# TREE DIAGRAM FOR IMPROVING THE QUALITY OF WELDED SUBASSEMBLIES

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**ABSTRACT:** *In this paper the authors present the application of a modern tool of quality management for improving the quality of welded subassemblies. A tree diagram has been developed which illustrates the measures needed to improve the quality of welded subassemblies. The proposed measures were based on a preliminary study of the causes which generate welding defects.*

**KEYWORDS:** welding process, quality, tree diagram

## 1. INTRODUCTION

Today, with the development of technology, the development of welding technologies continues. In this way, at the international level, research and development efforts are underway to improve the quality and properties of welding and to reduce welding costs. At present, welding technology has an essential and irreplaceable role in the manufacture of many products. Welding technologies are used in almost all important industries: car manufacturing, the manufacture of equipment and tools for the navy, the manufacture of aerospace ships, the construction of industrial halls, the petrochemical industry, etc.

Recently, there is also a concern of researchers for the development of sustainable welding technologies. Thus, 3 research directions were defined: innovative welding technologies, environmental impact and social aspects. A paper presenting innovative welding technologies is [1] in which the authors present the use of ultrasound in the welding process. The works [2, 3] present studies on the impact on the environment and the social impact of some welding processes. In other papers, such as [4, 5, 6], interesting studies on the impact of welding processes on environmental pollution are presented.

In engineering practice, in the stages of design, manufacture, inspection and operation of products, safety issues must be considered. It is well known that most modern technologies cannot provide zero risk. In the manufacture of welded metal structures, the paper [7] highlights three sources of risk: improper material, inadequate welding and deviations from the execution documentation.

The issue of welding defects and quality aspects of welded products and subassemblies and have been studied extensively and the results of research are presented in many works in the literature. In the works [8, 9] are presented the factors that determine the quality/defects resulting in the welding process. Also, studies were performed on the internal stresses in the welding process and their influence on the quality of the welds, for exemple papers [10, 11].

The quality of welded products is achieved in every stage of life: design, selection of materials, manufacturing and final inspection. It should be noted that a high quality of the final inspection cannot compensate for previous mistakes made during design or manufacture. Moreover, it can be said that design and manufacturing are dominant factors on the quality of welded subassemblies.

In the technological process of welding execution, imperfections cannot be completely eliminated. Quality assurance systems have been developed to assess and control these imperfections known as weld defects. A detailed classification of geometric imperfections in metallic material resulting in the welding process is presented in the standard [12].

Based on the results obtained in practice, it can be said that in welded structures the most common types of defects are the following, [7]:

- Plane defects: lack of melting, cracks, incomplete penetration, material leakage, lateral notch, on the surface, at the root, concavity;
- Volume defects: cavities, solid inclusions;
- Shape imperfections: misalignment, uneven profile.

From the perspective of the quality of the welding process, we can discuss the control, assurance and evaluation of the quality of the welded constructions. In this sense, the classic and modern tools of quality management can be applied. Practice has shown that quality management tools are techniques that can be used successfully in various fields of activity. In this sense, we exemplify with the works [13, 14, 15, 16, 17] which present studies of the application of the Ishikawa diagram and the tree diagram in different sectors of activity. In this paper the authors present a modern tool of quality management - tree diagram, applied to improve the quality of welded products and subassemblies.

## 2. TREE DIAGRAM FOR IMPROVING THE QUALITY OF WELDED SUBASSEMBLIES

The realization of the diagram is essentially based on the extension of the concept of functional analysis promoted by the "Value Analysis" method. Thus, for the elaboration of a tree diagram we start from a topic of general interest and the possible solutions are investigated.

The tree diagram systematically approaches each aspect to solve a problem by finding the optimal solutions that are generally of the type of measures or actions. The elaboration of the diagram is done by going through the following stages:

- The primary measures for the direct solution of the proposed problem are identified and they form the level 1 branch;
- The primary measures become main objectives and for each of them the possible measures are sought that determine their solution. Thus the branches of the 2nd level are formed;
- The procedure is repeated and the branches of level 3, 4, etc. can be obtained.
- The diagram is analyzed in both directions, by verifying the relations between objectives and measures.

In this paper we propose the topic "Improving the quality of welded subassemblies" and try to answer the question "How can we improve the quality of welded subassemblies?". In this regard, we conducted a preliminary study on the potential causes that can cause defects in welded products. On this basis, we have identified several actions / measures that must be taken to reduce the causes that generate welding defects.

