Why Simulator for Welding?

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Welding is a process of metal joining in which both parts to be joined and filler metal if used are melted in a particular direction and allowed to solidify as welding progression happens in the chosen direction. Sometimes position of welding is having benefit of gravitational force sometimes it is not having much of an impact and sometimes it makes a serious impact.

Process of welding, material type and thickness, type of joint are some of the other critical variables. Ability of welder and welding operator to deposit consistently same bead and maintain heat input and protect weld from contamination etc also makes an impact on quality of the joint produce.

In short there are number of variables, and one need to choose the right parameters to get a sound defect free and distortion free weld joint. Fixtures and accessories used in welding setup or during and post welding may impact on control of dimensions and protection and access during welding and can leave behind stresses in the joint, which may show up after part or assembly is removed from the fixture.

On the other hand, we have strict control over time and budget, materials for mock ups or try outs takes time and money, leanings need to be re-evaluated by conducting one more trial and so on.

In competitive market like today where both money and time is limited, and quality expectations are very high or in other words these are the parameters which helps you identify as a special knowledge-based manufacturers. Secondly advancement in digital technology, capability to build mathematical model and SOFTWARES to solve it by imposing various constraints conditions as explained above is possible and in many areas of mechanical design it is proving to be very useful and accurate. So, industry started working on weld simulations by cross functional teams from material sciences, mechanical and computer engineering, and then various models and SOFTWARES to solve by imposing constraints started getting developed. In earlier days over a period and by sharing experiences over few generations we captured the data and using simple equations and physical constants like thermal coefficient of expansion, young modules, thermal conductivity, density, viscosity at various temperatures, stiffness due to form , thickness and shape, process followed to get up to the dimensions, type of joint, we use to do fundamental calculations at few nodal points. For example, if you are joining carbon steel cylinders of 10 mm thickness and 2 mt diameter we will provide 0.5 mm per meter length of cylinders per joint. Nozzle of 6-10" dia and thickness of 6-10 mm will shrink by 1 mm, ray support rings of 5/6 mm welded over 270 deg will shrink length by 1 mm for 10 mm shell in carbon steel. However these are all approximations and to put all the constraints discussed above and solve for each joint or equipment was talking too much time and still it was not very accurate.

Similarly measuring most critical and essential variables in welding like current, travel speed, voltage, gas flow rate was a marathon activity. Today use of electronics in welding power sources and its accessories, manipulators for relative movement in job and welding head, has made it simple, material characteristics are available in soft format and with models available for large number of alloys used in fabrication has made manual calculations very tedious and not required as mechanical or structural stability SOFTWARES are readily available. Now super imposing material Science data and validation by conducting large trials can perfect welding simulation. AI needs to be established after conducting series of experimental by scientific way WIP lead to perfection in welding and that will require first to define the problem, with current QCD parameters and what is desirable. Use of IoT to ensure that variation is minimum and if happens it is captured and notify.

I am sure we have exciting times ahead of us to perfect this art of welding in science and monitor production jobs and simulate new geometries, materials, for dimensions and quality.