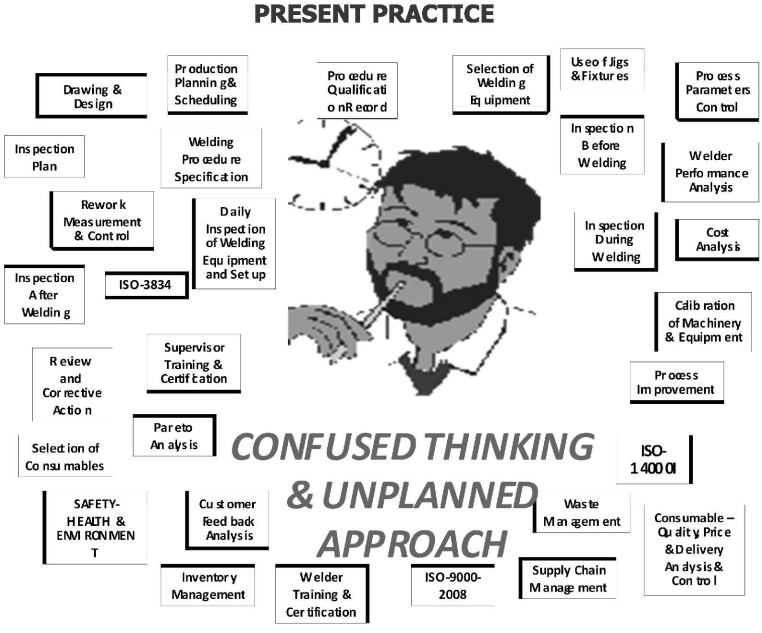
To produce what the customers want, when they want it, exceeding their quality expectations, while being productive, profitable and safe.

CRITICAL ELEMENTS

The elements on which the best welding practice depend can be specified as under :

- Product Life Cycle.
- Design of the product and the process of design.

PRESENT PRACTICE



- Market Demand and Business Strategy.
- Materials and Preparatory Processes.
- Machinery and equipment, type and operating level.
- Gases / Mixtures of Gases, their storage and supply.
- Inspection system of the items 5 and 6.
- Operator Training and Certification Level.
- Production procedure, systems, monitoring and control.
- Management Systems of Production Planning, MIS, Quality Management, Materials Management, Cost Management, Waste Management & Control
- Innovation and continuous improvement.
- Safety – Health – Environment control.

In fact, the above mentioned elements can be broadly grouped under :

- Business Strategy covering Product Design, Design Methodology, Product Life Cycle and Technology to adopt.
- Linking the Technology adopted, the Engineering is to be detailed out as machinery, equipment, process, consumables and operator skill to produce to specifications.
- Management of the Production – Operation systems for effective and efficient utilization of Resources.
- Quality Management and Continuous Improvement.

There is every reason to face such a situation from Order Receipt to Dispatch in the Supply Chain if advance planning accompanied by a technical expert (welding) inputs is not arranged. One may examine one aspect in the total length of Supply and Operational Chain – DESIGN to the variable factors it is subjected to for selecting a suitable and possible process.

Design of a product can be made by any one of the following methods :

Design of a product can be made by any one of the following methods :

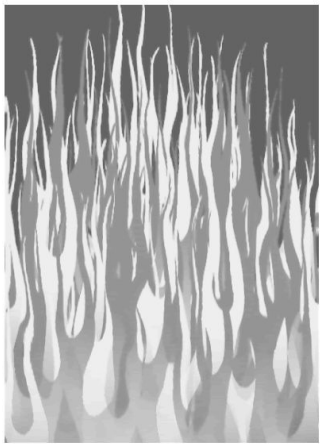
1. On the Drawing By The Thumb Rule (Unsafe ?)
2. Manual Calculations with High Factor of Safety (Over Design)
3. Computer Aided Design (Depends on Technical Expertise)
4. Three-dimensional Modeling and Steel Plate Integration
5. Combination of above methods

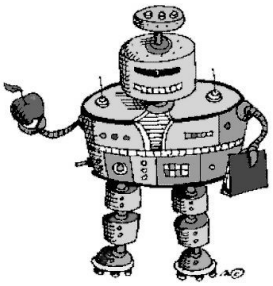
Selection of a method will again depend upon :

1. Life Cycle of the Product – also on which part of the life cycle – Initiation, Growth, Maturity or Decline ?
2. Volume of Demand – Low–Medium–High ?
3. Criticality of the Product usage.
4. Price offered by the customer / market price.
5. Infrastructure available / To be made available.