The identified measures were structured on three main objectives:

1. Proper design of welded subassemblies,
2. Proper manufacture of welded subassemblies,
3. Involvement of the management at the highest level in the problem of the quality of the welded subassemblies

Figure 1 shows the tree diagram elaborated for the studied topic.

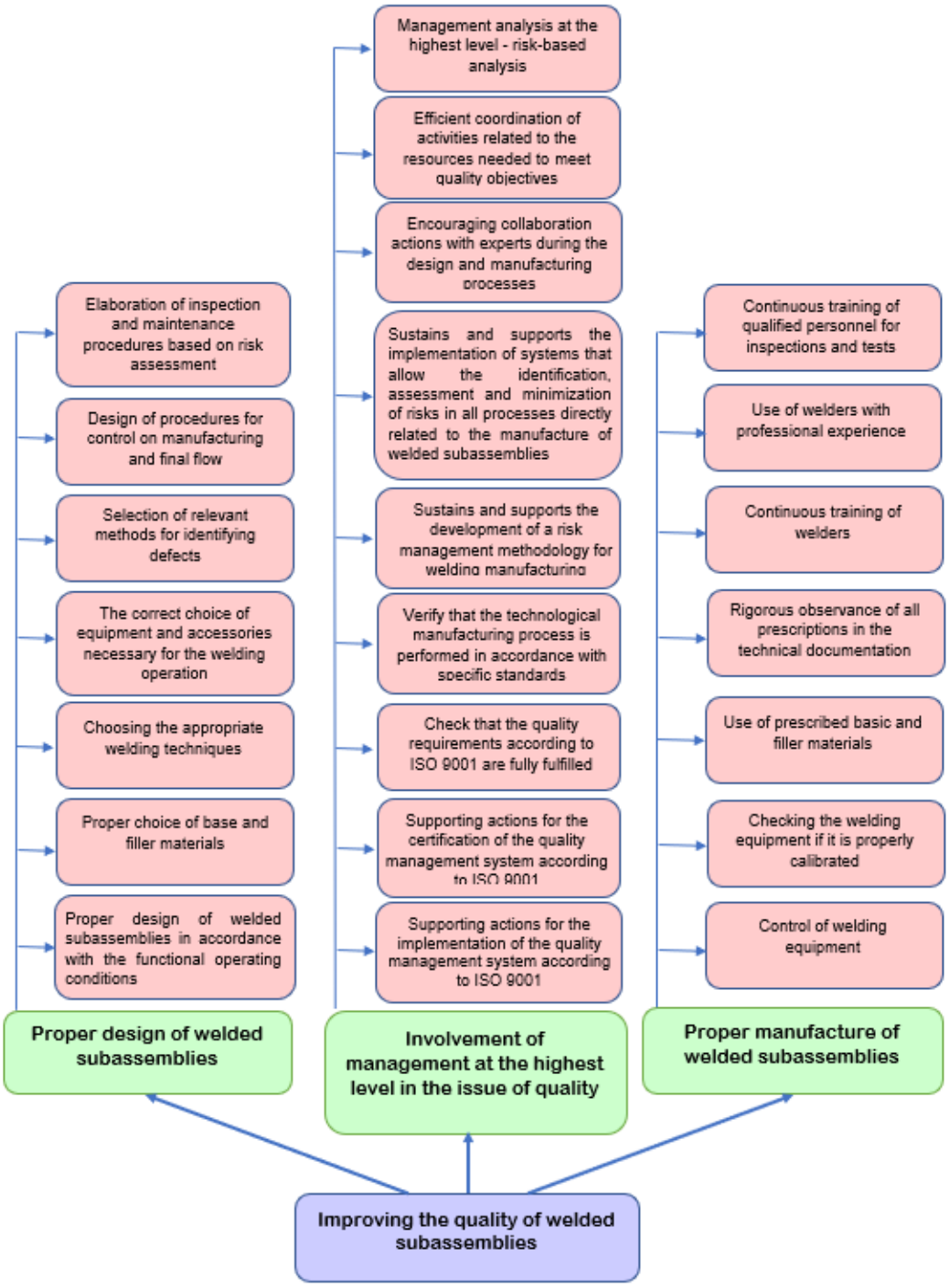


Figure 1. The tree diagram

## 3. CONCLUSIONS

The tree diagram developed to improve the quality of welded subassemblies can be used to reduce potential causes which generate defects. The proposed actions/measures have been grouped accordingly for three main objectives. The three objectives form level 1 of the diagram, and the measures proposed for these objectives form level 2. The studies can be extended and the proposed tree diagram can be developed on other higher levels.

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