RESULTING FIRE FIGHTING AT ALL STAGES ESPECIALLY MATERIAL PROCUREMENT AND MANUFACTURING.

NORMAL PRACTICE IS BY FIRE FIGHTING AT ALL LEVELS ESPECIALLY AT THE OPERATIONAL OR SHOP FLOOR LEVEL TO GET THE JOBS DONE BY ANY MEANS





6. Others
7. In the similar way, Decision to frame WPS, conduct PQR, Process Design and Planning, Selection of Machinery and Equipment, Quality assurance and Inspection, Training and certification – in fact all the above mentioned twelve Critical Elements are to be examined for deciding a CONGRUENT methodology to work upon.

FOCUSSED THINKING AND A PLANNED APPROACH WITH DEDICATED TEAM MEMBERS IS THE SOLUTION

A Step By Step Approach on the KEY ELEMENTS will provide a directive and pathway to start and move.

Step – I.

The Best Practice in Welding starts with the Product Design and the following points are to be examined thoroughly for review and may be seeking for alternate design :

- Material of content
- Joints type – in tension, compression, shear or combination
- Weld size
- Positional approach
- Inspection and Testing requirement

Step – II.

Once the Design is FROZEN, the immediate next is to prepare the Welding Procedure Specification (WPS). All the welding parameters to include :

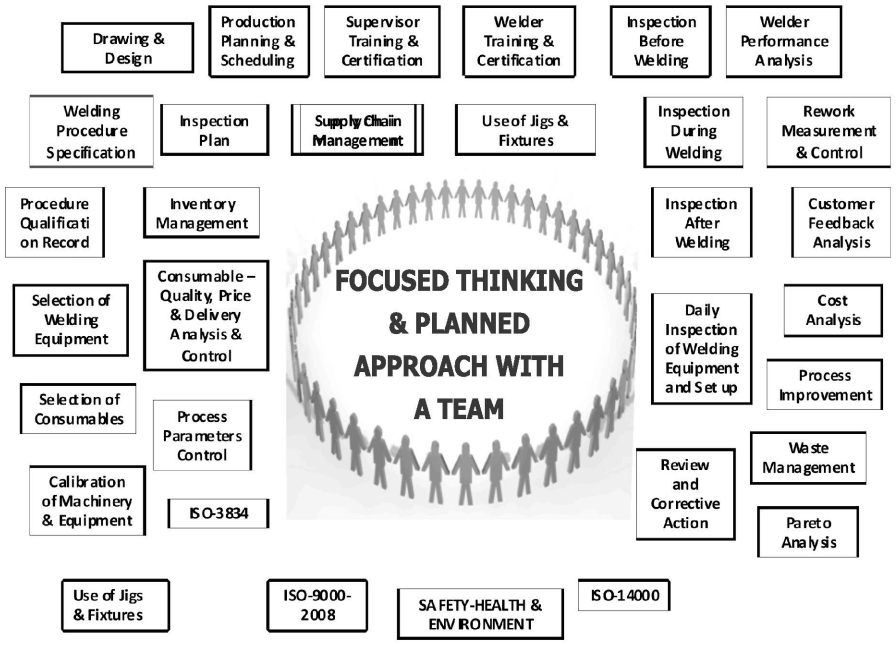
- Welding Position, Weld size, Current, Voltage, Welding speed, Number of Passes, Consumables, Joint Preparation, Pre-heating and Post weld heat treatment etc.
- At this stage the Welding Engineer tends to follow a pattern set in the previous Joint / past experience for playing safe.
- Past experience, coupled with updated knowledge of shop floor practices and problems and the End Result obtained earlier must be used NOW.

Step – III.

The Joints must now be tested as per Specifications / Codes to consolidate and validate the parameters and the process set in WPS to form the Procedure Qualification Record (PQR).

- This PQR must be followed in totality for the Best Practice. This author is discussing it from the start.
- PQR must not be treated as a Document only. It must be used in Operational Practice religiously.
- WPS as qualified must be displayed at the shop floor locations where the welding will be done.

WHAT IS THE NEED TO APPROACH FOR THE BEST WELDING PRACTICE



- Supervisors, Welders, Inspectors must be thoroughly acquainted with WPS and PQR.

Step – IV.

A number of Positive actions must be initiated for implementation at Planning and Management Systems to include :

- Production Planning, Scheduling, Material Planning – in fact Supply Chain Management concept and application is wanted.
- Material Management involving Material Purchase and Inventory Management must be technical knowledge oriented rather than Vendor Influenced.
- Systems Management and Control as in ISO 3834, ISO-9000, ISO 14000 as Operational Support Systems.

Step – V.

The most important part in Best Practice in Welding is played by Operational Team at the Workplace.

- This starts with the Machinery and Equipment to be used. The selection of the machinery and equipment for the welding to be done effectively and efficiently should not necessarily be made on the basis of most sophisticated or expensive machinery and equipment, but on their appropriateness of the application to meet the requirement. It is not always necessary to deploy Synergic Pulse MIG or Robotic Welding in all types of welding for Fabrication or Manufacturing Operations.
- USE THE MOST AFFORDABLE & APPROPRIATE MACHINERY AND EQUIPMENT

Step – VI.

The Best of Equipment will not be able to instrumental in producing Best Practice. It needs :

- Periodical Calibration.
- Every beginning of shift inspection
- Protection from Weather and Vandalism
- Proper Earthing System for all types of Power Sources.
- Stable Power Supply at correct Frequency.
- Immediate Repair and Maintenance on detection of Faults.
- Upgradation / Replacement as the need be.

Step – VII.

Best Welding results from Best Inspection Before and During Welding.

- Before welding inspection will ensure proper joint preparation and fitment, correct use of clamps in Jigs and Fixtures, specified positional welding, pre heating if prescribed, correct setting of Gas inflow, electrode tip shape and size, etc.
- During welding inspection will ascertain use of correct / specified current, voltage speed, weaving, gas pressure and flow, maintaining welding position, filler rod feeding rate, interpass temperature, interpass weld cleaning etc

Step – VIII.

In pursuit of Best Welding Practice one of the most important and essential step is the development of skills of the supervisors and welders. Both are complementary in work situations and as such both are to be developed in :

- Knowledge
- Mental and Manual Skills
- Attitude

Skill Development is a continuous process Off the Job and On

Step – IX.

An important and effective step to achieve Best welding Practice is Quality Control and Inspection. The targets of QC & Inspection should be :

- Defect Identification and advise Rectification measures.
- Apply Statistical Methods in repetitive welding processes especially in Spot Welding.
- Generate KPIs for Weld Quality Performance and circulate to all concerned for target achievement.
- Propagate Quality as an uncompromising Work Culture.

WELDING PROCESS IMPROVEMENT AND WELDER PERFORMANCE EVALUATION

Planning and implementation of an aggressive welding process improvement program to evaluate welding methods and develop and implement more efficient procedures where needed has to be carried out.

A welding improvement committee of employees and contractors directly involved with welding has to be formed with authority to implement improvement decisions.

The committee has to devise methods to measure quality output, and launch accountability standards, and research and implement new technology, providing innovative solutions to existing challenges.

Deployment of a Welding Manager who is highly skilled and experienced in all types of welding to evaluate existing methods and develop more efficient welding procedures is essential.

Designing and implementing new welding procedures as well as the developing measurement tools for studying welds and individual welders, designing and preparing Welder Efficiency Work Sheets are required to be introduced to the welding supervisors as the method to track weld footage and welder performance.

The welders in the shop floor are to be evaluated to determine the performance baseline. Difficulty factors are to be assessed to each weld job in order to determine the time required to complete each task. From this, a spreadsheet is to be developed to weigh the following factors: size of weld (3 mm, 6mm, 8 mm); difficulty factor based on kind of weld and location of weld; vertical versus overhead weld; length of weld; and actual hours worked by the employee. The result would be an efficiency rating for each welder.

This daily report allows the welding supervisors to evaluate their staff and make changes as required. In this way Welders will become accountable for their work quality and quantity.

Training and Certification programs by the Indian Institute of Welding is absolutely necessary to be implemented for Welders, Supervisors, Inspectors. These programs are Certified Welding Educator, Certified Welding Inspector (CWI), and Certified Welding Supervisor (CWS). As of September 2002, Bender has 17 CWSs employed in its shipyard. The IIW program teaches industry skills that include material and labor cost management. The training and certification programs educate welding supervisors in both welding quality and quantity issues.

WELD AND PRODUCT QUALITY

In Welded product manufacture, the terms LEAN and SIX SIGMA are far away cry till today and will take a long, long time to establish. The target for QUALITY as a measure of BEST PRACTICE must be NOT about scrapping defective parts, but scrapping defective operational methodologies. The result of the endeavour should be – doing the right things right, the first time, and every time. It is a value adding function; which when built into the product, far from being an expense, becomes a powerful asset ascertaining the economic success of the company.

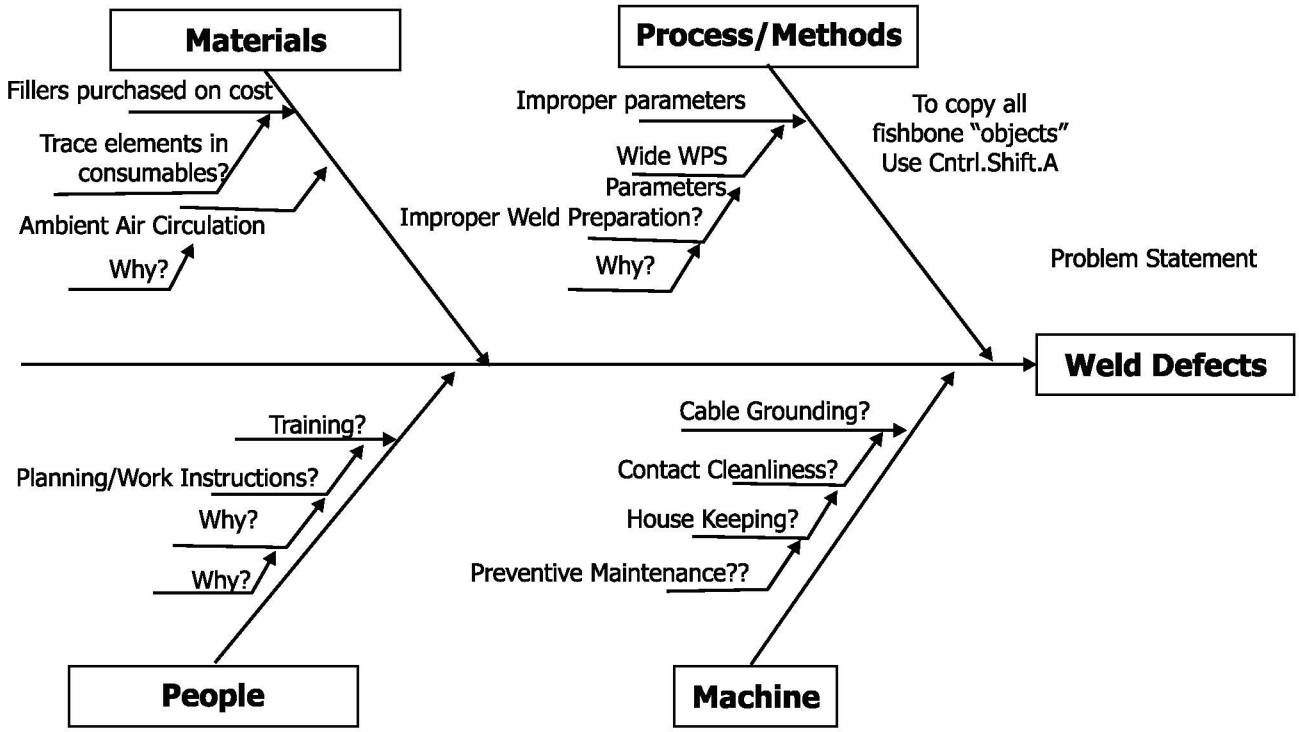
The focus, therefore, should be on preventing the occurrence of defects (process and material variations), instead of policing and repairing defects.

Weld Defects like Surface Porosity, Craters, Undercut, Oversize / Undersize, Unequal Leg Sized welds are most common and rectification is essential requiring additional cost of Consumables and Labour, not to talk about loss of Production and wastage of inspection time.

Statistical data collection and analysis methodologies with tools like FISHBONE ANALYSIS it is possible to identify recurring defects and thereby eliminating them. Cost of Poor Quality (COPQ) that masked as repair, re-work, set-up time or unplanned repetitive maintenance, does not show up on balance sheets, but eats away at the profit margins.

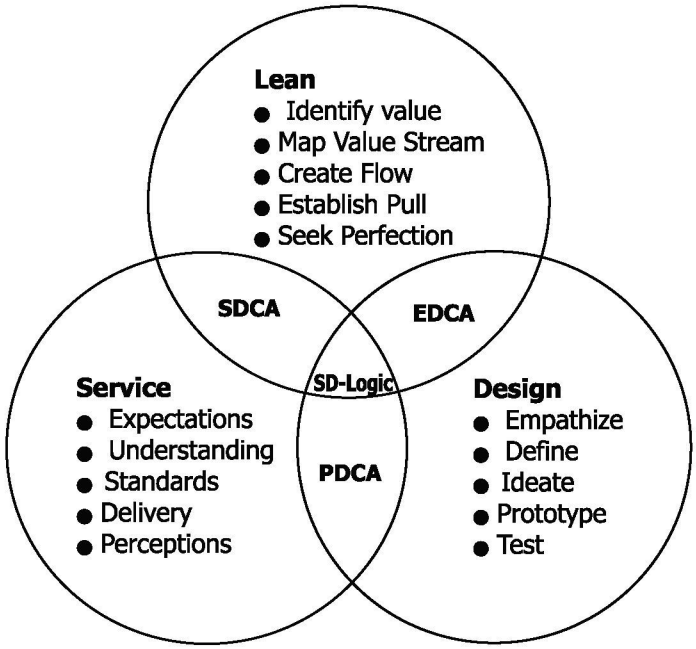
Waste Management in Welded Fabrication and Product manufacture, especially in repetitive production is essential. Lean Production Management in the area of Waste Management addresses Seven Wastes endemic in Production:

1. Overproduction. Poor planning leading to producing well over customer requirements, where the customer is also the next consecutive process. More raw materials are consumed and wages paid than necessary or planned,



Ishikawa Fishbone Diagram
Cause Effect Analysis

ELIMINATION OF WASTE TOWARDS BEST PRACTICE IN WELDING



resulting in procurement of extra inventory, additional material handling and reduction in storage space and restricted work space.

2. Unnecessary Stock. Poor scheduling, holding or purchasing excessive materials, lack of housekeeping or well defined material layout.
3. Inefficient Transportation. Improper or unnecessary handling. The number of material handling operations is directly proportional to the likelihood of damage to the vessel or piping spool.
4. Unnecessary workforce motion. Time lost in searching for materials and tools, out of immediate reach of the work station, as well as, Non productive/non value adding operations such as re-work and defect repair.
5. Waiting time – waiting and queuing for the next sequence in the operation, typically when the flow of material (scheduling and housekeeping of raw materials), and information (process parameters, client specifications, traceability documentation etc) availability is poor.
6. Rejects and Defects. This waste goes beyond the items rejected by quality control before shipment. Rework and re-testing may be required to make the part usable (code acceptable), increasing labor costs. Additional labor may be required for disassembly and reassembly, sorting the defective from acceptable parts. Additional materials may be needed for replacement parts. As such there is a cost escalation in both materials and manpower.
7. Inappropriate Processing. Producing scrap and/or parts (either because of lack of traceability or lack of definitive work instructions) that require rework and repair.

Identifying and eliminating wasteful processes is, therefore, the Best Practice that, when implemented, increases the work flow and production capacity without an increase in capital or operational costs. This LEAN methodology of continuous improvement, accelerates product delivery, combats budget overruns and perpetual over time and delivers a quality product appreciated by customers. The end result is improved cost competitiveness and business profitability.

CONCLUSION

Most of the Welding Practitioners confine their thinking and activities to the Weld Production Back Up and the Weld Production. Under prevailing circumstances at the shop floor Welding Engineers have limited scope to hold their views to prevail. It must be made absolutely clear to the Production Manager, Shop Floor Supervisors, Inspectors, Contractors and the Operators that:

QUANTITY MUST BE PRODUCED WITH QUALITY AND THAT CAN BE DONE AT THE LEAST COST PROVIDED ONE FOLLOWS THE APPROACH TO BEST WELDING PRACTICE EFFECTIVELY AND EFFICIENTLY.